BOARD # 308: What Do Students Remember and Take Away from An Ecological Belonging Intervention Designed to Address Equity Gaps for Women and Black, Latiné, and Indigenous Students in Engineering?

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Linda DeAngelo is Associate Professor of Higher Education in the School of Education and Director of Graduate Studies with a secondary faculty appointment 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.

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Kelly Tatone (she/her), M.Ed., is a research project supervisor at the University of Pittsburgh. She earned her graduate degree in 2022, working full-time and going to school part-time as a post-traditional student. She graduated from The Pennsylvania State University in 1990 with a B.A. in English Literature. She is the proud mother of three amazing women, which is her greatest source of pride.

What Do Students Remember and Take Away from An Ecological Belonging Intervention Designed to Address Equity Gaps for Women and Black, Latiné, and Indigenous Students in Engineering?

Introduction

This collaborative project funded by an NSF IUSE: EDU Program, Institutional and Community Transformation track grant (2111114/2111513) at the University of Pittsburgh, Purdue University, and the University of California, Irvine, entitled "Collaborative Research: Strategic Course-based Adaptations of an Ecological Belonging Intervention to Broaden Participation in Engineering at Scale" uses a brief ecological intervention that only requires one class or recitation/discussion session to implement and has been shown to erase long-standing gender and racial equity gaps in academic achievement in introductory STEM courses [1]. The intervention is contextualized [2] for each course at each university and our research 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 a first-year programming course [3]. 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 [4] and that women students who receive the intervention may have more positive self-efficacy [5].

To expand on understanding the impacts of the intervention on students, we have recently begun to examine how students experience the intervention, if they remember it, what they remember about it, and what they feel they gained from it. In this paper, we provide an overview of our findings in this area using data collected from surveys of one first-year engineering programming courses at one study institution and focus groups and interviews with students at a second study institution where the intervention is being implemented within second-year courses in specific engineering majors.

Project Description

Our project builds on previous social-belonging interventions [6], [7], [8] by adapting them to address challenges specific to engineering course contexts and by training instructors to incorporate the intervention as part of a social "icebreaker" activity early in the term, during the first week of classes [1].

The Ecological Belonging Intervention (Base Form)

Rooted in earlier social belonging interventions that aim to help students understand that adversity in college is both normal and surmountable [7], our ecological adaptation delivers this same message, but within the social context of the classroom rather than targeting individuals alone. The base form of the intervention has been shown to reduce demographic achievement gaps in previous research [1], [9]. Unlike earlier interventions that took place in controlled lab environments, our ecological approach is implemented directly within the courses that have known demographic disparities in academic outcomes. The intervention materials, such as student narratives or "stories" of struggle, are created and tailored based on focus groups made up of students who have previously taken the course [2]. Rather than being delivered by external researchers, our ecological belonging intervention approach is led by the course instructors. This allows instructors to connect more meaningfully with students and engage in open discussions

about challenges and how to overcome them. Instructors also facilitate peer conversations to foster a sense of community and shared understanding of adversity.

The goal of the intervention is to establish a classroom norm in which (a) adversity is acknowledged as a natural part of the course experience, and (b) these struggles are viewed as temporary and surmountable with persistence and effort. The intervention is broken down into five stages, delivered within a single class period: 1) Instructors explain that adversity in college is normal, that it can be overcome, and that challenges specific to the course are common; 2) Students reflect on their own challenges in college and write about how they believe those challenges will evolve; 3) Instructors share first-person stories of past students who faced and overcame struggles in the course; 4) Students engage in small-group discussions where they share personal experiences and talk about dealing with adversity in college; 5) Finally, the instructor leads a class-wide discussion based on the key themes identified in the group conversations. For a detailed guide to the intervention and its adaptations see [2].

Research Questions

Our project includes seven overarching research questions around two main topics: 1) ecological belonging intervention effects on students and 2) research on scaling and transformation of the intervention. These have been presented in previous reports [2], [10], [11].

***Intervention Effects on Students* – RQ1 (the course contexts):** How do students, with a focus on minoritized students (i.e., Black, Latinx, and Indigenous, women and non-binary students), describe their lived experiences in courses that show demographic-based achievement differences? **RQ2 (the immediate effects on students)**: How does the ecological belonging intervention change students' feelings of belonging in the course, their disciplinary-based growth mindset, and perceptions of academic norms in the course, major, and engineering overall? **RQ3 (the broader effects on students):** 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)?

***Research on the Scaling and Transformation Approach* – RQ4 (context effects on onboarding strategies):** What are the key disciplinary and institutional factors that demand adaptation to the onboarding strategies? **RQ5 (impact of onboarding strategies on instructor beliefs):** What are the effects of the onboarding strategies on instructor beliefs that are key to intervention implementation? **RQ6 (impact of instructor beliefs on intervention implementation):** What are the instructor beliefs most critical to implementation (initial and sustaining implementation) of the intervention? **RQ7 (impact of implementation on instructors):** What impact does implementing the intervention have on instructors' mindsets, attitudes, and practices?

Perceptions of Intervention

As we continued to study the intervention and address RQs 2 and 3, understanding student perceptions of the intervention and its impacts emerged as an important area for inquiry. We are in the beginning phases of this work. We developed a measure that asks students if they recall the intervention activity. Students were then asked two additional questions, one about the usefulness of the activity and a second if they would recommend that this activity be continued in the class. After these ratings, students responded to an open-ended prompt where they were asked to elaborate on the recommendation they provided for the activity (see [12] for a full description of this measure). This measure was used at one university where the intervention was

given in three different second-year major courses – one each in chemical, mechanical, and electrical – and at a second institution in a first-year course that all engineering students complete. All the data was collected during academic year 2023-2024.

Second Year Major Courses

To understand students' experiences in the term in which they received the intervention, a focus group (five students in chemical) and interviews (ten students in mechanical or electrical) were conducted at the end of the term in which the intervention was implemented. Students were given and completed the measure at the end of the focus group or interview. All five participants in the focus group were women, with two identifying as white and three as Black or African American. Of the students interviewed, six were white, two were Asian, and two were Black or African American. Six participants identify as women, two as men, and two chose not to disclose their gender identity.

Of the total 15 participants, all remembered the intervention activity correctly, all qualified the intervention as useful, to some degree. Three participants (20%) indicated it was somewhat useful, seven (47%) noted it was useful, and five (33%) stated it was extremely useful. Of the electrical engineering students, 50% deemed the intervention as extremely useful, while 33% noted it was useful and 17% indicated it was somewhat useful. Among the chemical engineering students, 60% indicated that the intervention was useful and the remaining 40% noted it was extremely useful. Fifty percent of the mechanical engineering students noted the intervention was either somewhat useful or useful.

Participants across majors discussed how the intervention helped them realize they were not alone in facing challenges. Many found it reassuring to hear that others had struggled and succeeded, with one student saying, "It was reassuring to know other students felt the same way I did. It was also good to know that they overcame the same difficulties I faced." Even those who didn't expect to struggle appreciated reflecting on the intervention when the course became difficult, with one noting, "In the moment, I didn't take it very seriously but as the course became more challenging it was nice to know that I wasn't alone and it was a big sense of comfort." Another noted, "It was good to see other students in my situation and turn out successful. It gave me a realistic glimpse of my future, for better and for worse."

The intervention also helped manage expectations, as one student shared, "It made me realize that this major is tough, and I shouldn't put too much pressure on myself." Another noted, "The activity gave me a better sense of belonging in the class. It helped me not feel discouraged during the first exam and gave me hope that I would pass the class." Students also indicated that the intervention helped them to recognize that their instructors wanted them to do well in the course and would support them, with several students indicating that learning about their professors' past struggles as undergraduate students and how they overcame them was particularly profound. One student commented, "It was empowering to know my professor understood the struggle." Another student stated, "I felt more confident about my ability to succeed as an engineering student, developed a closer relationship with my peers, and felt the professor cared about my success."

First-Year Engineering Course

In the first year second semester engineering course students were asked to complete a survey in

the fourteenth week of the semester in which they participated in the intervention which included the measure at the very end. Of the total responses, 245 participants responded to quantitative items in the measure, and 228 responded to a qualitative follow-up item. Participants reflected the PWI institution population, with the majority self-identifying as White and as men.

The mean for the usefulness item was 2.10 “useful” with a standard deviation of 0.72. The mean for recommendation was 2.41 “between recommend and strong recommend” with a standard deviation of 0.78. The two items were significantly and strongly correlated without indicating multicollinearity ($r = .63$, $p < .001$).

Qualitative responses tended to fall into four categories based on useful and recommendation ratings: useful and recommend (n = 178), useful and not recommend (n = 4), not useful and recommend (n = 22), and not useful and not recommend (n = 20). The useful and recommended responses were positive and general statements in support of the intervention. In contrast, the not useful and not recommended were negative and general statements not in support of the intervention. The useful and not recommended responses indicated participants had participated in the intervention the previous semester or did not remember the intervention sufficiently to provide feedback. The most interesting responses came from those students who found the intervention not useful, but recommended it be continued. These responses focused on the students’ recognition that they did not need the intervention, but other students in the course likely found the intervention useful. Two example responses are, “I've had no difficulties with the course, so the activity wasn't very useful to me, and I assume there were other people who felt the same. Still, I can see how it could be helpful to some, which is why I put somewhat recommend” and “It didn't help me, but it likely helped other people in the class, so I don't think it should stop.”

Status of Project and Next Steps

To date as we approach the end of our initial four-year grant period, the research team has produced five journal articles [3], [4], [13], [14], [15] and has seven more under review. In addition, we have 15 published conference proceedings, including five at ASEE 2025 beyond the NSF Grantees Session. Data collection is winding up with our last data collection events occurring in Spring 2025. We currently have additional articles in various developmental stages including an article addressing our focus group methods, the ways that student perceptions of the intervention relate to academic outcomes, how faculty who implement the intervention are impacted by having engaged with the intervention in their classroom and continued testing of the intervention and academic outcomes at a Hispanic Serving Institution.

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