

WIP: Belonging matters: Exploring student engagement in innovation ecosystems

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Abstract—This innovative practice WIP paper describes how a sense of belonging is a crucial element in closing the participation gap in Innovation Competitions and Programs (ICPs) among underrepresented students. Apart from fostering student innovations and career readiness, ICPs, such as hackathons, start-up incubator competitions, and customer discovery labs, are essential to college entrepreneurship ecosystems. However, there is a participation gap in ICPs among traditionally underrepresented students (e.g., students identifying as women, ethnically or racially diverse, low socio-economic status, or individuals with disabilities) compared with their counterparts. In addition, employers now look for distinctive innovation-focused skills on resumes and consider ICPs as a differentiating attribute. Therefore, low ICP participation among underrepresented students places them at a disadvantage regarding their career development. Using an interview research methodology, this paper investigates two research questions: (i) what are the dimensions of belonging in the context of ICPs? (ii) how does belonging manifest in various student groups?

Index Terms—Co-curricular activities; diversity; inclusivity; entrepreneurship education; underrepresented students; innovation

I. INTRODUCTION

In today's engineering and technology education, fostering innovation and entrepreneurship is crucial for empowering students to cultivate essential 21st-century skills. Student Innovation Challenges Programs (ICPs), which include but are not limited to hackathons, idea challenges, technical competitions, start-up competitions, and customer discovery labs, are an effective way of introducing students to innovation and entrepreneurship. ICPs also provide students with opportunities to apply their classroom learning in real-life settings, expose them to new areas and interests, and support them in making more informed decisions about their career choices. In recent studies, ICP organizers [1] and participating

students [2] mentioned that ICPs develop abilities and skills such as adaptability and resilience, communication, domain-specific knowledge, networking, entrepreneurship, problem-solving, and teamwork, which are critical to innovation. Apart from fostering student innovations and career readiness, ICPs are essential to college entrepreneurship ecosystems [3], [4]. Despite booming university entrepreneurship ecosystems that provide opportunities for enhancing STEM education [5], there is a participation gap in ICPs among traditionally underrepresented students (e.g., students identifying as women, ethnically or racially diverse, low socio-economic status, or individuals with disabilities) compared with their counterparts [6], [7]. A lack of diversity and inclusion is identified as one of the student's negative experiences with ICPs [2] and a barrier to underrepresented student participation in ICPs [8]. Underrepresented students often find ICPs unwelcoming with judgment and perceive ICPs and the innovative industry as misogynous [9], [10]. These perceptions can significantly reduce the diversity of students who participate in ICPs. With these concerns, this paper investigates the role of belonging in enhancing the inclusivity of ICPs and the perceived belonging of students in ICPs, which is an under-studied topic in STEM education.

In higher education, belongingness refers to students' perceived social support, interconnectedness, and feeling of being esteemed by the campus community. Social belonging impacts students' engagement, achievement, and health. Not belonging may negatively affect student motivation to participate in ICPs. Employers are now looking for innovation-focused skills on student resumes and consider ICPs as a differentiating attribute. Unfortunately, low ICP participation among traditionally underrepresented students may put them at a disadvantage in their career development. In this research, we argue that a perceived sense of belonging is a crucial element when underrepresented students consider participating in ICPs. To understand students' motivation for ICP participation and make ICPs inclusive learning experiences for all students, this

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paper will answer two research questions: (RQ1) what are the dimensions of belonging in the context of ICPs? (RQ2) how does belonging manifest in various student groups?

II. BACKGROUND

A. Definition of belonging

Belonging is a basic human need and motivation. In the college context, belongingness refers to students' perceived social support on campus, a feeling of connectedness, the experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community [11]. Sense of belonging is relational, such that members feel that the campus community is important to them and that they are important to the community [11]. Extant research suggests that belonging is multidimensional: social connectedness and cultural capital [12], [13]. Social connectedness refers to a sense of affiliation with the university (identification with the university), perceived similarity to others at school (social match), and feelings of acceptance and getting along with others at school (social acceptance) [11]. Cultural capital, on the other hand, refers to having knowledge about how to navigate the academic system successfully [13].

Some studies suggest that social belonging is a psychological level that may have broad consequences that lessen inequalities in engagement [14], achievement, and health among college students [15]. Research has shown that positive social and situational support will facilitate students' college engagement and success [16], [17], particularly if faculty encourages engagement [18]. Peers also play an essential role in integrating students academically [19] and socially into the campus by encouraging extracurricular activities [18].

B. Extant research on the research between belonging and student involvement

The relationship between educational activities and entrepreneurial intentions is complex, as entrepreneurship education can sometimes deter students from pursuing entrepreneurship by highlighting the required commitment in time and financial resources [3]. Nevertheless, research suggests that students' campus involvement, including ICP participation, engenders their sense of belonging in college, and many even claimed that they did not feel like "part of the campus" until they were involved in a few clubs or campus activities [11]. Campus involvement gives rise to students' belonging by 1) connecting students with others who share their interests, values, and commitments; 2) familiarizing students with the campus environment and ecology; 3) affirming students' identity, interests, and values as "a part of campus"; and (4) generating feelings among students that they matter and others depend on them [11].

However, research has also shown that students from diverse backgrounds face various challenges that affect their engagement in university settings [20]. For example, underrepresented students in predominantly white institutions (PWI) may have access to spaces (e.g., student organizations and

affinity-based counseling groups) that support the social factors of belonging. However, they still encounter cultural capital barriers as PWI privilege the cultural capital of white, affluent students (e.g., computer-related vocabulary and technological skills) over that of underrepresented students (e.g., multiple language and communication skills) [12], [13].

III. RESEARCH METHODOLOGY

A. Research design

The primary research methodology in this research is a semi-structured interview to gather responses from students enrolled in various programs at a land-grant university in the Northeastern United States. Recruitment survey links were emailed to targeted academic programs and clubs. Then, 249 students responded to the survey, and 38 were invited to participate in the interviews. Interviews were conducted remotely and independently via video conferencing by two research team members, who were trained with uniform interview objectives and skills, at scheduled times and varied from 20-40 minutes in length. Questions touched on several areas, including barriers to participation in ICPs and challenges experienced by the ICP participants. Thirty-eight students (25 females vs. 13 males, 21 ICP participants vs. 17 non-participants, and 9 whites vs. 29 non-whites) were interviewed after a recruitment survey. About 85% of the students interviewed were from STEM-related majors. The complete recordings of the interviewee's responses to interview questions were transcribed into text for analysis.

B. Analytical approaches

In this paper, we analyzed the question, "Some students choose not to participate in innovation competitions and training programs because they're worried about fitting in and working with their team. Did/Do you have any similar concerns?". Thirty-six students responded to this question. The interview transcripts were analyzed using NVivo using a three-step approach. In the first stage, two members of the research teams reviewed the transcripts and independently generated codes using an "open-coding approach." These common codes were then combined to create a list of 28 common codes. In the second stage, team members coded the transcripts using these common codes. In the final stage, these codes were grouped into higher-level concepts (themes), which represented students' perceived sense of belonging to ICPs.

IV. RESULTS

Table I summarizes the identified codes and themes, the number of students mentioning a code related to the themes, and the average of the Kappa values, indicating inter-rater reliability of coding between two coders. The average Kappa value was calculated using NVivo's coding comparison query [21]. The average Kappa values indicate excellent agreement between the coders.

Three major categories of themes emerged from the data (RQ1): "social connectedness", "cultural capital", and "no concerns." Social connectedness is conceptualized as students'

concerns about receiving insufficient social support in ICPs, a feeling of connectedness, and the experience of mattering by the faculty/staff/peers in ICPs. Cultural capital is conceptualized as students' concerns about possessing insufficient knowledge of how to complete the tasks that pertain to ICPs. "No concerns" were coded when students claimed that they had no concerns about fitting in ICPs. The conceptual definitions of the themes are provided below, along with unedited sample student comments.

TABLE I
THE EXTRACTED THEMATIC CONCEPTS AND NUMBER OF PARTICIPANTS
MENTIONING THE CONCEPTS

Themes	Number of Students	Average Kappa	Codes
Perceived Negative Environment	8	0.82	Microaggressions; Unwelcoming environment
Fear of Being Discriminated	7	0.90	Challenges as a minority woman; Concerned about stereotypes; Discomfort of being different
Social Anxiety	10	0.94	Intimidation of working with more experienced students; Intimidation of voicing opinions in a group setting; Intimidation of working with investors; Introversion, shyness with new people; social anxiety; isolation
Team Dynamics Concerns	18	0.77	Stress-related to teamwork; team cohesion concerns; lack of team diversity
Team Formation Concerns	9	0.89	Difficulty finding a compatible team; not having a team with friends
Low Confidence in Skills/Knowledge	10	0.91	Feeling not qualified enough; imposter syndrome; lack of confidence; nervousness about skills and expertise; questioning own creativity or innovation
No Concerns	16	0.93	Encouraging environment; feel secured as outlier; friends participated in competitions; get along with others easily; growth opportunity despite fears; learn about oneself; learn from others; mentor support

A. Issues with social connectedness

1) *Perceived Negative Environment*: This theme refers to students' feelings of discomfort due to the lack of diversity, the challenge of fitting into existing group dynamics, or being unwelcome in competitive environments due to a lack of relevant background or skills.

"As a woman myself, sort of awkward when you walk into a room and it's mostly men especially, and the STEM field..."

2) *Fear of Being Discriminated*: This theme refers to concerns that students might be unfairly treated or judged based on characteristics such as gender, race, or background. In this study, some students expressed a sense of discomfort and alienation when entering new or existing groups where they are in the minority, such as being one of the few women or people of color.

"Being a minority and then a woman and then a Black woman. It's just not everyone shares my background. I've discovered, being at this university (a PWI), not everyone has talked to a Black person before, so it's kind of startling, coming from my suburban background to someone who's maybe lived

in a very small town, interacting with different perspectives."

This fear of discrimination is rooted in personal experiences and societal observations of discrimination, particularly in engineering programs, where certain demographics may be underrepresented. However, fear of discrimination may go beyond demographic characteristics to students' majors and disciplines.

"But when you read them, it seemed like it was a lot of just business engineering type things. So I think that would probably make people not want to participate if they don't have that type of background."

When the fear of discrimination becomes a reality, it can have a profound impact on a student's confidence, willingness to participate in group activities in competitive settings, or overall engagement. The students' perceptions of ICPs as a space where everyone is welcome are crucial. This underscores the urgent need to address and mitigate these concerns.

3) *Social Anxiety*: Social anxiety often stems from fears about initiating interpersonal interactions and fitting into student groups. Such social anxiety is caused by entering a new group without prior connections or fitting into the existing dynamics.

"I was interested, But I didn't know anyone who was in there. I was sort of scared of that. Going into a group of people you don't know and they're actually part of a team."

Addressing these anxieties through inclusive practices and support networks can help alleviate these barriers to student participation.

4) *Team Dynamics Concerns*: This theme is about working as a team with trustworthy members towards a common goal. Students have concerns about team conflict and strained relationships that may be caused by interpersonal compatibility, various points of view, social loafing, and free riders.

"I'm pretty particular about who I socialize with. I have to know people first in order to consider working with them on anything. So the feeling of being thrown into a group with people, I don't know. It's kind of antithetical. So what I do, which is how It works"

5) *Team Formation Concerns*: Team formation concerns refer to the issues and anxieties individuals face when assembling or finding teams to participate in ICPs. Some students considered team formation an essential prerequisite for ICPs.

"I almost think that you have to have a team before you even go into a competition, especially with the Hackathon, like I went in with the Tech Club, and like we already knew each other."

B. Issues with cultural capital

These concerns revolve around aligning goals, ensuring complementary skills, navigating interpersonal dynamics, and fostering an inclusive environment. Issues with cultural capital are manifested in the "low confidence in skills and knowledge" theme.

1) *Low Confidence in Skills and Knowledge*: Students had concerns about not being sufficiently prepared, skilled, or knowledgeable to contribute effectively to a competitive or team-based environment, particularly in fields like engineering. For example, a student expressed anxiety about not having the necessary knowledge or experience to participate meaningfully in competitions, fearing that this lack of preparation might prevent them from fitting into the team.

“Kind of similar to fitting in..., I’m ill-prepared. Like I don’t have the knowledge necessary or the experience necessary to sufficiently participate in a meaningful way.”

Another student mentioned hesitation in engaging in innovative projects due to a perceived lack of qualifications:

“I don’t think I’m qualified enough or I don’t think I know enough to be able to do well. If I were to do something like an innovative thing, I feel like there’s still more, I need to know more or I need help to support it.”

The above comment also illustrates the fear of fulfilling their own expectations or those of others. Low confidence in skills and knowledge or the inability to meet others’ expectations can influence students’ decisions to participate in ICP and be a barrier to participation and engagement.

C. No concerns

Many students indicated that they had no concerns about feeling they did not belong to ICPs. Several students highlighted the positive experiences of working in diverse teams.

“Not really, I like working with a team like that. It does make you learn more about people and you can learn more about the process itself. You just learn more from everyone’s experience.”

Some students also mentioned that the presence of supportive professors and mentors also played a crucial role in alleviating concerns about belonging. Students indicated that everyone participating in ICPs has similar fears and apprehensions, but the welcoming environment and supportive mentors helped.

“You’d think everyone who goes into an innovation competition is like an expert in the field and way better than you, especially as a freshman. But as soon as I got together with my team and our professor was really, really supportive.”

Cross-tab queries were used to investigate the patterns in students’ responses about “belonging” with respect to their demographic attributes (RQ2). Table II presents the ratio of students who mentioned a code related to the identified themes in four groups: Underrepresented-Female (UR-F), Underrepresented-Male (UR-M), Overrepresented-Female (OR-F), and Overrepresented-Male (OR-M). The overrepresented groups are white and Asian students who are more likely to participate in ICPs, and the underrepresented groups represent other races/ethnicities.

TABLE II
RATIO OF STUDENTS WHO MENTIONED A CODE RELATED TO THE THEMES, CROSS-TAB BY REPRESENTATION AND GENDER

Theme	UR-F	UR-M	OR-F	OR-M
Perceived Negative Environment	0.31	0.25	0.14	0.00
Fear of Being Discriminated	0.31	0.13	0.14	0.00
Social Anxiety	0.31	0.38	0.14	0.20
Team Dynamics	0.31	0.75	0.43	0.40
Team Formation	0.19	0.13	0.43	0.20
Fear of Failure	0.06	0.00	0.14	0.00
Low Confidence in Skills/Knowledge	0.25	0.25	0.29	0.40
No Concerns	0.44	0.50	0.43	0.40
Total (Unique)	16	8	7	5

Among UR-F, social connectedness-related themes, such as perceived negative environment, fear of being discriminated against, social anxiety, and team dynamics concerns, are mentioned the most (each 31%). As for UR-M, team dynamics received the most mentions (75%), followed by social anxiety (38%). As for OR-F, team dynamics and team formation have the most mentions (43% each). Lastly, for OR-M, team dynamics and low confidence in skills and knowledge received the most mentions (40%).

Overall, students from underrepresented groups reported concerns related to social connectedness more often than those from overrepresented (i.e., dominant) groups. In addition, underrepresented female students reported a perceived negative environment and fear of being discriminated against more frequently than their male counterparts. A higher ratio of underrepresented male students indicated social anxiety and team dynamics issues as concerns compared to female students. In fact, various demographic groups frequently mention concerns about team dynamics.

V. IMPLICATIONS: RELATIONSHIP BETWEEN BELONGING AND PARTICIPATION IN ICPs

When undergraduate students are regularly involved in clubs, organizations, and community groups, they feel that they are connected to the campus community. However, some underrepresented students reported that ICPs appear to be unwelcoming as they perceived that only “traditional” (i.e. white male) students with high-level technical skills participated in them. Female Black and Hispanic students experienced various forms of microaggressions, which made them uncomfortable in being involved in ICPs, such as ideas being passed on, excluding from team discussion, and outright isolation. As ICPs are mostly team-based activities, students said that they were stressed about fitting into the teams, especially if they felt they did not possess high-level technical skills. These concerns should be carefully considered by ICP organizers while designing their programs. As fostering a sense of belonging requires intentional and persistent support [22], ICPs should create a welcoming environment for all students. This includes inclusive messaging, rules and policies, opportunities for self-

reflection, and effective mentoring. Nevertheless, some underrepresented students also indicated that the ICP environment was welcoming once they engaged in the competition and learned a lot from their peers and mentors.

While ICPs are recognized for promoting students' innovation mindset, they can also offer fun and welcoming social contexts for students to engage physically, mentally, and socially on campus, thus creating a sense of belonging among students. They can contribute to fostering an innovation identity and belongingness in students by providing opportunities to work together in groups and support each other toward a common objective. The future research direction is to share the findings about perceived belongingness among underrepresented students with the ICP organizers. This will form a basis for designing and testing interventions to make ICP participation more inclusive and diverse.

VI. LIMITATIONS OF THE RESEARCH

The analysis of interview transcripts in qualitative research can be influenced by the research team's subjectivity and bias. To reduce researcher bias, two different research teams conducted and analyzed the interviews. The coding and thematic extraction processes were carried out using a collaborative consensus-building approach. Another limitation of this study is that it depends on students' self-reported perceptions and speculations about others' concerns. Although some participants reported that they personally do not experience any worries about fitting in or collaborating with others in innovation teams, they also acknowledged that these concerns could be significant barriers for other students. This reliance on conjecture rather than direct testimony may limit the accuracy of our findings concerning the broader student body's experiences.

VII. CONCLUSION AND FURTHER RESEARCH

This study analyzed student perceptions about belonging in innovation competitions and programs (ICPs), which play an important role in exposing students to entrepreneurship and innovation. Our findings indicated that fear of being discriminated against and perceived negative environments of ICPs are important concerns raised by student groups who participate in ICPs less frequently, which are represented by female, African American, or Hispanic/Latino students. However, whether these concerns about belonging have turned into a barrier to their ICP participation requires further investigation. Improving social connectedness, such as mitigating issues about social anxiety, team dynamics, or team formation, may encourage more diverse student groups to participate in ICPs.

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