

Faculty Sensemaking in the Enactment of an Equity-Orientated Social Belonging Intervention in Engineering

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This research paper explores how engineering faculty make sense of changes in the climate of their classrooms and their instructor identity after implementing an equity-oriented intervention that asked them to authentically share their own personal stories of struggle in engineering. Using semi-structured interview data from ten engineering faculty from two large public research institutions in the Midwestern United States, this qualitative study examines how engineering faculty made sense of implementing an equity-oriented social belonging intervention and how that sensemaking shaped instructional practices, classroom interactions, and perceptions of student engagement. A deeper understanding of how engineering faculty make sense of equity and belonging initiatives and how their mindsets shape classroom dynamics provides a foundation for scaling interventions like the one used in this study to foster more inclusive environments for underrepresented students. Furthermore, the findings highlight how faculty sensemaking shapes ongoing engagement with equity-oriented interventions and their continued enactment in engineering classrooms.

Introduction

This research paper focuses on the experiences of engineering faculty involved in facilitating a brief social belonging intervention aimed at normalizing typical struggle in introductory engineering courses. The intervention, built on previously studied belonging interventions [1], [2], encourages persistence, improves GPA, and enhances sense of belonging for all students, and particularly women, Black, Latiné, and Indigenous students [3]. Research demonstrates that sense of belonging is a crucial component of student retention and success in STEM [4], [5]. Belonging interventions are a common method to address this need, and support students in countering the culture of competition in STEM classrooms [6]. Research on intervention outcomes typically focuses on students (the intervention targets), but there is a need to also understand how faculty experience implementing belonging interventions. This paper responds to the dearth of studies examining how engineering instructors experience belonging interventions by examining how faculty who implemented an ecological belonging intervention describe their perceptions of themselves in their instructional role and in their interactions with students. This study was guided by the following research question: How do engineering faculty who implement a brief social belonging intervention describe changes in their instructional role, classroom interactions, and understanding of student engagement?

The Ecological Belonging Intervention and Instructors Who Facilitate the Intervention

The ecological belonging intervention used in this study extends prior social belonging intervention work and was contextualized for required first-year engineering programming courses as well as discipline-specific gateway courses for engineering majors across two institutional settings. Building on earlier interventions that taught students that typical adversity in college is common and surmountable (e.g., transition to college or the major, finding friends, time management, etc.) [7], the ecological approach shifts the focus from individual students to the social ecology of the classroom [3], [8]. Rather than being delivered in a laboratory setting, the intervention is implemented within carefully selected courses where known equity gaps in student outcomes in the courses exist in historic data by race/ethnicity or gender.

Equity gaps occur because of systemic issues rather than something particular about specific student groups, and in this work, we focus on testing how this intervention reshapes perceptions of struggle within the classroom culture for students and faculty. The intervention is delivered by course instructors during a single in-class session of approximately 40 minutes in the first week of the term. Grounded in the concepts of belonging uncertainty [1] and stereotype threat [9], the session engages students in structured reflection and peer discussion designed to establish a shared classroom norm that typical struggle in the course is both common and temporary, and that success is attainable with time and effort. Critically, the intervention leverages peer interaction among classmates who will continue working together throughout the term, positioning belonging as a collective, contextual property of the classroom rather than an individual disposition [10]. Our research to date has demonstrated that the intervention is effective during the first year in supporting belonging for Black, Latiné, and Indigenous (BLI) students and in reducing equity gaps in academic performance during the first year [4]. Our research has also demonstrated that BLI students who receive the intervention have improved help-seeking behaviors and are more likely to be retained in engineering into the second college year [11] and that women students who receive the intervention may have more positive self-efficacy [12].

Courses were identified for participation through the full research team's examination of institutional data to locate required engineering courses with persistent equity gaps by race/ethnicity or gender (refer to [4] for a description). In collaboration with department leadership, faculty teaching these courses were invited to learn about the intervention and the documented equity patterns in their courses, with these conversations intentionally framed to recognize faculty members' ongoing efforts to support students while situating equity gaps as structural and longstanding features of engineering education rather than individual instructional shortcomings.

Faculty elected to participate after learning about the purpose of the intervention, the evidence supporting its use, and the expectations for implementation. In the weeks just prior to the implementing semester, participating faculty completed a three-component training designed to support confident and effective implementation. This training included two asynchronous modules introducing the theoretical foundations of the intervention and step-by-step guidance for implementing the intervention in their classrooms, followed by a two-hour synchronous session focused on anticipated challenges, discussion of implementation scenarios, and peer exchange around issues such as managing student responses, navigating competing instructional priorities, and determining how to share personal experiences of struggle with students. Faculty who implement our intervention are prompted to share their own struggles on their academic path. This sharing is counter to traditional educational methods where faculty are positioned like the gatekeepers of knowledge, and work to earn legitimacy in the eyes of their peers and field, often refraining from sharing personal information within technical spaces such as the classroom. Faculty were also provided with course-specific implementation materials, including a customized lesson plan, intervention slides, and a timeline of actions, with training intentionally designed to minimize implementation burden and support faculty self-efficacy [13].

Review of Relevant Literature

In this review, we first discuss engineering faculty's professional training and development, followed by scholarship on student-faculty interactions and instructional practices that communicate norms about

struggle, belonging, and persistence in engineering. Taken together, these areas of the literature provide context for understanding faculty engagement with equity-oriented practices in engineering education.

Engineering Faculty Professional Training and Development

Teaching is a core component of faculty life, yet faculty often receive little training on teaching, and even less on supporting marginalized students [14], [15]. Earning a faculty position requires both technical knowledge and knowledge of how to navigate academic and professional spaces [16]. Engineering faculty often come to their positions through technical expertise and understand their primary role as introducing students to technical information and skills to foster their professional development [17], [18]. While some faculty come from an engineering education background, which focuses on the process of effectively teaching engineering content, they make up a small portion of all engineering faculty [19]. These differences in pedagogical training, and faculty perceptions of their roles and responsibilities complicates building faculty adoption of evidence-based teaching strategies [20], [21]. This work highlights that engineering faculty often enter teaching roles with strong technical preparation but uneven preparation for engaging equity-oriented instructional practices.

Studies of equity focused professional development indicate that engineering faculty are motivated and open to evidence-based practices to better serve students [22]; however, STEM faculty can view equity as outside of their realm of professional expertise and may need support finding connections to their discipline, and integrating the value into their teaching practices [23]. Engaging in equity-oriented teaching often involves faculty negotiating how such practices fit within their disciplinary identity and instructional responsibilities. Supportive learning environments can provide faculty with opportunities to develop pedagogical skills and rehearse how they respond to challenges that arise in classroom settings.

Student/Faculty Interactions and Sharing Stories of Struggle

Faculty interactions with students can be a crucial source of motivation for students [24], large class sizes pose a significant threat to meaningful engagement that is crucial for student retention and success [25]. Faculty recognition of student potential and encouragement to persist can be an important support for students [26], [27], which is made much more difficult in large classes. This type of support is especially important in disciplinary spaces in engineering, where there is an intense culture of competition and exclusion of students with marginalized identities [2], [28]. Instructional messages that frame engineering as a field where students must be exceptional to succeed [29], [30], [31], can discourage students in the face of struggle, signaling they may not have the inherent talents needed to succeed.

Faculty have successfully navigated the challenges presented along their academic journey; this experience provides an experiential knowledge that can be developed into a powerful pedagogical tool. Faculty draw on their own academic pathways as experiential knowledge that can shape how instructional norms about struggle, belonging, and persistence are communicated to students. For junior faculty or faculty with marginalized identities who already face biases and stereotypes which challenge perceptions of their ability [32], [33], this process of sharing vulnerably may be especially challenging. Understanding how engineering faculty navigate these tensions is critical for examining how equity-oriented instructional practices are taken up and sustained in engineering classrooms.

Positionality

The authors of this paper are a subset of researchers working on a larger intervention project [10], who partnered on this paper out of an interest in the perspectives of instructors, and their responsibilities in the classroom. As an author team, we brought our varied personal experiences, perspectives, and understanding of the importance of enhancing diversity, equity, inclusion, and justice in engineering to this study. Our team includes individuals who identify as white women and a nonbinary Latiné member. Some of us are faculty members who have been engaged in the design and study of the intervention, of which some are engineering educators, and others are graduate students who joined the project along the way. Our academic and research training spans engineering education and higher education, introducing variability with our familiarity with engineering disciplinary culture and norms. Some of us have expertise in the study of faculty, while some focus on students. The variance in our identities, teaching experiences, and areas of expertise helped us to collectively develop this study. During the data analysis, we spent time iteratively and collectively discussing evolving interpretations of the data and approached the narratives that faculty shared with reflexivity, humility, and curiosity when developing this manuscript.

Methodology

Participants

This study draws on interviews with ten engineering faculty who attended our research team's three-part training and implemented our ecological belonging intervention in their engineering courses, seven implemented the intervention in a first-year engineering programming course, and three in a second year courses within specific engineering disciplines (Table 1). Faculty were recruited from two large public research institutions in the Midwestern United States and taught courses with documented equity gaps between BLI and/or women and non-binary students and their peers. All participating faculty completed the full training to support fidelity of implementation and participated in two semi-structured interviews. The first interview occurred shortly after implementing the intervention, and the second took place at the end of the semester. Interviews probed faculty perceptions of the intervention, including reflections on implementation, observations of student responses to the intervention, and any changes faculty noticed in student engagement or attitudes. The protocol also explored faculty mindsets and approaches to teaching, particularly in relation to student struggle and instructor's responsibilities to support equity in their classrooms. Interviews were conducted either in person or via Zoom and ranged from approximately 30 minutes to one hour.

Data Analysis

We followed Braun and Clarke's [34] approach to reflexive thematic analysis to identify patterns across faculty interviews. Two members of the author team began by familiarizing themselves with the data, independently reviewing interviews from two participants and writing analytic memos to capture emerging insights. These authors then met with the first author to discuss initial codes and calibrate their coding approach. The remaining interviews were divided between the two members who made up the coding team and were coded independently using open coding to capture emergent themes across faculty participants. Coding focused on how faculty interpreted and described their experiences implementing the intervention, reflected on their instructional role, and made sense of changes in classroom interactions and

student engagement. Following this round of coding, the full author team met to refine and solidify themes through iterative discussion.

Table 1. Participant Characteristics

Pseudonym	Institution	Gender	Discipline	Implementation
Brian	Mid-Atlantic U.	Man	Mechanical/Materials Eng.	Spring 2024
Bridget	Mid-Atlantic U.	Woman	Chemical/Petroleum Eng.	Fall 2023
Daphne	Midwestern U.	Woman	First-Year Engineering	Spring 2023
Lawrence	Midwestern U.	Man	First-Year Engineering	Spring 2023
Lewis	Midwestern U.	Man	First-Year Engineering	Spring 2024
Matt	Mid-Atlantic U.	Man	Electrical/Computer Eng.	Spring 2024
Miles	Midwestern U.	Man	First-Year Engineering	Spring 2024
Shana	Midwestern U.	Woman	First-Year Engineering	Spring 2023
Whitney	Midwestern U.	Woman	First-Year Engineering	Fall 2023
Zachary	Midwestern U.	Man	Materials Eng./Engineering Ed.	Spring 2023

Findings

Claiming and Negotiating Power Through Story

Faculty used sharing their own stories of struggle as a pedagogical resource to shape how students understood belonging, persistence, and success in engineering. In implementing the intervention, participants made deliberate choices about whether and how to share personal experiences related to academic difficulty, identity, or not fitting within engineering spaces. These moments of disclosure were described as both agentic and vulnerable, requiring faculty to navigate how their own histories could be brought into the classroom in ways that supported students while maintaining their role as instructors.

For some participants, this process involved reflecting on longstanding struggles with belonging and identity in engineering. Shana, for example, described feeling misaligned with dominant expectations of who belongs in engineering throughout her education:

All along though, I felt like in my undergrad and my master's, I really struggled with my own personal identity as an engineer. And I felt I never felt like I really melded or belonged in the space. (Interview 1)

Drawing on their own experiences of struggling with belonging and identity in engineering, faculty framed struggle as a normal and surmountable part of becoming an engineer. In doing so, they positioned themselves in the classroom as individuals who had encountered similar challenges.

At the same time, participants varied in how they understood and narrated their own experiences of adversity. Miles (Interview 1), for instance, reflected on the internal and external voices that shaped his early sense of not belonging, while also expressing ambivalence about positioning himself as a model for students. This hesitation points to an ongoing negotiation of authority, as faculty sought to humanize themselves without undermining their legitimacy as engineering educators.

Other faculty described academic struggle in ways that were less explicitly framed as such, revealing differences in what participants recognized as “struggle” and how they made sense of its impact. Brian, for example, recounted being discouraged from pursuing graduate education based on his academic record but narrated the experience during the interview without overt emphasis on its emotional weight. Despite this, he drew on his academic history as a concrete way to normalize difficulty for students:

The practice I have is at least making everyone feel they belong. I let them know that it's okay to struggle. As I said, I pull up my transcript. I say, it's okay to struggle. I say, here's a whole bunch of Fs and Ws and withdrawals in my transcript. That's right. You guys can get through it. I'm like, I'm here to make sure you guys don't have these things.
(Interview 1)

Through the practice of faculty sharing personal narratives of struggle with students, participants used these disclosures to redefine what competence and success in engineering look like, emphasizing persistence rather than uninterrupted achievement. Participants described the intervention as providing a structured opportunity to make these messages explicit early in the semester, rather than allowing them to emerge implicitly over time. As an example, Bridget (Interview 2) noted that the intervention enabled her to be more vocal about her commitment to student success and to set an intentional tone at the outset of the course.

Faculty also described how sharing stories of struggle altered their relationships with students. Several participants noted feeling more connected to students after the intervention, with these connections often extending across the semester. Ken (Interview 2) reflected that sharing experiences created a sense of mutual recognition that reshaped classroom dynamics, while Lewis (Interview 1) emphasized the importance of communicating that persistence and help-seeking are normal parts of engineering education. Collectively, these accounts suggest that faculty came to view storytelling around struggle as central to shaping how students interpret challenges, their place within engineering, and their relationship to those teaching them.

Reframing Relationships with Students

Faculty interpreted changes in students' interactions with them over the course of the term as evidence that the intervention reshaped the relational dynamics of their classrooms. Following implementation, participants described shifts in how students engaged with them inside and outside of class this term as compared to when they had taught the same class previously. They made meaning of these changes in relation to their teaching practice and professional identity. These relational shifts were most often described as students appearing more comfortable initiating contact, asking questions, and engaging in conversations that extended beyond immediate course content.

Nearly every participant noted an increased sense of connection with students after the intervention. For some faculty, this was experienced as students seeing them more fully as people rather than solely in their instructional role. Brian reflected on how sharing aspects of himself through the intervention altered how students related to him:

Yeah, I think having the opportunity for them to see the human side of me has probably made a better relationship with the students... You just have more of these conversations with students that are building rapport and kind of a sense of community as opposed to, "Oh, this guy's just the instructor." (Interview 1)

Faculty described these shifts as lowering the threshold for interaction, particularly early in the semester. Bridget emphasized the importance of setting this relational tone at the outset of the course and how the intervention made that process more explicit:

I think setting that tone the second day of the semester that I am here to be your cheerleader and to support you and to help you as we go. I think it has lowered the barrier for them to feel like I am approachable in asking for help. (Interview 2)

As the semester progressed, faculty pointed to changes in student behavior as evidence that these relational shifts had taken hold. Participants described students initiating conversations more frequently before and after class, reaching out via email, and encouraging peers to connect with faculty. Faculty interpreted these interactions as indicators that students felt more comfortable engaging and approaching them for support.

Faculty also interpreted additional help-seeking behaviors, such as increased attendance at office hours, more frequent questions during class, and greater use of instructional support resources, as further indicators that students felt more comfortable engaging. Rather than treating these behaviors as isolated outcomes, faculty understood them as signals that the relational terms of the classroom had shifted. Observing these changes reinforced faculty members' interpretation that the intervention had altered how students related to them and strengthened their confidence in continuing to incorporate the intervention into their future teaching.

Mindsets of Self as Educator: Humanizing Engineering

Faculty reflections reveal how implementing the intervention prompted participants to articulate and reaffirm who they understand themselves to be as engineering educators and what they see as their pedagogical responsibility. For many participants, reflecting on their own pathways into engineering surfaced a commitment to humanizing the discipline by foregrounding the people and communities affected by engineering work. These values, while often present prior to the intervention, became more explicit as faculty considered how they positioned themselves and their teaching in relation to students' experiences.

Faculty described personal motivations for teaching engineering that extended beyond technical knowledge transmission. Shana, for example, articulated the importance of connecting engineering work to its ethical and human consequences, framing this orientation as central to her teaching identity:

I think bringing in that personal connection and having students see that it's not just sitting behind a computer and typing. There's a person on the other side of your work. A lot of what I like to do is drawing in the ethics of things, the morals of things that when you are doing something in engineering, [you need to] know that it will have an effect on populations. (Interview 1)

For Shana, humanizing engineering was not an add-on to technical instruction, but a motivating value that shaped how she approached inclusive teaching. Other faculty similarly described their commitment to helping students persist in a demanding discipline by reframing struggle as an expected and meaningful part of professional formation. Ken emphasized that engineering education necessarily involves sustained engagement with complex problems and that frustration should be understood as intrinsic to the work:

Oftentimes, I think [students] just get frustrated because things don't come to 'em at first nature. They've done everything they've done previously in their lives. As an engineer, you want to tackle the problems that take some time and some deep thought, and that they're not just giving you, that's a part of the profession. Things aren't going to be straightforward. (Interview 1)

In discussing his broader pedagogical approach, Ken also in the same interview discussed breaking complex problems into smaller components to help students see challenge as manageable rather than insurmountable, noting that he wanted students to recognize difficulty as “a normal part of being an engineer” rather than as evidence of personal inadequacy. These reflections align closely with the intervention's emphasis on normalizing struggle as a surmountable aspect of learning.

Faculty also reflected on how their sense of pedagogical responsibility shaped the strategies they employed to support students. Lawrence (Interview 1), for example, emphasized the importance of scaffolding complex material and communicating in ways that offer multiple entry points for understanding, recognizing that students vary in how they make sense of engineering concepts and in the kinds of support they need.

These reflections highlight how faculty connected their values to concrete pedagogical responsibilities, particularly in large lecture environments. Daphne described adapting her role based on course context, recognizing that relational accessibility in first-year engineering courses often involves directing students toward appropriate support structures rather than providing individualized attention to every student:

In the first-year engineering class, I do office hours by request, but there's also help sessions and there's a coding lab they can go to get help, and there's the TA they can get help from, and there's peer teachers. I'm available, but my responsibility is more to make sure that they feel comfortable going to these other resources. I also can't have 120 students come to my office hours either. (Interview 1)

Across these accounts, faculty articulated a view of their role that balanced care, accessibility, and structural constraint. Humanizing engineering did not mean eliminating difficulty or guaranteeing relational access to all students, but rather creating conditions that supported persistence, sensemaking, and help-seeking within the realities of engineering education. Implementing the intervention prompted faculty to make these commitments more explicit, reinforcing their understanding of themselves as educators responsible for shaping how students interpret challenge, belonging, and possibility in engineering.

Discussion and Conclusion

This study extends prior research on social belonging interventions [1-3], [7], [8] by shifting analytic attention from student outcomes to the ways engineering faculty make sense of implementing the intervention in their classrooms. Rather than focusing solely on whether the intervention “works,” our findings foreground how faculty experiences, identities, and instructional commitments shape how the intervention is enacted and understood. Across interviews, faculty described how engaging with the intervention prompted reflection on their own educational pathways, altered how they related to students, and reframed their understanding of their instructional role within engineering classrooms. These findings suggest that social belonging interventions operate not only through their design features, but through the relational and interpretive work faculty undertake as they integrate them into their teaching. Prior research has similarly pointed to the instructional environment as central to whether such interventions take hold in practice [35]. Understanding faculty sensemaking is therefore central to explaining how and why such interventions are efficacious in practice, how they may reshape classroom dynamics over time, and how they can shift how faculty understand themselves and their roles in the classroom.

In implementing our ecological belonging intervention, faculty made sense of the work by locating it within their own educational histories and instructional commitments, rather than treating it as an externally imposed practice. Faculty participants drew on memories of academic difficulty and belonging uncertainty in engineering not simply as personal history, but as pedagogical resources for anticipating how students interpret struggle within engineering. In this process, storytelling about struggle was not framed as retrospective reflection or personal disclosure, but as deliberate instructional work that aligned with how faculty already understood their role in supporting students. Faculty described negotiating questions of authority, vulnerability, and legitimacy as they shared these experiences, particularly within engineering contexts that often prize certainty and individual competence [16-18]. Faculty understood the use of these narratives as a way to disrupt deficit interpretations of struggle and to normalize persistence for students encountering typical instructional and belonging-related challenges in engineering. Situated within prior work on faculty engagement with equity-oriented teaching [23], this finding suggests that adoption and enactment of equity-oriented interventions depend not only on their design, but on how faculty interpret their relevance to who they are as instructors and how they understand their pedagogical responsibilities.

Faculty made sense of the intervention’s value by attending to subtle shifts in how students related to them over the course of the semester. Alongside attention to student performance and course-level assessments, faculty described everyday classroom interactions as key indicators of how the intervention was shaping the learning environment in meaningful ways. Faculty noted that students appeared more comfortable initiating contact, engaging earlier and more frequently, and seeking help during class and outside of it. These types of interactions have been shown to play a central role in shaping students’ motivation, persistence, and help-seeking behavior particularly in large or competitive learning environments [24–27]. Importantly, faculty interpreted these behaviors as signals that the relational norms within the classroom had shifted, reflecting changes in the broader social ecology of the learning environment that the intervention was designed to support. These changes were understood as evidence that students experienced a more personal and approachable relationship with them as instructors, felt more comfortable navigating difficulty, asking questions, and accessing support without interpreting struggle as a personal failure. In this way, faculty relied on relational cues embedded in daily instructional life to assess whether the intervention was supporting student engagement and persistence in engineering. These relational cues also reinforced

how faculty understood their instructional role, positioning relational work as a legitimate and meaningful component of supporting student success in engineering.

Faculty accounts also complicate simple oppositions between humanizing teaching and the realities of engineering instruction, showing how instructors located the equity-oriented practices contained in the intervention within the limits of what they could reasonably enact in their classrooms. Rather than describing humanizing practices as offering unlimited or individualized support to every student, faculty were explicit about the boundaries of their roles and responsibilities, even as they expressed clear commitments to and engagement in actions to support student success. These boundaries were not framed as resistance to equity-oriented teaching, but as conditions for sustaining instructional practices over time, a pattern consistent with prior work emphasizing the importance of role alignment and contextual fit for the continued adoption of equity-oriented teaching practices [20], [21]. Within these constraints, faculty described the humanizing practices of the intervention as shaping how students were invited to interpret struggle, seek support, and engage with instruction, rather than as expanding faculty labor or redefining professional expectations. In this way, faculty made sense of the equity-oriented practices embedded in the intervention as aligned with their instructional identities and responsibilities as engineering educators. This underscores the need for approaches that engage faculty in making sense of equity-oriented practices in ways that resonate with how they understand their roles, responsibilities, and commitments within engineering education. A limitation of the scope of this study is that it focused only on the semester of implementation. Future research in this area should consider tracking changes in practices or mindset over time.

To conclude, this study foregrounds faculty sensemaking as a central mechanism through which equity-oriented interventions are enacted, interpreted, and sustained in engineering classrooms. Faculty in this study did not experience the ecological belonging intervention as a discrete or technical add-on, but as a practice that gained meaning through its alignment with their instructional identities, commitments to students, and interpretations of everyday classroom interactions. How faculty made sense of the intervention shaped how it was taken up in practice and how its value was assessed. For equity-oriented practices and faculty development, these findings underscore the importance of engaging faculty in interpretive work that supports meaning-making, rather than focusing solely on implementation fidelity or student outcomes. Attending to how faculty understand their roles, responsibilities, and relational work with students may be critical for supporting sustained engagement with equity-focused practices. More broadly, this study highlights the value of centering faculty experience within engineering education research on equity interventions, positioning faculty not as passive conduits of change, but as active participants whose interpretations shape how and why equity-orientated interventions work and endure.

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References

- [1] G. M. Walton and G. L. Cohen, "A Question of Belonging: Race, Social Fit, and Achievement," *J. Pers. Soc. Psychol.*, vol. 92, no. 1, pp. 82–96, 2007, doi: 10.1037/0022-3514.92.1.82.
- [2] G. M. Walton, C. Logel, J. M. Peach, S. J. Spencer, and M. P. Zanna, "Two brief interventions to mitigate a 'chilly climate' transform women's experience, relationships, and achievement in engineering.," *J. Educ. Psychol.*, vol. 107, no. 2, pp. 468–485, May 2015, doi: 10.1037/a0037461.
- [3] K. R. Binning *et al.*, "Changing social contexts to foster equity in college science courses: An ecological-belonging intervention," *Psychol. Sci.*, vol. 31, no. 9, pp. 1059–1070, Sep. 2020, doi: 10.1177/0956797620929984.
- [4] A. Godwin *et al.*, "Belonging in Engineering for Black, Latinx, and Indigenous Students: Promising Results From an Educational Intervention in an Introductory Programming Course," *IEEE Trans. Educ.*, vol. 67, no. 1, pp. 56–64, Feb. 2024, doi: 10.1109/TE.2023.3312628.
- [5] T. L. Strayhorn, *College students' sense of belonging: a key to educational success for all students*, Second edition. New York: Routledge, 2019.
- [6] What Works Clearinghouse, Institute of Education Sciences, and U.S. Department of Education, "Social Belonging Interventions," Jan. 2022, [Online]. Available: <https://whatworks.ed.gov>
- [7] G. M. Walton and S. T. Brady, "The social-belonging intervention.," *Handb. Wise Interv. Soc. Psychol. Can Help People Change*, pp. 36–62, 2021.
- [8] S. P. Hammarlund, C. Scott, K. R. Binning, and S. Cotner, "Context Matters: How an Ecological-Belonging Intervention Can Reduce Inequities in STEM," *BioScience*, vol. 72, no. 4, pp. 387–396, Apr. 2022, doi: 10.1093/biosci/biab146.
- [9] C. Steele, *Whistling Vivaldi : how stereotypes affect us and what we can do*, 1st ed. in *Issues of Our Time*. New York: W.W. Norton, 2011.
- [10] L. DeAngelo *et al.*, "Course-based Adaptations of an Ecological Belonging Intervention to Transform Engineering Representation at Scale," in *2022 ASEE Annual Conference & Exposition Proceedings*, Minneapolis, MN: ASEE Conferences, Aug. 2022, p. 41987. doi: 10.18260/1-2--41987.
- [11] M. Bahnson, A. Godwin, C. Schunn, E. McChesney, and L. DeAngelo, "Retention in engineering pathways: an ecological belonging intervention supports help-seeking and continued enrollment," *Int. J. STEM Educ.*, vol. 12, no. 1, p. 6, Feb. 2025, doi: 10.1186/s40594-025-00530-w.
- [12] K. Nortz *et al.*, "First-Year Women's Interpretations of Self-Efficacy After an Ecological Belonging Intervention," in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, Jun. 2024, p. 47468. doi: 10.18260/1-2--47468.

- [13] L. DeAngelo *et al.*, “The process of building faculty buy-in for course-based adaptations of an ecological belonging intervention to transform engineering representation at scale,” in *ASEE Annual Conference Proceedings*, Baltimore, Maryland: ASEE Conferences, Jun. 2023, p. 43144. doi: 10.18260/1-2--43144.
- [14] L. D. Baber, “Considering the Interest-Convergence Dilemma in STEM Education,” *Rev. High. Educ.*, vol. 38, no. 2, pp. 251–270, Dec. 2015, doi: 10.1353/rhe.2015.0004.
- [15] S. E. Brownell and K. D. Tanner, “Barriers to Faculty Pedagogical Change: Lack of Training, Time, Incentives, and...Tensions with Professional Identity?,” *CBE—Life Sci. Educ.*, vol. 11, no. 4, pp. 339–346, Dec. 2012, doi: 10.1187/cbe.12-09-0163.
- [16] K. Culver, A. Kezar, and E. R. Koren, “Faculty, Academic Careers, and Environments (FACE) Framework: A Guide to Faculty Work for Research, Practice, and Policy,” *J. High. Educ.*, pp. 1–33, Feb. 2025, doi: 10.1080/00221546.2025.2466421.
- [17] C. Winberg, “Teaching engineering/engineering teaching: interdisciplinary collaboration and the construction of academic identities,” *Teach. High. Educ.*, vol. 13, no. 3, pp. 353–367, Jun. 2008, doi: 10.1080/13562510802045394.
- [18] F. Trede, R. Macklin, and D. Bridges, “Professional identity development: a review of the higher education literature,” *Stud. High. Educ. Dorchester--Thames*, vol. 37, no. 3, pp. 365–384, 2012, doi: 10.1080/03075079.2010.521237.
- [19] M. Borrego and J. Bernhard, “The emergence of engineering education research as an internationally connected field of inquiry,” *J. Eng. Educ.*, vol. 100, no. 1, pp. 14–47, 2011.
- [20] T. Holloman, J. Brisbane, N. Huggins, W. Lee, and D. Knight, “Exploring Department Readiness for Equity-Work and Inclusive Practices in Engineering PhD Programs: A Competing Values Approach,” in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, Jun. 2024, p. 47403. doi: 10.18260/1-2--47403.
- [21] T. Russo-Tait, “Science faculty conceptions of equity and their association to teaching practices,” *Sci. Educ.*, vol. 107, no. 2, pp. 427–458, Mar. 2023, doi: 10.1002/sce.21781.
- [22] K. J. C. Espinoza and B. E. Rincón, “Color-Evasive/Conscious? A Content Analysis of How Engineering Faculty Discuss Race and Racism in a U.S.-Based Equity-Focused STEM Professional Development Program,” *Educ. Sci.*, vol. 13, no. 3, p. 233, Mar. 2023, doi: 10.3390/educsci13030233.
- [23] C. Haynes and L. D. Patton, “From Racial Resistance to Racial Consciousness: Engaging White STEM Faculty in Pedagogical Transformation,” *J. Cases Educ. Leadersh.*, vol. 22, no. 2, pp. 85–98, Jun. 2019, doi: 10.1177/1555458919829845.
- [24] T. Wilson, Y. K. Kim, and C. Conn, “Centering Faculty in Student-Faculty Interaction: Work Environment Facilitating More Interactions and Its Difference by Gender and Race,” *J. Scholarsh. Teach. Learn.*, vol. 25, no. 4, Oct. 2025, doi: 10.14434/josotl.v25i4.39513.

- [25] J. Cuseo, "The Empirical Case Against Large Class Size: Adverse Effects on the Teaching, Learning, and Retention of First-Year Students," *J. Fac. Dev.*, vol. 21, no. 1, pp. 5–21, 2007.
- [26] L. M. Harrison and K. B. Mathuews, "How Students Experience Faculty Responses to Academic Struggle," *J. Coll. Stud. Dev.*, vol. 63, no. 4, pp. 399–413, Jul. 2022, doi: 10.1353/csd.2022.0034.
- [27] L. I. Rendon, "Validating Culturally Diverse Students: Toward a New Model of Learning and Student Development," *Innov. High. Educ.*, vol. 19, no. 1, pp. 33–51, Sep. 1994, doi: 10.1007/bf01191156.
- [28] S. Secules, "Making the Familiar Strange: An Ethnographic Scholarship of Integration Contextualizing Engineering Educational Culture as Masculine and Competitive," *Eng. Stud.*, vol. 11, no. 3, pp. 196–216, Sep. 2019, doi: 10.1080/19378629.2019.1663200.
- [29] R. J. Downey, J. A. Mejia, D. A. Chen, and G. D. Hoople, "Meritocracy and Colorblindness: The Perpetuation of Whiteness in Engineering Education Through False Narratives," Jun. 2024, Accessed: Oct. 18, 2025. [Online]. Available: <https://par.nsf.gov/biblio/10523605-meritocracy-colorblindness-perpetuation-whiteness-engineering-education-through-false-narratives>
- [30] E. A. Cech, "The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices," in *Engineering Education for Social Justice*, vol. 10, J. Lucena, Ed., in Philosophy of Engineering and Technology, vol. 10. , Dordrecht: Springer Netherlands, 2013, pp. 67–84. doi: 10.1007/978-94-007-6350-0_4.
- [31] E. National Academies of Sciences and Medicine, *Advancing Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation*. Washington, DC: The National Academies Press, 2023. doi: 10.17226/26803.
- [32] I. Villanueva, T. Carothers, M. Di Stefano, and M. T. H. Khan, "'There Is Never a Break': The Hidden Curriculum of Professionalization for Engineering Faculty," *Educ. Sci.*, vol. 8, no. 4, Art. no. 4, Dec. 2018, doi: 10.3390/educsci8040157.
- [33] E. O. McGee and D. B. Martin, "'You Would Not Believe What I Have to Go Through to Prove My Intellectual Value!' Stereotype Management Among Academically Successful Black Mathematics and Engineering Students," *Am. Educ. Res. J.*, vol. 48, no. 6, pp. 1347–1389, Dec. 2011, doi: 10.3102/0002831211423972.
- [34] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, Jan. 2006, doi: 10.1191/1478088706qp063oa.
- [35] G. M. Walton et al., "Where and with whom does a brief social-belonging intervention promote progress in college?," *Science*, vol. 380, no. 6644, pp. 499–505, 2023, doi: 10.1126/science.ade4420.