ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #40738

An ecological belonging intervention for equity: Impacts to date and promising directions

Dr. Allison Godwin, Cornell University

Allison Godwin, Ph.D. is an associate professor in the Robert Frederick Smith School of Chemical and Biomolecular Engineering at Cornell University. Her research focuses on how identity, among other affective factors, influences diverse students to choose engineering and persist in engineering. She also studies how different experiences within the practice and culture of engineering foster or hinder belonging and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. Her research earned her a 2016 National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning to understand engineering students' identity development. She has won several awards for her research including the 2021 Journal of Civil Engineering Education Best Technical Paper, the 2021 Chemical Engineering Education William H. Corcoran Award, the 2022 American Educational Research Association Education in the Professions (Division I) 2021-2022 Outstanding Research Publication Award, and the 2023 American Institute of Chemical Engineers Award for Excellence in Engineering Education Research.

Dr. Linda DeAngelo, University of Pittsburgh

Linda DeAngelo is Associate Professor of Higher Education, Center for Urban Education Faculty Fellow, and affiliated faculty in the Gender, Sexuality, and Women's Studies Program at the University of Pittsburgh. Dr. DeAngelo studies social stratification, investigating how social inequities are produced, maintained, and interrupted. Currently her scholarship focuses on access to and engagement in faculty mentorship, the pathway into and through graduate education, and gender and race in engineering.

Eric Trevor McChesney, University of Pittsburgh

Eric McChesney (he/him) is a Postdoctoral Scholar for Psychosocial Interventions at Scale with the Learning Research and Development center at the University of Pittsburgh. His work focuses on the development of robust, transferrable psychosocial interventions that improve the outcomes of and environments experienced by women, people of color, and other historically-marginalized students pursuing degrees in Science, Engineering, Mathematics, and Technology (STEM). A further strand of his research examines the development of interdisciplinarity in the sciences and works to define the mechanisms by which it is formed, identify the contexts conducive to its flourishing, and develop the educational experiences that accelerate its development.

Erica McGreevy, University of Pittsburgh

Teaching Associate Professor Department of Biological Sciences

Gerard Dorvè-Lewis, University of Pittsburgh

Gerard Dorvè-Lewis (he/him) is a higher education PhD student and scholar at the University of Pittsburgh. His broad research interests include emerging adulthood, diversity, equity, and inclusion in higher education, first-generation college students, Black students, higher education policy, and student success. Prior to beginning his doctoral journey, he worked full-time in student affairs at the University of Florida where he also earned his bachelor's and master's degrees in Family, Youth, and Community Sciences.

Anne-Ketura Elie, University of Pittsburgh

Anne-Ketura Elie earned a BS degree in 2019 in psychology from the University of Florida, Gainesville, Florida.

She is currently a graduate student researcher at the University of Pittsburgh in Pittsburgh, Pennsylvania. Her research interests are the factors that foster sense of belonging in academic settings, more specifically teacher-student relationship factors that promote student's sense of belonging and adaptive meaning making.

Ms. Elie is also a member of the Society for Personality and Social Psychology.

Kevin Jay Kaufman-Ortiz, Purdue University at West Lafayette (COE)

Kevin Jay Kaufman Ortiz holds a B.S. in Industrial Engineering from the University of Puerto Rico Mayagüez Campus and is a licensed mathematics teacher by the Department of Education in Puerto Rico. Kevin is currently an M.S. student in the School of Industrial Engineering as well as a Ph.D. student in the School of Engineering Education at Purdue University. His interests currently lie in cultural identity, engineering culture, acculturation, decolonization, belonging, and inclusion of occupational migrants from the U.S. territories who are looking to pursue engineering degrees and work in the mainland U.S.

Ms. Jacqueline Ann Rohde, Georgia Institute of Technology

Jacqueline (Jacki) Rohde is the Assessment Coordinator in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. Her interests are in sociocultural norms in engineering and the professional development of engineering students.

Dr. Heather Lee Perkins, Purdue University at West Lafayette (PPI)

Heather graduated from the Applied Social and Community Psychology program in the spring of 2021, after completing her Bachelor of Science in Psychology from the University of Cincinnati. She has participated in various research projects examining the int

Charlie Díaz, University of Pittsburgh

Charlie Diaz is a PhD student studying Higher Education at the University of Pittsburgh. He is a recipient of the K. Leroy Irvis Fellowship. His research interests include minoritized student experiences in Higher Ed, student activism, and the development of inclusive policy and practice in Higher Ed.

Kevin R. Binning

Social psychologist with an interest in diversity and belonging in STEM.

CornellEngineering
Robert Frederick Smith School of Chemical and Biomolecular Engineering

An Ecological Belonging Intervention for Equity: Impacts to Date and Promising Directions

Allison Godwin, Linda DeAngelo

Eric McChesney, Erica McGreevy, Gerard Dorvè-Lewis, Anne-Ketura Elie, Kevin Kaufman-Ortiz, Jacqueline Rohde, Heather Perkins, Charlie Díaz, Kevin Binning

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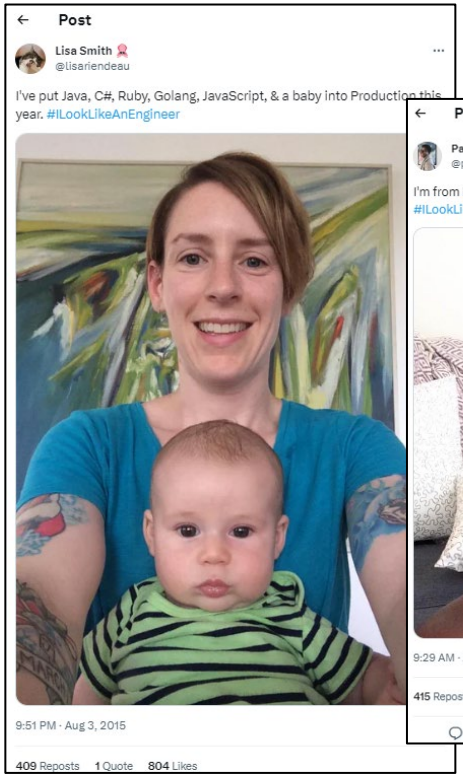
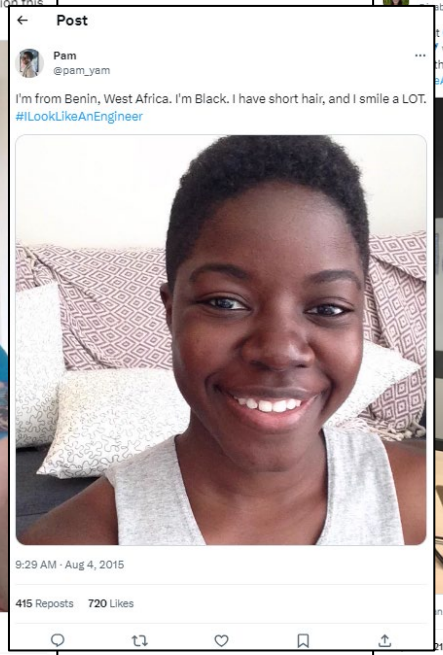
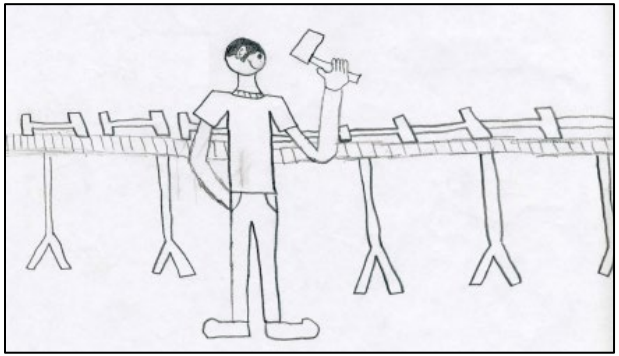
Transforming Higher Education

Stereotypes are “in the air.”



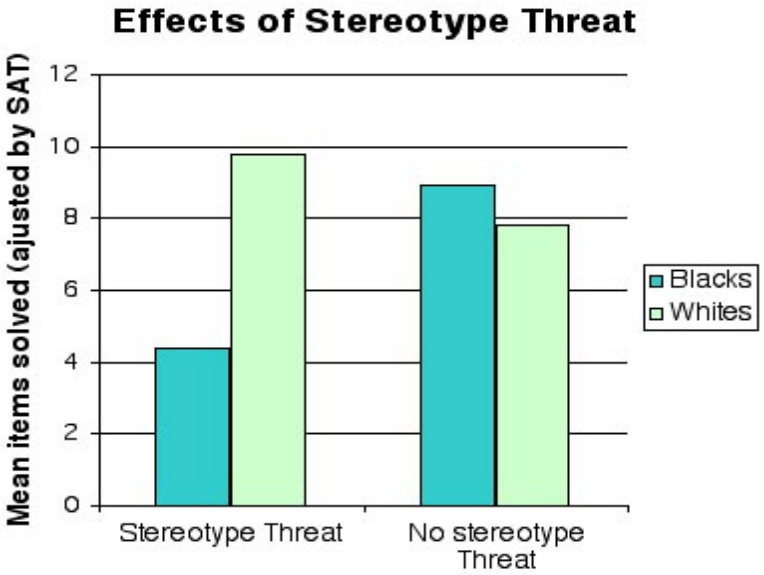




Ganesh, T. G. (2011, June), *Analyzing Subject-Produced Drawings: The use of the Draw an Engineer Assessment in Context* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17489

The mere existence of a stereotype is enough to cause negative outcomes.

- Studies demonstrate that the effort of trying to disconfirm a stereotype of about your group affects performance.
- In particular, Black, Latino/a/x, and Indigenous students (BLI) students often experience chilly or hostile climates
- Two salient mechanisms link environments to experiences to performance
  - Stereotype threat
  - Lack of social belonging



Appel, M., Kronberger, N., & Aronson, J. (2011). Stereotype threat impairs ability building: Effects on test preparation among women in science and technology. *European Journal of Social Psychology*, *41*(7), 904–913.
Nguyen, H.-H. D., & Ryan, A. M. (2008). Does stereotype threat affect test performance of minorities and women? A meta-analysis of experimental evidence. *Journal of Applied Psychology*, *93*(6), 1314–1334.
Aronson, J., Steele, C. M., Salinas, M. F., & Lustina, M. J. (1998). The effects of stereotype threat on the standardized test performance of college students. *Readings about the social animal*, 9th ed., ed. Aronson, E., 400-412. Worth. p.404.

The mere existence of a stereotype is enough to cause negative outcomes.

"I think there's less than a 1,000 Black students on campus and I think in my class, like my year in chemical engineering, there's maybe five or six other Black students that at least I've seen or talked to in any way…I have never felt any malicious intent towards me at this institution purely because I am Black, but I have had experiences where I've had to deal with ignorance from my white peers. And I know that it happened just because they have never met a Black person before. So, there's always this feeling that just knowing that the way I've maybe talked to someone in my family, I can't talk to a peer about like a complex engineering process. I can't necessarily just talk how I would to anyone about that, like in the same way that I'd talk to a family member because that could either take credibility away from me in their eyes or almost intimidate or confuse someone who's not used to, I don't know, hearing someone who talks like me or seeing someone who looks like me."

Malik, Black man, chemical engineering student

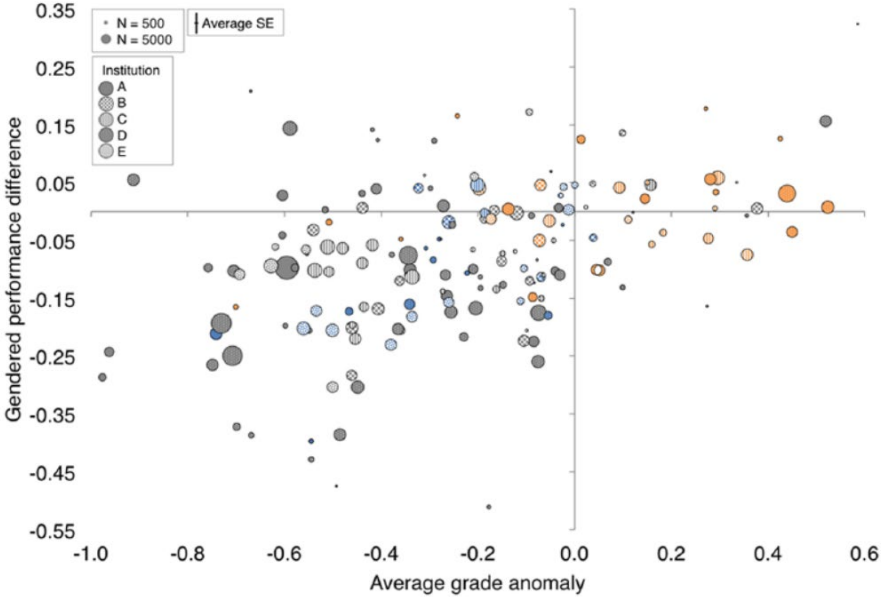
Dorvè-Lewis, G., Lewis, D. V., Bañuelos, M., Buswell, N. T., & DeAngelo, L. (2023). *A Narrative Analysis of Black, Latino/a/x, and Indigenous Students' Sense of Belonging in Engineering at a Predominantly White Institution* Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore, MD. https://peer.asee.org/42435

Belonging uncertainty and stereotype threat can prompt students to ask, “Do I belong?”

“In some classes my identity really makes me feel weird or different to others.”

Angelica, Peruvian Woman, Mechanical Engineering Student

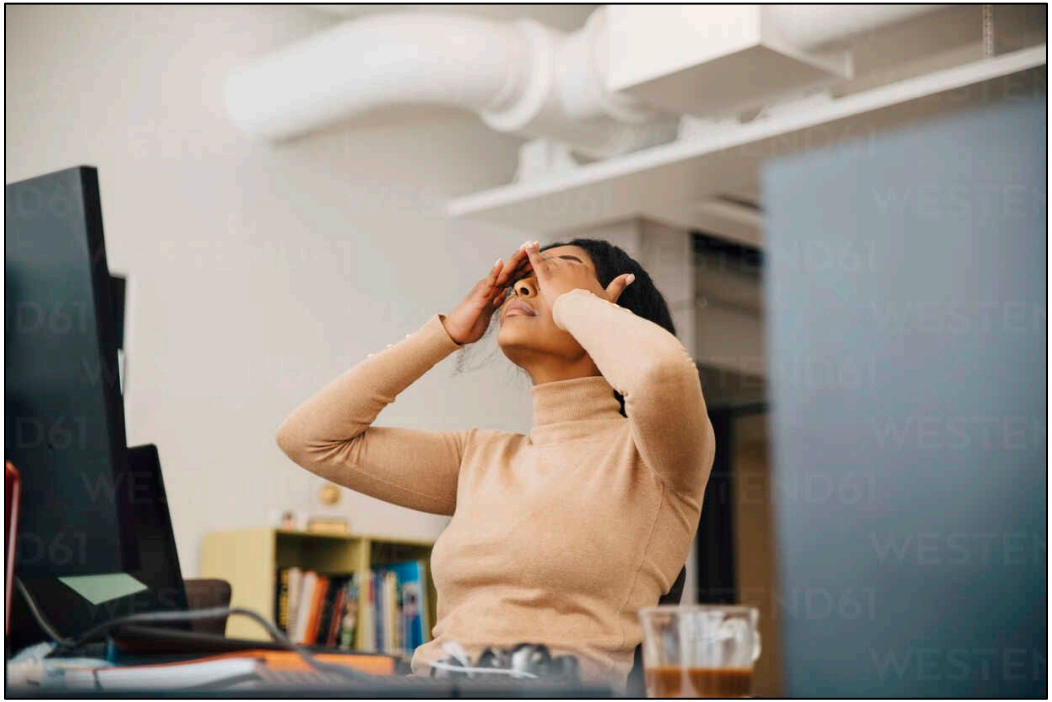
Gateway courses shape students' experiences in engineering.

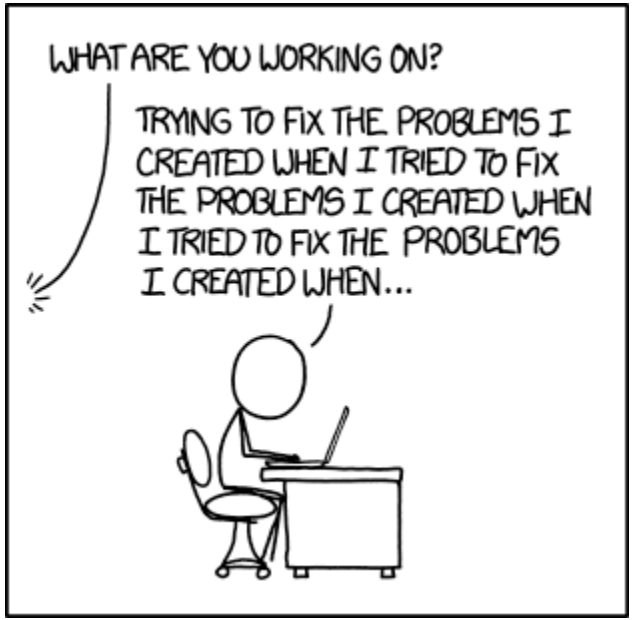


Gendered performance differences in science, technology, engineering, and mathematics (STEM) courses. Gendered performance differences based on a matching method versus average grade anomaly for 172 introductory STEM courses across five universities, representing 677,949 course enrollments, including lectures (gray), labs (orange), and mixed courses (blue). Crosshairs indicate the average standard error on the mean.

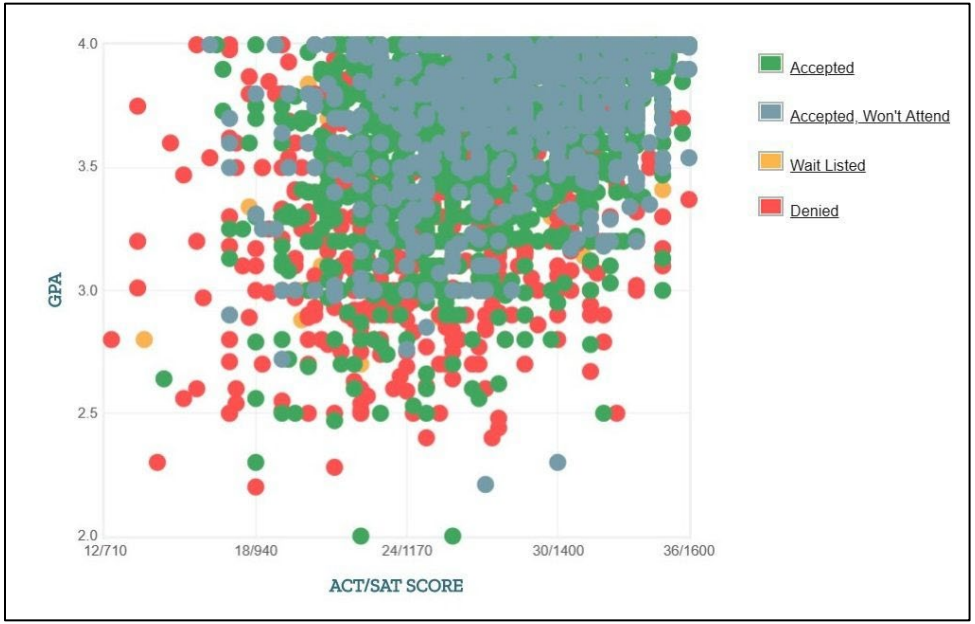
Matz, R. L., Koester, B. P., Fiorini, S., Grom, G., Shepard, L., Stangor, C. G., Weiner, B., & McKay, T. A. (2017). Patterns of gendered performance differences in large introductory courses at five research universities. *AERA Open*, *3*(4), 2332858417743754.

One of the first courses that may negatively shape experiences is in programming.



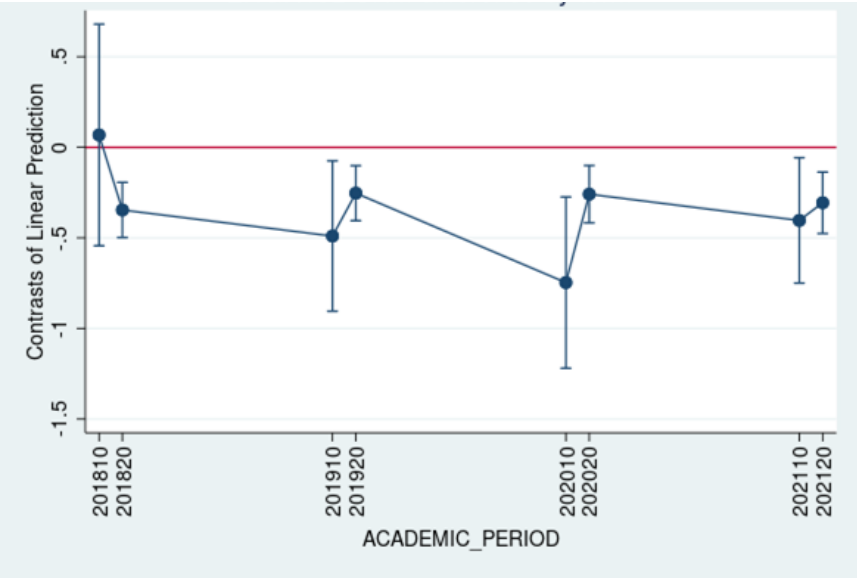


We define the difference in academic outcomes as an **equity gap** because something in the environment rather than the student or their preparation is the root cause.



Admissions statistics for students at participating institution.

We identified a first-year programming course with an equity gap in BLI students' academic performance.



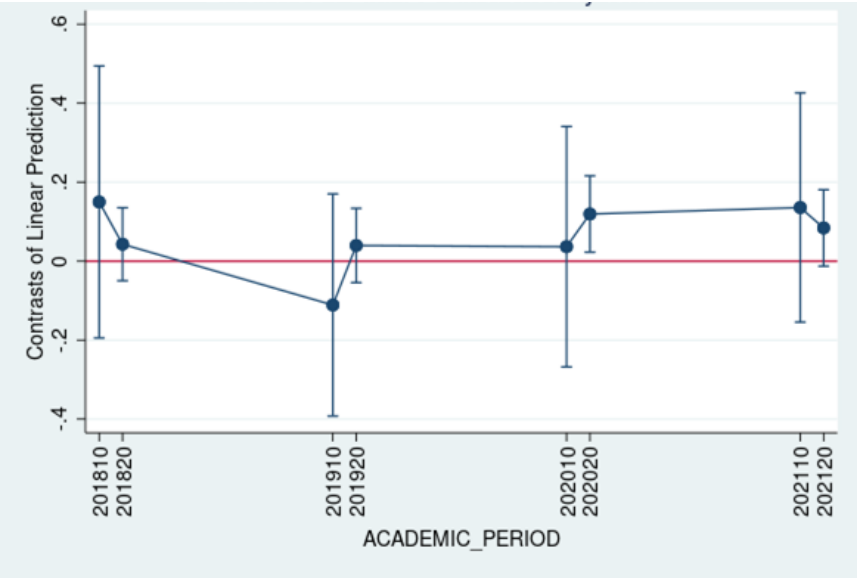
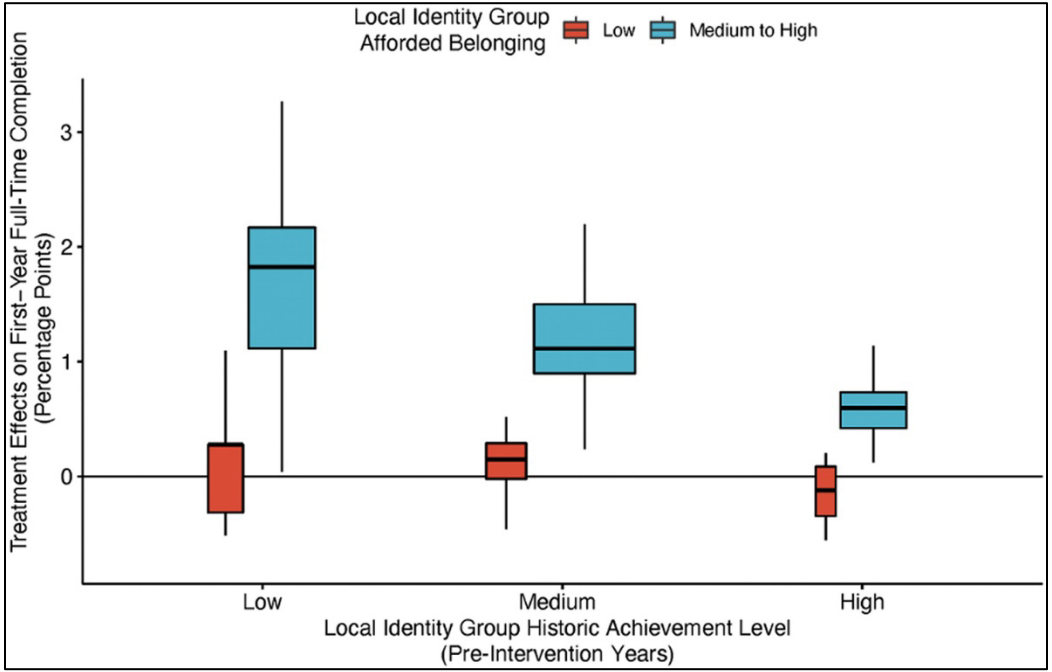


Figure 1. Normalized GPA differences on a 4.0 scale for BLI students (left) and women (right) controlling for gender, race/ethnicity, first-generation college student status, HS GPA, and instructor.

Prior work on belonging interventions demonstrate significant impact.



"These results are consistent with the emerging theory that positive change requires planting 'high-quality seeds' (hopeful answers to threatening questions) in 'fertile soil' (contexts in which these answers are true)."

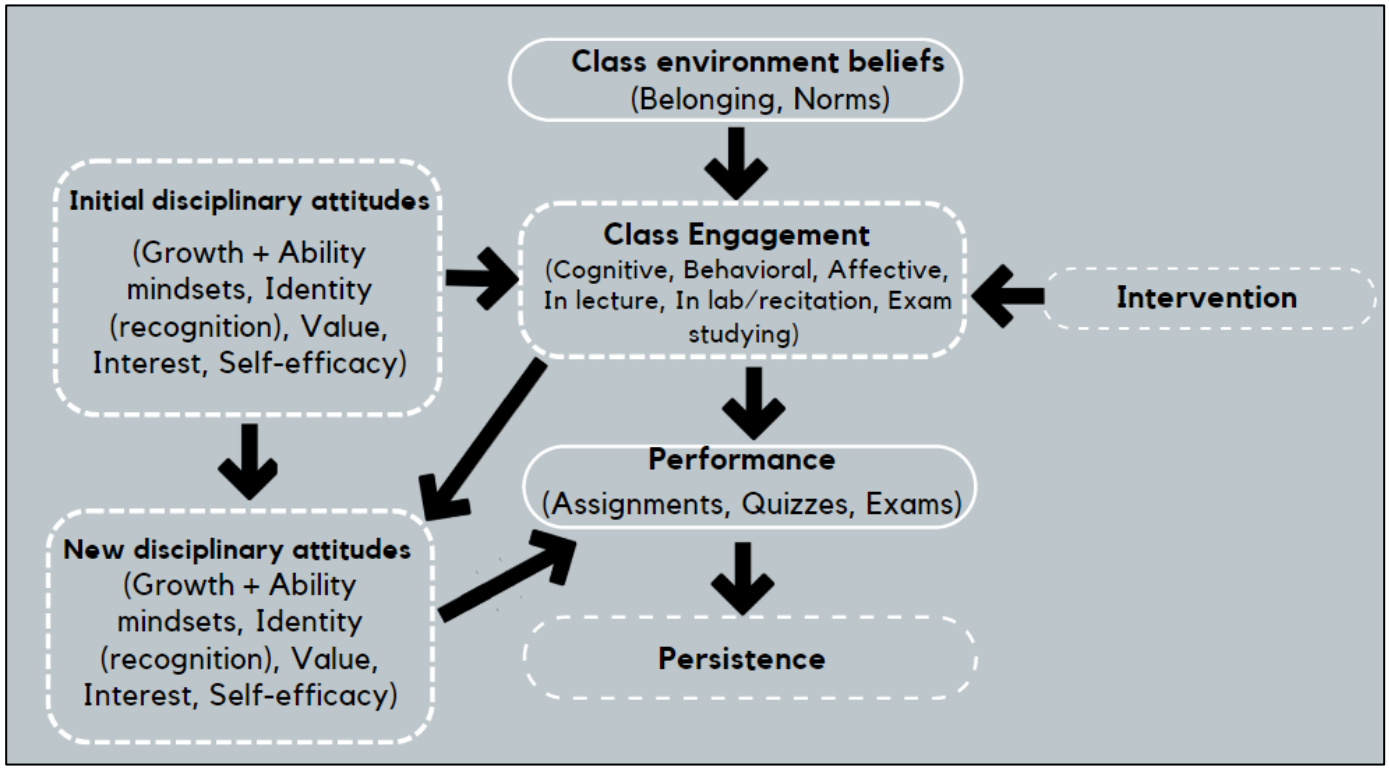
Walton, G. M., Murphy, M. C., Logel, C., Yeager, D. S., Goyer, J. P., Brady, S. T., ... & Krol, N. (2023). Where and with whom does a brief social-belonging intervention promote progress in college? *Science*, *380*(6644), 499-505.

Our work focused on an ecological belonging intervention in the FYE programming course.

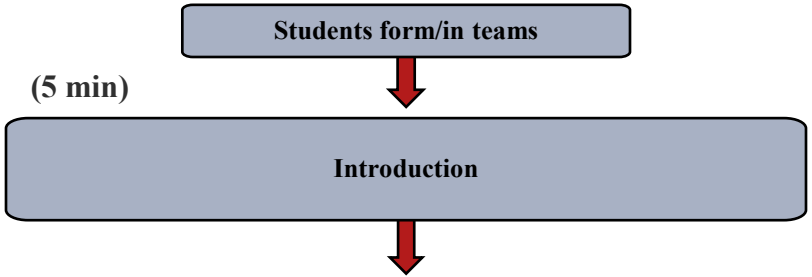
RQ1: What are the experiences of students in an introductory engineering course?
RQ2: How does the ecological belonging intervention change students' feelings of belonging in the course?
RQ3: What effect does the intervention have on short- and long-term academic success as measured by achievement (course-specific, overall GPA) and choice (retention, engineering career pathways)?
RQ4: What are the effects of implementing the intervention on instructors' attitudes and mindsets about supporting students in their courses?

Binning, K. R., Kaufmann, N., McGreevy, E. M., Fotuhi, O., Chen, S., Marshman, E., ... & Singh, C. (2020). Changing social contexts to foster equity in college science courses: An ecological-belonging intervention. *Psychological Science*, *31*(9), 1059-1070.

We hypothesize a theory of action for an ecological belonging intervention.

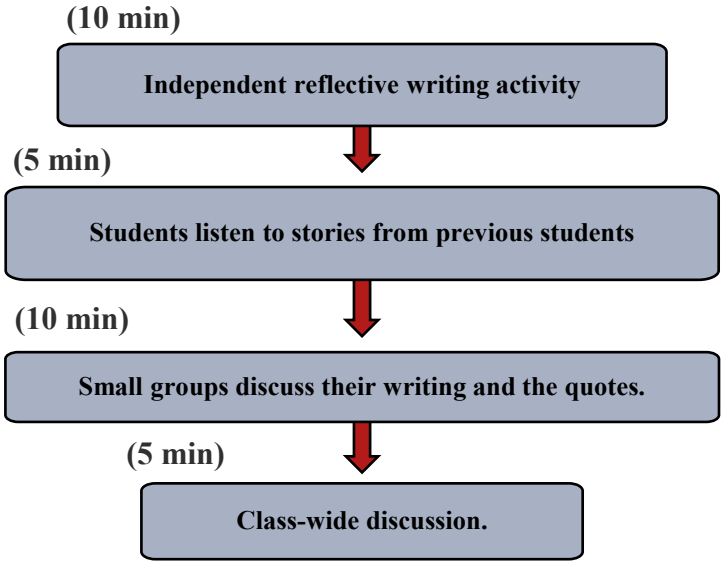


The intervention conveys the message that typical adversity is **normal** and **surmountable**.



"It can be easy to feel overwhelmed or to sometimes wonder to yourself 'do I really belong here?'…

"Everyone goes through struggle. It could be a bad grade, learning to manage free time, making new friends – regardless of the challenge, everyone goes through them. And, over time, you'll discover that you get better at dealing with these challenges."



We used focus groups to customize the intervention to the context.

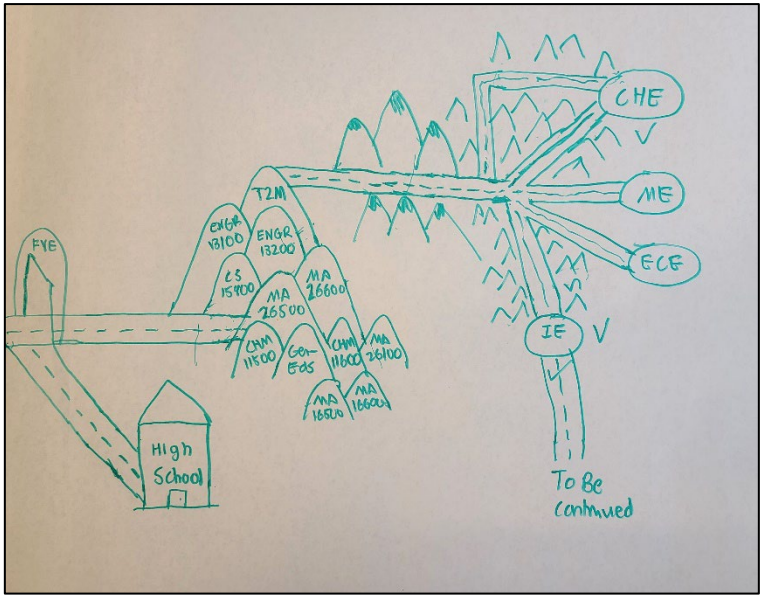
By gender and race/ethnicity of 4-6 students who previously completed the course

1) Students talk about their challenges
2) Index card activity where students write good and bad things they have experienced in their context
3) Shift from challenges to how students resolved some of the challenges they faced
4) Complete a journey map and present to the group
5) Students engage in a reflective writing exercise where they write a postcard to a past self about a time they didn't belonging in the context and how they overcame that.

DeAngelo, L., Godwin, A., Binning, K., Buswell, N., Cribbs, J., McGreevy, E., Schunn, C., Elie, A., Kaufman-Ortiz, K., Conrique, B., Cooper, C., Lewis, D., & Rohde, J. (2022). Course-based adaptations of an ecological belonging intervention to transform engineering representation at scale. In *ASEE Annual Conference & Exposition*, Minneapolis, MN. https://peer.asee.org/41987

We used focus groups to customize the intervention to the context.

- Identified common themes and experiences of struggle
- Developed small stories around these themes
- Used in vivo methods for authenticity from one main student (over composites)
- Reviewed with team members or faculty who have experience teaching the course



Godwin, A., DeAngelo, L., McGreevy, E., Schunn, C., Binning, K., Díaz, C., Dorvé-Lewis, G., Elie, K. A., Kaufman-Ortiz, K., & Rohde, J. (2023). Communicating for belonging in first-year engineering. In *IEEE ProComm Conference* (In review).

Stories address common struggles following an arc from struggle, action, to resolution.

“If you don’t know anything about coding—like me—you’re probably feeling like you did something wrong. You didn’t. The class is just tough sometimes. And that’s okay! You’re more than capable to get through this. Stack exchange is your friend. Don’t be afraid to ask other groups for help, and never think you’re not good enough. Have faith in yourself and your teammates. Learn to rely on yourself sometimes, but you gotta have a support system, both academically but more importantly emotionally. You got this! Signed, a fellow engineering idiot.”

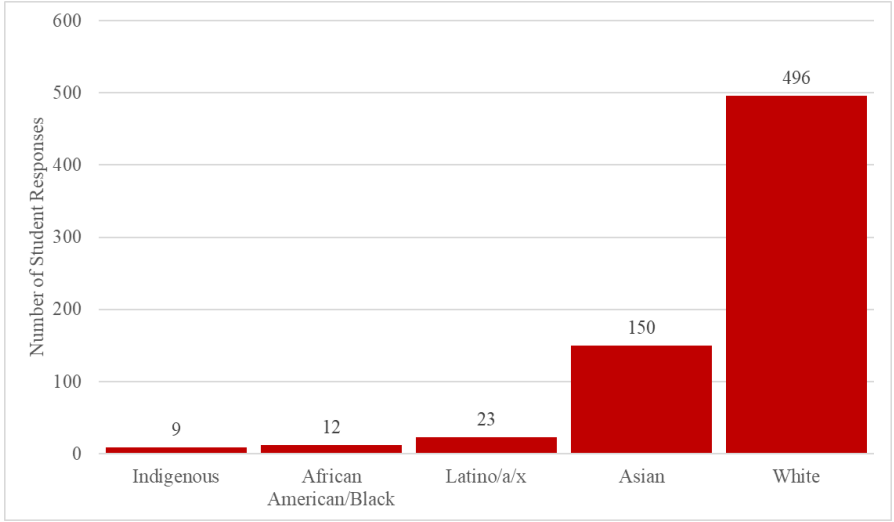
Michael, Junior, Civil Engineer

We use mixed methods to understand the intervention effects and integrity of implementation

- Pre/post-survey (Spring ‘22, ‘23)
- Course-level grades data (Spring ‘22, ‘23)
- Institutional records (Spring ‘22, ‘23)
- Instructor survey and interviews (Spring ‘23)
- Longitudinal interviews with stratified sample by intervention, gender, and race/ethnicity (Spring ‘22, ‘23)

We conducted the intervention with 691 students in Spring 2022.

- Pre-survey made available on the first day of class and closed before intervention (n = 334; 53%)
- Intervention administered on second day of class
- Post-survey completed during last two weeks of class



Godwin, A., Perkins, H. L., DeAngelo, L., McChesney, E., Kaufman-Ortiz, K., Dorvé-Lewis, G., & Conrique, B. (2023). Belonging in engineering for Black, Latinx, and Indigenous students: Promising results from an educational intervention in an introductory programming course. *IEEE Transactions on Education*. (In press).

We examined belonging score changes and course grades.

Measures

- Belonging ($\alpha = .82$)
  - Sense of belonging, ability to be themselves, and feelings of acceptance within their class
- MATLAB Grade
  - Weekly assignment in MATLAB; dichotomized as pass ($n = 561$) or fail ($n = 43$)

Analysis

- Belonging
  - 2x2x2 RM ANOVA (time x BLI x condition)
- MATLAB Grade
  - Logistic regression (grade on class project entered as a control)

The intervention addressed declines in BLI students' belonging.

Effects of Intervention on Students' Belonging

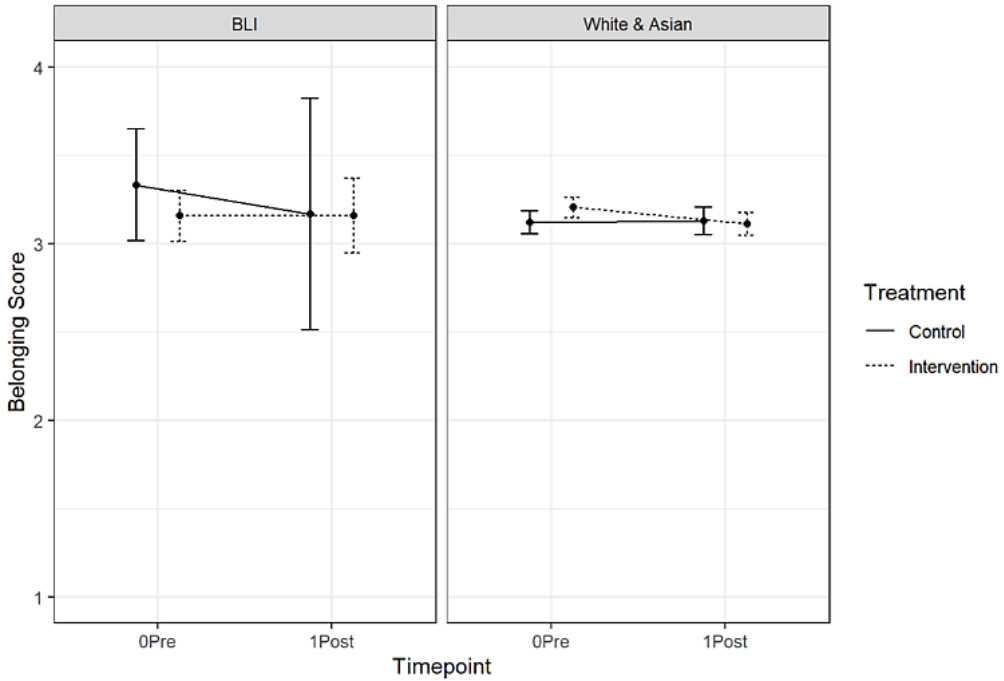


Table 1: Three-Factor Split-Plot ANOVA Results

		F	p	η^2_p
Main Effects				
	Treatment	0.22	0.643	<.001
	BLI x Majority	0.45	0.504	0.002
	Treatment x Control	0.97	0.326	0.004
	Time	1.04	0.31	0.004
Interactions				
	Treatment x Time	0.54	0.465	0.002
	Race x Time	0.63	0.427	0.002
	Treatment x Race x Time	2.99	0.085	0.011

The intervention partially addressed the academic equity gap for BLI students.

Effects of Intervention on Students' Individual MATLAB Grades

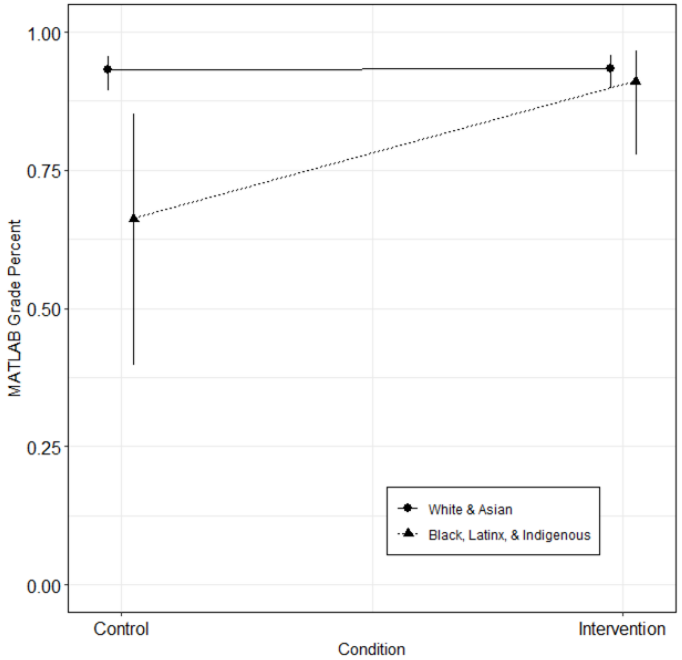


Table 2: Logistic Regression Analysis of Treatment and Race/Ethnicity on MATLAB Grades

Predictor	B	SE B	z-value	p	OR	Wald's χ^2	df	*p*
Constant	-1.88	1.21	-1.55	0.121	-1.88	28.25	4	<.001
Project Grade	4.88	1.32	3.69	< .001	132.48			
Treatment	0.03	0.34	0.08	0.937	1.03			
BLI Status	-1.95	0.61	-3.21	0.001	0.14			
Treatment x BLI Status	1.61	0.85	1.90	0.057	5.01			

Nagelkerke $R^2 = .106$

Results show promising trends for addressing equity in the engineering course.

- Intervention acting as a buffering effect against belonging declines
- Need to consider larger classroom context and instructor in closing the academic equity gap completely
- Limitation of not being able to model BLI student groups separately

We have expanded the intervention and added faculty training.

- Ran the intervention with 1482 students in Spring 2023
- Three faculty trainings
  - Why the ecological belonging intervention works (26 min)
  - How to run the ecological belonging intervention in your classroom (11 min)
  - Navigating the Pressure Points of the Ecological Intervention (2 hours synchronous)

Faculty engaged in the intervention grappled with tensions in doing this work.

100% **of faculty agreed that they …**

- were willing to take time to understand students' challenges
- were willing to provide additional resources to students
- were willing to adjust teaching methods to better meet student needs
- disagreed or strongly disagreed that students had a certain amount of intelligence, and they could not do much to change it

97% **of faculty agreed that they…**

- believed that students should work harder in the course

83% **of faculty agreed that they…**

- would be willing to give additional feedback on student's work
- felt a personal responsibility for helping struggling students succeed
- were willing to incorporate something new in their class, given the constraints of their curriculum
- were willing to give up time for course content in exchange for an activity that enhances learning

67% **of faculty agreed that they…**

- were very willing to give up time for course content in exchange for an activity that closes equity gaps

50% faculty **agreed that…**

- that sometimes there was nothing more they could do for their students

I'm very definitely encouraged, by the results. I wonder about the long-term impact. When the structure of the course itself is not changing. So, I think it's more of like it's an incremental step and incremental steps are like very important. I recognize that you know what can be done within the academic structure can be limited. And that an incremental step is better than no step.

Kevin Binning, PhD
University of Pittsburgh

Linda DeAngelo, PhD
University of Pittsburgh

Allison Godwin, PhD
Cornell University

Natascha Buswell, PhD
University of California, Irvine

Erica McGreevy, PhD
University of Pittsburgh

Chris Schunn, PhD
University of Pittsburgh

Robert Toutkoushian, PhD
University of Georgia

Beverly Conrique, M.S.
University of Pittsburgh

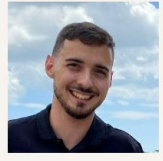
Carlie Cooper, MEd
University of Georgia

Charlie Diaz
University of Pittsburgh

Gerard Dorvè-Lewis, M.S.
University of Pittsburgh

Ketura Elie
University of Pittsburgh

Rachel Forster
University of Pittsburgh



Kevin Kaufman-Ortiz
Purdue University

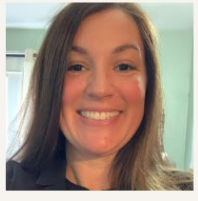
Maricela Bañuelos, M.A.
University of California, Irvine

Liwei Chen
University of Pittsburgh

Eric McChesney, PhD
University of Pittsburgh

Nelson O. O. Zounlome, PhD
University of Pittsburgh

Kelly Lee Tatone, MEd
University of Pittsburgh



Danielle Lewis, PhD
University Buffalo

Matthew Rowland Moreira Bahnson, PhD
Purdue University

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Thank You

Allison Godwin, Ph.D.
afg64@cornell.edu