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Introduction

- Ecological belonging interventions seek to reduce inequities in STEM by creating a learning environment which normalizes intellectual struggle as a common and expected experience, so that students can build positive STEM identities rather than internalize stereotyped messages about who does and doesn't belong (Binning et al., 2020; Hammarlund et al., 2022).
- A study of an ecological belonging intervention designed for introductory STEM undergraduate courses found that intervention students demonstrated higher class attendance and grades, with greater effects for students who identified with groups minoritized in that field (Binning et al., 2020).
- An LRDC Internal Grant Award enabled a research-practice partnership between the Binning and Iriti labs at LRDC, in which they jointly worked to adapt and test the original ecological intervention for out-of-school time (OST) STEM programs serving high school students.
- Study participants were precollege STEM programs belonging to the STEM PUSH Network, a National Science Foundation INCLUDES Alliance focused on increasing rates of Black, Latine, and Indigenous student enrollment and persistence in STEM undergraduate study.

Intervention

Facilitator introduction: "It can be easy to feel overwhelmed or to sometimes wonder to yourself 'do I really belong here?' or 'Am I smart enough to make it?'"

Students write independently about an academic challenge they've experienced in STEM, and how it was (or might be) resolved.

Students listen to stories from program alum which highlight overcoming challenges in STEM learning.

Students discuss themes of stories in small groups.

Facilitator leads whole group discussion and sharing of themes.

Methods

Participants

Over 300 students experienced the intervention from 2022-2023; this analysis included 107 student pre-post survey responses from 5 programs covering 7 instances of implementation. 75% of survey respondents identified with racial/ethnic groups minoritized underrepresented STEM. Program STEM domains included biology research, engineering, environmental sustainability, science research, math & computer science, & general STEM.

Procedures

- Each program customized intervention materials – facilitator protocol, slide deck, student story vignettes, pre-and post-survey items – for their STEM domain and context.
- Intervention facilitators attended a 75-minute online training session walking through the intervention theory, purpose, and key components.
- A pre-survey was administered to participating students up to one week before the intervention. A post-survey was administered up to one week afterwards.
- Facilitators completed a form that prompted them to rate intervention components, reflect on levels of student engagement, and what they learned about students' and their own STEM experiences.

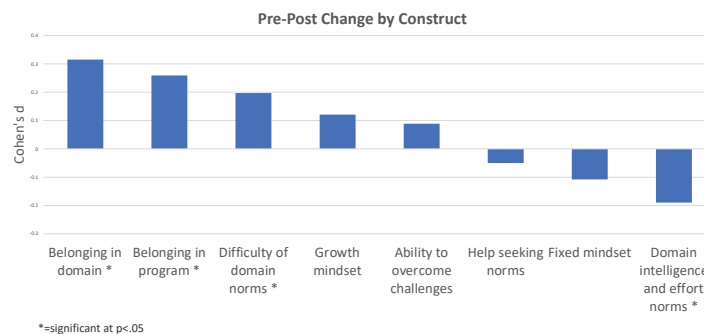
Data Analysis

- Paired t-tests to examine pre-post changes on survey constructs (n=107)
- Cohen's d to measure size and direction of changes
- Analyses of Variance (ANOVAs) to detect if changes in belonging constructs varied by year or program.
- Thematic analysis of open-ended reflection form responses (n=9)

Research Questions

- To what extent is an adapted ecological belonging intervention successful in increasing OST high school students' sense of STEM belonging and efficacy?
- What adaptations are required in translating the intervention from an undergraduate STEM course in the collegiate context to a high school level out-of-school time STEM program context?

Findings



RQ1. Effect of adapted intervention on STEM sense of belonging and efficacy

- Significant pre-post increase observed in *belonging in domain* ($p = .001$) and *belonging in program* ($p = .007$), consistent across year and program
- Significant pre-post changes observed in *difficulty of domain norms* ($p = .04$), and *domain intelligence and effort norms* ($p = .05$). For the latter, an average decrease is desirable.
- Constructs of growth mindset, fixed mindset, and help-seeking behaviors did not differ significantly from pre to post.
- Facilitators reported generally high levels of student engagement during the intervention, including a willingness to openly share their experiences of self-doubt and confusion in STEM subjects.
- Overall, most facilitators observed an increase in students' comfort level with each other, with asking questions, and with admitting when they were struggling. One facilitator said that students seemed "more at ease and happier to participate" after the intervention. Another summarized,

"I saw a huge difference this year in how engaged the students were in their lab work, analysis, lectures, etc. I never had to re-focus them or prompt them for questions or answers to my questions. This is different than years past. I really feel like this intervention allowed the students to feel safe in asking questions, making hypotheses, and voicing their opinions."

RQ2. Adaptations for college course-to-OST high school program context

- Intensive up-front customization process (program format, STEM domain, references to prior STEM experiences)
- Creation of alum reflection form to collect stories specific to program and high-school audience
- Group training routine for multiple facilitators per program (rather than single instructor at collegiate level)
- Intentional incorporation of facilitator stories of STEM struggle - especially when alum of their program - to increase student engagement and openness to share their own experiences within intervention
- Space for facilitators to reflect on personal approach to STEM teaching, and on their own STEM journey and identity

Conclusions & Implications

Overall, this study provides initial evidence that the adapted ecological belonging intervention has positive effects on participating students' sense of belonging in the domain and program. Further, preliminary evidence suggests that adaptations to the facilitator role may further strengthen the intervention's impacts on students and on STEM teaching practice.

- The adapted ecological belonging intervention is a promising tool for use in equity-driven, STEM-focused OST spaces.
- Greater variation in OST program structures requires the creation of efficient customization protocols for key intervention components. These efforts appear to increase message resonance with students, which in turn increase the power of the intervention.
- Insight into student experiences can inform program improvement and affirm program strengths.
- The opportunity to reflect on STEM, classroom, and program norms acts as a professional learning experience for facilitators that can influence STEM teaching practice and reframe narratives about their own STEM journey.
- High baselines suggest the intervention benefits may be less dramatic when there is explicit focus on building belonging for minoritized students, versus STEM courses at a predominantly white higher education institutions where this is not the focus.
- The salience of facilitator identity is an unknown factor, which also possibly influences the power of the intervention for different groups.

References

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