Systemic Barriers to Participation in Innovation Competitions and Programs

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Abstract
In addition to promoting student innovations and career readiness, Innovation Competitions and Programs (ICPs), such as hackathons, idea design challenges, start-up incubator competitions, and customer discovery labs, are essential to college entrepreneurship ecosystems. The benefits of these experiential learning experiences for student development are well-documented in the literature. However, only a small percentage of STEM students participate in ICPs. The participation rate among underrepresented STEM students is even lower than that of other groups. Overall, the literature lacks empirical evidence on systemic barriers to ICP participation. This paper describes an investigation of systemic barriers that discourage students from participating in ICPs, based on eight focus groups (four male and four female) conducted across two institutions, totaling 38 participants (18 female and 20 male). During the focus groups, the participants analyzed a fictitious ICP and its promotional materials, identifying factors that may prevent them from participating. Transcripts of the focus groups were analyzed using thematic analysis, and the emerging themes from the results revealed several systemic barriers that discourage students from participating in ICPs, including but not limited to ICP promotional materials, recruitment processes, identities of mentors and judges, and program design (format, duration, rules, and policies). The findings inform the development of a theoretical model that explains how these barriers lower the participation among underrepresented students in the STEM fields. The paper concludes with recommendations to mitigate these barriers and enhance the inclusiveness and accessibility of ICPs across student groups.

Introduction

Student Innovation Challenges and Programs (ICPs) are a central component of many universities' innovation and entrepreneurship (I&E) ecosystems, fostering STEM-based student innovations and improving students' career readiness. In this paper, ICPs refer to formal or informal non-credit learning experiences that supplement STEM students' formal education. These ICPs include but are not limited to start-up incubator competitions, social entrepreneurship challenges, design challenges, start-up idea competitions, hackathons, innovation boot camps, idea discovery labs, and accelerator programs.

As noted in the literature, ICPs provide students with unique learning opportunities allowing them to: test ideas and work on real-world applications in a risk-free environment [1]; experience teamwork and leadership in multi-disciplinary settings[2]; access informal mentorship and networking opportunities with future employers [2, 3]; gain self-efficacy and enthusiasm [2, 3]; build innovative mindsets [1, 4]; and foster innovation, creativity, and critical thinking skills [5-7]. Collectively, these outcomes suggest that ICPs can strengthen students' agency and help cultivate resilience, complex reasoning, and adaptive problem-solving capacities.

Despite the above noted benefits and the booming university I&E ecosystems that provide these opportunities for enhancing STEM education [8], there is a participation gap in ICPs among traditionally underrepresented students in STEM (e.g., students identifying as women, ethnically or racially diverse, low socio-economic status, or individuals with disabilities) compared with

their counterparts [9-13]. Research on broader college experiences has shown that students from diverse backgrounds face various challenges that affect their engagement in university settings. Factors such as family income, parents' educational level, geographic location of home and high school, gender, race, and ethnicity have been linked to college learning outcomes [14, 15]. Other factors, such as stereotype threat [16], loneliness, and a sense of not belonging, along with students' previous educational and social preparedness, may negatively influence student motivation to participate in ICPs.

However, individual and demographic factors only partially explain students' decisions. Structural, systemic, or social barriers inherent in ICPs could also contribute to underrepresented students' low participation in ICPs [17]. Understanding the connection between barriers and student motivation is essential for devising interventions to overcome the barriers and fostering a more welcoming I&E ecosystem for all students. However, much of the discussion of ICP barriers remains fragmented or anecdotal, and there is a need for theory-driven, systematic inquiry into which ICP features were perceived as barriers by students. Although many papers introduce ICPs in the literature, only a limited number of studies have focused on the difficulties in supporting students' participation. Moreover, the literature has insufficiently explored strategies for enhancing diversity in ICPs [9, 13, 18-20], although an increasing number of universities are adding innovation hubs to their entrepreneurship ecosystems. A systematic review by Zappe et al. [21] highlighted the scarce examination of Diversity, Equity, and Inclusion within STEM entrepreneurship. This underscores a substantial literature gap that necessitates addressing disparities within STEM innovation and entrepreneurship programs. This paper aims to address this gap by examining the systemic barriers that affect students' decisions about ICPs.

We conduct face-to-face focus groups to understand the barriers that discourage students from participating in ICPs, using questions informed by the literature. To elicit grounded responses from participants, they review a fictitious ICP, respond to semi-open-ended questions, and discuss why they might or might not participate in the ICP. We then conduct a thematic analysis to identify and categorize perceived systemic barriers and to examine which program attributes are considered most consequential. The findings of our study answer two key research questions regarding ICP participation.

- *RQ1-What are the systemic barriers that discourage diverse student groups from participating in ICPs*?
- *RQ2-How do these perceived systemic barriers manifest differently among female versus male students?*

Based on students recruited from engineering, technology and science programs at two collaborating institutions, our results suggest systemic barriers play an important role in discouraging underrepresented students from participating in ICPs. This paper contributes to the literature by providing a systematic, theory-informed account of which ICP features act as systemic barriers and introducing a replicable focus-group study and thematic analysis approach for prioritizing program design interventions to increase ICP participation for all students. In doing so, this study not only identifies barriers specific to ICPs but also examines the extent to which these barriers align with or extend patterns observed in the broader literature on student engagement and entrepreneurship education.

Theoretical frameworks

ICPs are co-curricular activities. Hence, the theoretical models that describe students' motivation to participate in co-curricular activities apply to ICPs. These frameworks and models include Leisure Constraints Theory [22, 23], Expectancy-Value Theory [24, 25], Belonging Theory [26], and Theory of Planned Behavior [27].

Leisure Constraints Theory [23] explains why individuals may not engage in preferred leisure activities by categorizing barriers as intrapersonal (internal, such as stress), interpersonal (social, such as lack of companions), or structural (external, such as cost or time). The theory suggests that intrapersonal constraints must be addressed before others, but people often negotiate these barriers rather than simply forgoing leisure.

The Expectancy-Value (EV) theory of motivation [28] suggests that students' decisions to undertake a task are influenced by their perceived likelihood of success and how much they value the task compared to other options. According to Eccles et al. [25], a student must answer positively to two questions to engage in a task: "Can I do the task?" and "Is it worth doing the task?" The first question reflects the expectation of success in the task, and the second reflects the perceived value of performing the activity. Steegh et al. [29] use the EV theory to define motivations and characteristics of participants in a science competition. Their findings highlight the limiting effect of gender stereotypes and the importance of parental support for student success. Kulturel-Konak et al. [30] apply the EV theory in a thematic analysis of student interviews to understand how students decide to participate in ICPs, their motivations, and perceived barriers, which is highly relevant to increasing diversity and inclusivity in university entrepreneurial ecosystems. Their findings corroborate the theory's predictions by showing a disparity in perceived success expectancy between participating and non-participating students. An earlier quantitative research study using a survey based on the EV theory [31] reports that science students have lower value perceptions of ICPs than students majoring in professional degrees, which hinders their participation.

Leung et al. [32] adopt belonging theory as its primary theoretical framework, conceptualizing belonging as a motivational factor that influences whether students perceive that they "fit" and hence engage in ICPs, where belonging is operationalized as a two-dimensional construct: (1) social connectedness and (2) cultural capital. Specifically, threats to social connectedness can be regarded as interpersonal and social barriers, such as microaggressions, exclusion, and weak relational integration. In contrast, deficits in cultural capital can be interpreted as barriers tied to perceived competence, such as skills, know-how, and familiarity with innovation processes [32].

Theory of Planned Behavior (TPB) explains how intentions drive behavior using three constructs: attitude toward behavior, subjective norms, and perceived behavior control. Although TPB is frequently used to study student engagement or their intention to participate in entrepreneurship, its application in the context of ICPs has surprisingly been limited. TPB's subjective norms are related to social barriers while perceived behavioral control is related to

personal or structural barriers. Fu et al. [33] examine how external support, perceived usefulness, and perceived value influence ICP participation behavior, both directly and indirectly through institutional trust. Their findings indicate that perceived value is the strongest predictor of participation, highlighting the importance of students' evaluative judgments of competition benefits. External support also significantly enhances participation, reflecting the role of resources and encouragement.

Types of barriers

Recent bibliometric analysis of the literature on student participation in the I&E ecosystem using a Large Language Model suggests that students face four types of barriers that limit their participation in ICPs: structural, social, systemic, and psychological [34].

Structural barriers are the underlying policies, rules, and practices embedded in society that can have profound and unfair consequences for individuals, such as redlining [35] and funding formulas for school districts [36]. For ICPs, structural barriers include factors such as being a first-generation college student [37], gender stereotypes [38-42], or being a commuter student [43-45]. Structural barriers impede individuals or groups from accessing opportunities and resources.

Systemic barriers are interconnected patterns of policies, practices, and norms within institutions and programs that unintentionally sustain disadvantages. According to O'Brien et al. [46], underrepresented students face various systemic barriers, such as limited mentorship and restricted access to networks and resources, which hinder their entrepreneurial efforts. In the context of ICPs, these barriers may include patriarchal mentoring cultures [47], low awareness and outreach [48, 49], lack of diversity among ICP organizers and mentors [50], absence of explicit anti-discrimination policies [50], insufficient academic advising and encouragement [51], time constraints [49, 52], implicit biases in recruitment and promotion [50, 53], and a competitive environment [54].

Social barriers relate to students' interactions with family, faculty/staff, and peers, and to the resultant perceptions, attitudes, beliefs, and behaviors rooted in social norms and cultural expectations, both intended and unintended. Examples of social barriers include a lack of diverse role models and peer networks [12, 53, 55] and misconceptions about the innovation identity [30].

Psychological barriers refer to the cost concepts often found in the educational psychology literature across various educational contexts. In the EV theory, psychological barriers are conceptualized as costs that individuals evaluate to determine whether the costs of the task outweigh its benefits, particularly compared to alternative tasks [24]. Some of the costs theorized include emotional costs – the emotional or psychological costs of pursuing the task, particularly anticipated anxiety, as well as the emotional and social costs of failure [56, 57]. Students lacking prior experience with innovation tasks or those with low self-efficacy in their skills tend to view ICPs as having a low expectancy of success [31]. This barrier can interact with other systemic factors, such as the scarcity of role models and limited early exposure to open-ended design work, to further discourage participation.

The barriers mentioned above also do not act in isolation or additively. They interact with one another in complex ways. Therefore, an intersectional perspective [58] to analyze both individual-level and broader structural and systemic factors influencing students' engagement and participation in ICPs can be beneficial. In this study, we focus our investigation on the systemic barriers and how they potentially interact with other types of barriers that discourage students from ICP participation.

Methodology

Guided by the theoretical frameworks discussed in the background, we develop a list of systemic, structural, and social barriers to participation in ICPs. Students review and discuss these barriers in focus groups, providing the insights needed to answer our research questions. We recruited students from engineering, technology, and science programs at the two collaborating institutions via an emailed screener questionnaire. This questionnaire included additional demographic data beyond the major, such as race, gender, grants and scholarships received, co-curricular participation, part-time or full-time work, and first-generation status. We used stratified sampling to invite participants from various groups, ensuring that our recruitment aligns with our goals for equitable representation. Participants selected for the focus group performed the following activities:

1. Reviewed promotional material and policies for a fictitious ICP called AI for Good.
2. Wrote short responses to the focus group questions on a worksheet individually.
3. Discussed their opinions with other focus group participants.

A complete summary of the protocol used to administer the focus group is presented in the Appendix.

Our ICP promotional material, *AI for Good*, consisted of a flyer and a seven-page document outlining the following: benefits of participation; key milestones (defined as challenge phases) and expected deliverables; prizes available per challenge phase; expected development costs; instructions on how to build your team; and the evaluation rubric. The flyer provided a concise summary of the ICP benefits, key dates, and a web URL link for additional information. Two versions of the flyer were generated: one featured an all-male image, and the other featured a more diverse student representation, including both genders and ethnicities. These two promotional packets were combined with the focus group questions and randomly distributed to the students during the focus group session.

The focus group questions were structured into two sections: (i) an evaluation of the promotional materials, and (ii) an assessment of the systemic, structural, and social barriers that limit participation in ICPs. Students spent 10 minutes reading/viewing the promotional materials prior to answering the evaluation questions. The evaluation questions addressed scope, faculty mentorship, duration, policies and rules, and likelihood of participation. Students also identified the ICP's attributes that were most encouraging and most discouraging. The second section of the focus group questions involved the students' rating of questions related to the systemic, structural, and social barriers. Items were rated on a seven-point Likert scale from strongly disagree (1) to strongly agree (7), with neutral responses anchored at the midpoint. A higher

score indicated stronger agreement that the identified issue posed a greater barrier to participation. Each question was framed similarly, asking students to determine "to what extent do you agree or disagree that these barriers may prevent you from participating in these programs." Regarding systemic barriers, which are the primary focus of this paper, questions assessed participants' perceptions of access to information, competitiveness, competition requirements, competition theme, and recruitment processes. In addition to the quantitative ranking of the influence of the barriers, students were asked to elaborate on their ratings. Lastly, they were asked to offer suggestions for improvement in the access, appeal, and support of ICPs.

Thematic analysis and coding

During the focus groups, two data sets were collected: participants' individual responses to the open-ended questions in the handout and transcripts of the follow-up discussions. The focus group discussions were recorded on Zoom, and they were transcribed using automated transcription software. The transcripts were automatically parsed when possible, or manually by the research team, into participants' individual responses so that coding could be performed on a participant-by-participant basis. The parsed transcripts and codes were exported to Microsoft Excel for the coding process.

In this study, to facilitate the coding process of the transcripts, we utilized a deductive coding approach by using the codes based on recent bibliometric analysis [34]. During the coding process, however, these initial codes did not cover all the concepts mentioned by the participants. We added a few new codes directly extracted from the transcripts. We construct descriptive statistics (mean and frequency) to identify the most prevalent factors discouraging ICP participation.

Results

A total of eight face-to-face focus groups, across two institutions, were conducted. Four of the focus groups were male, four were female, resulting in 38 participants in total (18 female and 20 males). This research did not mix gender in the focus groups, as men may tend to speak more frequently and with more authority when in groups of women and can irritate the women in the group. Therefore, it is imperative to have gender homogeneity within groups for both participants' comfort and analysis purposes [59]. On average, each focus group lasted 94 minutes in length. Most (n=34) participants were Engineering majors, and the rest were Science (n=2) and Technology (n=2) majors. We triangulate the individual responses (from the worksheets) and codes that were mentioned in the focus group transcripts.

Table 1 presents the mean scores of three statements. The first two assess the likelihood of participation based on promotional materials (Q1) and ICP policies and procedures (Q2). The third statement (Q3) assesses the degree to which time commitment barrier prevents them from participating in the ICP. Each statement is answered using a Likert scale from strongly disagree (1) to strongly agree (7), with neutral responses anchored at the midpoint. After scrutinizing the promotional materials, the participants gave higher ratings to the policies than to the materials themselves (4.30 vs. 3.86), suggesting that there were design issues (e.g., images, colors, etc.) associated with the ICP materials. Male participants appear to report greater likelihoods of

participating in ICP compared to female participants, both based on promotional materials (4.39 vs, 3.29) and policies (5.06 vs. 3.50).

Among all barriers, time commitment has the highest score (5.72). Among various systemic barriers that discourage ICP participation, the themes of competition (5.00), the requirement for competition (4.94), and the recruitment process (4.76) have the highest mean scores. Nevertheless, females perceived access to information is the most challenging barrier (5.22 vs. 3.72), compared to their male counterparts.

Table 2 provides a summary of the codes used, along with their definitions and excerpts from the focus group transcripts. Table 3 presents the codes mentioned by the participants in the focus groups. Among the systemic barriers that are discussed, the codes that are mentioned the most are as follows: team formation obstacles (52), competition too long (34), patriarchal mentoring cultures (20), unclear competition information (17), delivery mode consistency (16), and limited mentorship & networking (15). Compared to the male participants, female participants were more critical about the patriarchal mentoring cultures of ICPs (20 vs. 0).

Table 1. Summary of mean scores based on individual responses to systematic factors

Question	Statement	Female	Male	Total
Q1	Likely to participate based on promotional materials	3.29	4.39	3.86
Q2	Likely to participate based on ICP rules and policies	3.50	5.06	4.30
Q3-i	Time commitment as a participation barrier	6.06	5.39	5.72
Q3-ii	Access to information is a barrier	5.22	3.72	4.47
Q3-iii	Requirement of competition is a barrier	5.0	4.89	4.94
Q3-iv	Theme of competition is a barrier	4.83	5.17	5.00
Q3-v	Recruitment process is a barrier	4.38	5.11	4.76
Q3-vi	Competitive environment is a barrier	3.72	3.94	3.83

Table 2. Summary of codes used, definitions and excerpts from the focus group transcripts

Code	Definition	Examples
Team formation obstacles	Difficulty finding, forming, or assembling a team/group in order to participate.	"I'm finding an effective team is, like the hardest part." (Male; PS21) "I think it'd be really hard to, like, find a team to, like, do it with" (Female; PS08)
Competition too long	The competition/program is perceived as too long/too lengthy, or participants want a shorter schedule/time period.	"I'm just not a fan lengthy projects and like even reading this is kind of" (Female; PS11) "Right. So I would also prefer a shorter time period, so it would be short and efficient kind of So" (Male; PS18)
Patriarchal mentoring cultures	Gendered dominance dynamics in group/learning/mentoring contexts (e.g., men "talk over" women, override ideas), explicitly marked with gendered terms (e.g., "guys," "girls").	"You can get a group of guys together with, like, a couple of girls with their guy to talk over you." (Female; PS10) "I would like say things, and they completely bulldozer over it." (Female; PS10)
Unclear competition information	Competition/program rules, instructions, or expectations are described as confusing/unclear, or the speaker says they misinterpreted them.	"I think I interpreted this wrong, . I'm confused. Okay," (Female; PS05) "it seems like a little bit confusing." (Male; PS22)

Delivery mode inconsistency	The program is framed as mixed or inconsistent in delivery mode (virtual vs in-person), or the mode shift/mix creates participation or communication issues.	"part of it's virtual and part of it's in person." (Female; PS10) "tougher to communicate with the group members virtually compared to in person." (Male; PS26)
Limited mentorship & networking	Insufficient access to mentorship, guidance, or networking, or explicit statements that mentorship/networking is needed to participate/succeed.	"lack of mentorship, like guidance" (Male; MS5) "I think I just need more networking opportunities" (Male; PS28)
Information access inequity	Unequal access to information/resources based on connections (professors/friends), institutional positioning, or uneven resources across groups.	"you either have a class or you're really tight with a professor." (Male; PS21) "It would be hard if they don't have any friends, or like anybody" (Female; FS1)
Interdisciplinary challenges	Difficulties tied to cross-discipline coordination, needing multiple domains, or figuring out roles/knowledge across disciplines.	"Tech skills. And then it's the business knowledge." (Male; PS21) "everybody's trying to know their place and who knows what so and like, an interdisciplinary group," (Female; PS06)
Biased assessment criteria	Evaluation/judging is described as hard to judge, favoring some participants, or otherwise not straightforward/fair.	"it would be kind of difficult to judge who is actually new at it" (Male; PS23) "It's those who have. There's like a sliver of favors" (Male; MS3)
Homogeneous judging panels	Judging panels are described as non-diverse/homogeneous, explicitly tied to evaluation.	"just feels more target towards STEM majors, and very specific niche things" (Female; PS14)
Inadequate university support structures	University/campus support is described as insufficient or hard to access, including costs falling on students or unclear campus resource pathways.	"The development to come out of your pocket." (Female; FS1) "Epicenter, because I feel like I don't know information." (Male; PS27)
Implicit bias in recruitment & promotion	Outreach/promotion is described as favoring/biased toward certain fields/groups, or promotional materials suggest the program is "for" certain majors.	"I do believe ICP programs and promotions are favored." (Female; FS3) "just from the first promotional materials, you would think that" (Male; PS28)
Lack of diversity in ICP leadership	ICP organizers/leaders are described as not diverse, explicitly tied to leadership/organizers.	"but I don't see a lot of Hispanics on this campus" (Female: PS11)

Discussions and Implications

These findings reveal several points along the participation pathway where students face obstacles. Some barriers occur before entry, others arise during ICPs, and additional challenges appear during judging and within the broader environment. Early on, factors such as unclear competition information and implicit bias in recruitment and promotion can prevent students from understanding the competition or from becoming involved, though explicit recruitment bias is rarely mentioned in our study. Information access inequity means essential details or resources are sometimes only available through selected classes, professors, or peer networks. Again, these concerns were mentioned by a few participants. At the entry stage, team formation difficulties and limited mentorship or networking are barriers that many may find significant, making it

harder for students to form groups and access guidance or connections. During participation, concerns such as overly long competitions and inconsistent delivery modes add stress, making coordination more complicated due to a mix of virtual and in-person formats. Interdisciplinary challenges arise from integrating multiple fields and coordinating diverse roles. Inadequate university support structures, such as financial burdens, limited campus resources, or restricted access during ICPs, may also pose problems, though not many participants report these issues. In fact, many commented on the availability of the resources for them. Cultural dynamics, such as patriarchal mentoring cultures where some voices dominate discussions, further shape the experience. Finally, at the conclusion of ICPs, students can be discouraged by biased assessment criteria, which are sometimes seen as favoring prior experience or resources or being difficult to judge fairly. The next section situates these findings within the existing literature and introduces several intervention strategies.

Table 3. The number of times that codes are mentioned in the Focus Group Transcripts

Codes	Female	Male	Total
Team formation obstacles	26	26	52
Competition too long	15	19	34
Patriarchal mentoring cultures	20	0	20
Unclear competition information	11	6	17
Delivery mode inconsistency	8	8	16
Limited mentorship & networking	9	6	15
Information access inequity	2	2	4
Interdisciplinary challenges	3	0	3
Biased assessment criteria	2	0	2
Homogeneous judging panels	2	0	2
Inadequate university support structures	0	2	2
Implicit bias in recruitment & promotion	0	1	1
Lack of diversity in ICP leadership	1	0	1

Our study suggests that team formation is the most significant systemic barrier, regardless of gender. Similar to the fictitious ICP used in focus groups, nearly all ICPs require team participation. Previous research consistently highlights team formation as a major challenge in ICPs. Students often report difficulty forming committed teams due to limited peer interest, scheduling conflicts, and concerns about uneven workload distribution or free riders [49]. These challenges are further worsened by issues in team dynamics, such as poor communication and lack of leadership, which negatively impact participation and overall outcomes [60]. Comparative studies of student experiences also show that team-related problems are among the most common barriers, alongside resource limitations and program structure issues [61]. To overcome team formation barriers, ICPs can adopt several best practices. These include structured team-matching platforms where students form teams based on shared interests, pre-ICP networking events, and team-building workshops to promote collaboration.

The second-highest reported barrier was the length of the competition. Some participants thought that the 7-month long fictitious ICP was too long, while others preferred longer ICPs. This emphasizes the need for different types of ICPs with varying challenge levels to better engage

more students. Providing flexible participation options (e.g., hybrid or modular formats) can reduce time burden.

Another significant barrier is the mentoring culture. As stated earlier, lack of diversity among ICP organizers and mentors is a concern [50]. In our study, female participants raised concerns about patriarchal mentoring cultures, while males did not. As a systemic barrier, patriarchal mentoring cultures may disproportionately affect women with multiple marginalized identities due to their interaction with social norms, implicit bias, and unequal access to informal mentoring networks. Walden et al. [11] suggest that the lack of diversity among engineering faculty members contributes to an overall deficiency of diversity in student design competitions. Both males and females also mentioned networking and mentoring. This finding highlights the social aspects of ICPs, as participants viewed them both as opportunities to build skills and expand their networks. Creating inclusive mentor groups with gender and cultural diversity is essential to reducing patriarchal mentoring cultures. Additionally, providing mentor training on equity and cultural sensitivity, along with transparent mentorship models, can enhance both students' and mentors' experiences and stimulate collaboration. ICPs should also make mentorship opportunities explicit for students to experience. Peer mentorship offers an additional approach to overcoming this barrier. When upper-division students or previous winners mentor novice teams, both the mentors and mentees benefit [62].

Several findings provide more nuanced, context-specific insights within ICPs. Female participants uniquely highlighted patriarchal mentoring cultures, revealing how systemic features are experienced differently and may be overlooked in aggregate analyses. Team formation emerged as the most common barrier, suggesting it acts as a key gatekeeping mechanism. Overall, these results deepen and contextualize existing literature within the structure and culture of ICPs.

An important yet often overlooked finding in this study is the disparity between participants' likelihood of participation based on ICP policies versus promotional materials, with promotional materials receiving consistently lower ratings. This gap was more pronounced among female participants, suggesting that promotional artifacts may function as an early gatekeeping mechanism that shapes students' perceptions of who belongs in innovation competitions. While formal policies may articulate inclusivity and equal access, promotional materials serve as the primary point of entry and are often the first signal students encounter when deciding whether to engage. Visual imagery, language choices, color schemes, and representations of prior participants can implicitly communicate normative expectations about identity, expertise, and fit. These findings underscore the need for ICP organizers to treat promotional materials not merely as marketing tools, but as critical design elements that shape access and participation. Intentional attention to inclusive language, diverse representation, and values-oriented framing may reduce perceptual barriers and better align promotional messaging with the inclusive goals articulated in ICP policies.

Conclusions

This study examined barriers to student participation in Innovation Competitions and Programs (ICPs), with a primary focus on systemic barriers and attention to gender-based differences in perceptions and experiences. Using a mixed-methods approach, the findings indicate that systemic design features, such as time commitment, team formation requirements, competition framing, and recruitment processes, significantly discourage participation, even among students initially interested in innovation activities. Female participants consistently reported lower likelihoods of participation and higher perceived barriers, particularly related to access to information and mentoring cultures, and uniquely identified patriarchal mentoring practices and homogeneous leadership as deterrents. The convergence of quantitative and qualitative findings demonstrates that participation inequities in ICPs are not driven solely by individual motivation but are largely shaped by systemic structures and norms embedded within these programs. Addressing these barriers requires intentionally redesigning ICPs to align participation structures, recruitment practices, and mentoring models with inclusive educational goals. This study confirms and extends existing knowledge about barriers to student engagement in innovation and entrepreneurship ecosystems. While it does not identify entirely new barrier categories, it offers one of the first systematic, empirical analyses of how these barriers function within ICPs, strengthening existing frameworks. The findings also highlight gender-based differences and underscore the need for broader intersectional analysis. Future research will examine how factors like first-generation status, socioeconomic background, and work commitments interact to shape access to and experiences within ICPs. In addition, triangulating the results with quantitative data from a large population, to be collected in the near future, will improve their credibility.

While the Likert scale instrument used in this study provides quantitative data on participant perceptions of systemic barriers, we acknowledge that the specificity of the questions may introduce response bias. Open-ended questions were included in the survey instrument to facilitate a comparative subjective analysis in future work, which will allow us to determine whether the qualitative themes align with the quantitative findings and provide a more robust interpretation of participant perceptions.

The next stage of the project involves assessing internal perceptual factors to understand how students perceive and develop their views on ICP opportunities. Building on insights into systematic, systemic, and social barriers, along with theoretical perspectives on how internal perceptual factors influence student participation in ICPs, the final stage will involve developing and testing interventions based on these findings. The aim is to address the adverse effects of these differences, ultimately helping to improve the participation of underrepresented STEM students in ICPs.

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Appendix.

The following protocol was used for all focus groups.

1. Confirm participants' participation via email. Only the same gender group is to be conducted.
2. Make sure the participants have completed the recruitment survey for the demographic data.
3. Ask the participants to complete the consent forms.
4. Mark the completed consent form with participants' "STUDY ID"
5. Distribute: Flyer 1 (Version A or B, ask the respondent to write their name on it), Flyer 2, and Case.
6. Host: Open a personal meeting room on Zoom. Do a test recording if needed.
7. Get blank paper and markers. Ask the students to make name tents for themselves, so that the moderator can call on students efficiently.
8. Moderator: self-introduction and explain the purpose of the focus group. Explain to the students that the focus group will be recorded so that transcript will be generated. The identity of the students remains anonymous in the analysis.
9. Ask the participants to read Flyer 1, Flyer 2, and Case (10 minutes)
10. Distribute Focus Group Questions document.
11. Click on "AI Companion" on Zoom, and click "record" in the Zoom meeting room.
12. Research assistant starts taking notes.
13. Participants answer individually: Q2-14 (~10 minutes)
14. Group discussions: Q2-14 (~15 minutes)
15. Participants answer individually: Q15-17 ~(5 minutes)
16. Group discussions: Q15-17 (~10 minutes)
17. Participants answer individually: Q18-19 (~4 minutes)

18. Group discussions: Q18-19 (~8 minutes)
19. Participants answer individually: Q20-23 (~8 minutes)
20. Group discussions: Q20-23 (~10 minutes)
21. Participants answer individually: Q24-25 (~2 minutes)
22. Group discussions: Q24-25 (~4 minutes)
23. Thank the participants and tell them that the gift card will be electronically sent to them.
24. Collect all materials from the participants. Use the tent to sort the materials (completed focus group questions, flyers, case) by “STUDY ID.” Mark “STUDY ID” on all materials.