

Original Research Paper

# Measures of Belonging in a Campus STEM Community

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**Abstract:** It is well documented that belonging in a STEM community can improve student engagement and persistence. This study examines the aggregated data from several interventions across multiple college campuses designed to improve STEM students' sense of belonging. Similar survey data were combined to determine the impact of First2 Network campus club participation and faculty-student engagement events on STEM students' self-reported feelings of belonging. Variables including students' year in school and levels of engagement were examined.

**Keywords:** belonging; persistence; undergraduate STEM

## Introduction

Research over decades, such as that summarized in the AAAS report focusing on NSF programs that support low-income students (AAAS, 2023), have shown that a student's sense of belonging—the feeling that they matter and are valued by peers, faculty, and staff—is one of the strongest predictors of both persistence and performance in STEM, especially in first-generation and other underrepresented students. When learners come to see themselves as bona-fide members of their institution's scientific community, they are more likely to participate in high-impact educational experiences and to remain on a STEM pathway (Hausmann et al., 2007; Hansen et al., 2020). This relationship holds true in a wide range of contexts, including Minority-Serving Institutions and both teaching- and research-focused schools (Wilson et al., 2015). Importantly, STEM-specific belonging predicts persistence more powerfully than a general campus-level sense of belonging, underscoring the need for domain-tailored support.

Belonging, however, is not a fixed trait; it is highly responsive to deliberate curricular and co-curricular design. Evidence-based practices such as structured mentoring, undergraduate research experiences, service-learning courses, and other cognitive or psychosocial interventions consistently boost educational outcomes for STEM students (Engle & Tinto, 2008). These strategies are especially potent for low-income and first-generation learners, who often enter college with less built-in academic capital. Even

brief, theory-driven psychological exercises—sometimes delivered in a single class period—have been shown to raise grades, strengthen persistence intentions, and improve overall well-being (Brady et al., 2020). Taken together, the literature suggests that cultivating STEM community belonging is not merely supportive but essential: when students genuinely belong, they stay and they succeed.

First2 Network is a networked improvement community that includes nine higher education institutions across West Virginia and Kentucky. Its members—undergraduate students, faculty, student success staff, and stakeholders from numerous partner organizations—are engaged in efforts to double the graduation rate of first-generation, low income and rural students in STEM fields of study. In this paper we examine data across the network that focuses on belonging. Eight participating higher education institutions in West Virginia and one in Kentucky have developed, tested and documented change ideas aimed at improving students' sense of belonging in a STEM community.

One of these change ideas is a Campus Club. First-generation student leaders working as part of First2 campus teams lead Campus Clubs that connect first-generation college students in STEM majors to other students and faculty with the aim of increasing first-generation students' sense of belonging to support overall academic success. Originally, club membership focused on the student leaders themselves and provided a platform for them to support each other and to plan

events for the larger student body. In recent years, membership has been widened to other STEM students.

A second change idea is faculty-student social interactions. These are often conceived and planned by First2 student leaders and take on a variety of formats. Examples include ice cream socials, faculty panels, bingo nights, improvisational events, and policy discussions.

## Materials and Methods

A key required component of improvement research is to collect quick data to determine if a change idea is making an improvement to the designated problem. In the case of interventions aimed at improving STEM student belonging, students who participate in these events are surveyed.

### *First2 Campus Club participation*

As part of this study, First2 obtained survey responses from a total of 74 students at 7 First2 Network higher education institutions. Surveys asked about students' participation in First2 Campus Clubs at the end of each semester from Fall 2022 through Fall 2024. The surveys asked about students' year in college, status as a funded First2 student leader, number of meetings attended, and whether they attended at least one meeting per semester.

Students were asked to respond on a 5-point scale how strongly they agreed with 3 statements adapted from the Sense of Belonging in Math scale (see Good, Rattan and Dweck, 2012):

- I feel respected in my STEM community.
- I feel comfortable in my STEM community.
- I feel that I belong in my STEM community.

The scale includes the choices “Strongly Agree”, “Somewhat Agree”, “Neither Agree or Disagree”, “Somewhat Disagree”, and “Strongly Disagree”

Students also responded to an open-ended question that asked for ways in which participation in the club impacted their “sense of acceptance and belonging at college.”

### *Student-Faculty Social Interactions on Feelings of Belonging*

Faculty-student social events, organized and led by First2 Network student leaders are open to all STEM

students on campus. These events, which enjoy a larger audience, are documented as First2 Network change ideas as well, and are therefore subject to measurement.

A total of 208 students were surveyed after they participated in a social event with faculty and administrators between Fall 2022 and Fall 2024. Of those surveyed, 141 responded to a survey that included the same three common questions on belonging that were used with the Campus Club surveys. Most of the students surveyed were not First2 student leaders but rather, members of the general STEM student population on their campus.

The following guidance was provided in the survey before presentation of the statements: “*STEM community refers to the broad group of people involved in a STEM field, including the students in your STEM courses. We would like you to consider your membership in the STEM community. By virtue of having taken many STEM courses, both in high school and/or in college, you could consider yourself a member of the STEM community at your campus.*”

We also examined responses to earlier surveys that pre-date the use of the three common questions. Below we discuss the results of these two activities separately, beginning with campus clubs.

## Results

### *Results from Campus Club Participation*

Of the 74 students surveyed, 68 responded to the belonging questions. Student leaders—students funded by the First2 Network—made up 58 (84%) of these responses; Eleven (16%) responses were from students never funded by or otherwise involved with First2 Network. Student responses were distributed across all four years in college - freshmen, sophomores, juniors and seniors - with a plurality of second-year students (Table 1). The data pool includes students who responded to the survey more than once, in different semesters.

**Table 1. Distribution of student survey respondents by year in college**

Year in College	Number of respondents
Year 1	14
Year 2	28
Year 3	17
Year 4	10

All non-funded students (100%) and most funded student leaders (94%) responded Strongly Agree or Somewhat Agree to all three belonging questions (Figure 1).

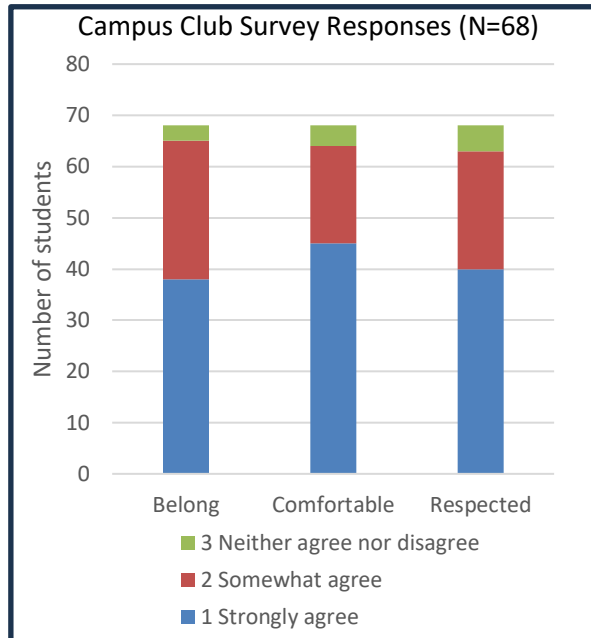


Figure 1: Student survey responses to 3 belonging items.

We looked at whether students’ responses were affected by how many meetings they reported attending during the semester (Table 2).

For each of the belonging questions, the percentage of students who answered “Strongly Agree” was higher for students who attended at least 3 meetings compared to those who attended only one or two. Students who were more engaged in campus clubs, attending more meetings, were more likely to acknowledge feelings of belonging.

Table 2: Belonging by campus club attendance.

Number of Meetings	Response Choice			Total Number of Students
	Strongly agree	Somewhat agree	Neither agree nor disagree	
<b>1-2 meetings</b>				<b>6</b>
Belong	33%	67%	0%	
Comfortable	50%	50%	0%	
Respected	50%	33%	17%	

<b>3-4 meetings</b>				<b>8</b>
Belong	50%	38%	13%	
Comfortable	75%	13%	13%	
Respected	63%	25%	13%	
<b>5+ meetings</b>				<b>54</b>
Belong	59%	37%	4%	
Comfortable	67%	28%	6%	
Respected	59%	35%	6%	

Another variable we examined was whether student responses were affected by their year in college (Figure 2 and Table 3).

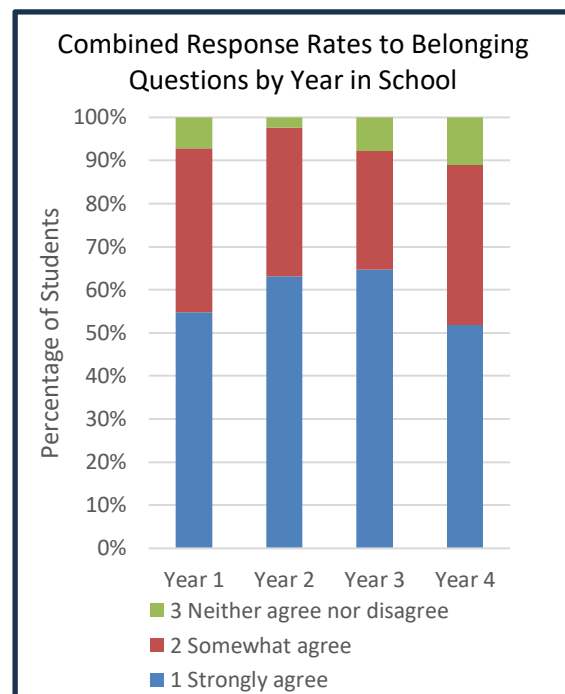


Figure 2: Belonging by year in college

Students in their second and third years report more positive responses to all three questions, with a noticeable drop in positive response in year 4.

When viewed individually, as seen in Table 3, second-year and third year students more often selected “Strongly agree” to the statement I feel like I belong in my STEM community (61% and 59% respectively), than first (50%), and fourth-year students (44%). Third-year students selected strongly agree at the highest rate for the question relating to comfort. These interesting findings-particularly the drop among fourth year students have prompted additional inquiry, and will be investigated in future student focus groups.

**Table 3: Response rates to each belonging question by year in college**

By Year in School	Response Choice			Total
	Strongly agree	Somewhat agree	Neither agree nor disagree	
<b>Year 1</b>				<b>14</b>
Belong	50%	43%	7%	
Comfortable	64%	29%	7%	
Respected	50%	43%	7%	
<b>Year 2</b>				<b>28</b>
Belong	61%	36%	4%	
Comfortable	64%	36%	0%	
Respected	64%	32%	4%	
<b>Year 3</b>				<b>17</b>
Belong	59%	35%	6%	
Comfortable	76%	18%	6%	
Respected	59%	29%	12%	
<b>Year 4</b>				<b>9</b>
Belong	44%	56%	0%	
Comfortable	56%	22%	22%	
Respected	56%	33%	11%	

Finally, we examined open-ended responses to the question “In what ways has your experience with First2 Campus Club this semester influenced your sense of acceptance and belonging at college?”

Forty-four unique responses were recorded. We conducted a basic thematic analysis (Hsieh and Shannon, 2005, Kiger and Varpio,2020) of the statements and six broad categories of responses emerged (Table 4). Some responses touched on more than one theme, so totals exceed 44.

Friendships, shared goals/interests, and mutual support were the most frequently mentioned benefits. For example:

*"Being able to finally find friends facing similar challenges has greatly increased my sense of belonging."*

**Table 4: Ways in which Campus Club participation influenced belonging.**

Theme	# Responses	% of Responses
Community & Peer Connection	28	63.6%
Access to Resources, Opportunities, & Mentorship	13	29.5%
Increased Comfort & Confidence	9	20.5%
Event Participation & Engagement	7	15.9%
Representation & Identity Affirmation	6	13.6%
Minimal or No Impact	4	9.1%

Also frequently cited, the club served as a pathway to research opportunities, professional and peer networking, and faculty or peer mentorship.

*"I have been able to connect to faculty members and have gained many research opportunities."*

Four respondents indicated the club had little or no effect on their belonging, often because they already felt connected.

*Results from Student-Faculty Social Interactions on Feelings of Belonging*

As in the campus club surveys, the responses were overwhelmingly positive. Of the 141 students who participated in faculty-student social events, and who answered the three belonging questions, most students strongly or somewhat agreed with the statements “I feel respected in my STEM community.” (90%), “I feel comfortable in my STEM community.” (93%) and “I feel that I belong in my STEM community.” (90%)

**Table 5: Responses to Belonging Questions after Faculty-Student Social Events N=141**

**I feel respected in my STEM community.**

Strongly Agree	87 (62%)
Somewhat Agree	40 (28%)
Neither Agree nor Disagree	5 (4%)
Somewhat Disagree	5 (4%)
Strongly disagree	4 (3%)

**I feel comfortable in my STEM community.**

Strongly Agree	98 (70%)
Somewhat Agree	32 (23%)

Neither Agree nor Disagree	4 (3%)
Somewhat Disagree	3 (2%)
Strongly Disagree	4 (3%)

**I feel that I belong in my STEM community.**

Strongly Agree	88 (62%)
Somewhat Agree	39 (28%)
Neither Agree nor Disagree	7 (5%)
Somewhat Disagree	3 (2%)
Strongly Disagree	4 (3%)

*Additional questions related to belonging.*

A number of the surveys, especially from earlier years, did not include the three belonging questions, but *did* ask questions about students’ feelings of comfort speaking and interacting with faculty and administrators. In addition, some of the surveys asked specifically about feelings of connection to their faculty, staff, and other students (Figure 3).

The wording of these questions varied somewhat on different surveys, but all were attempts to answer the question: Did the social event affect students’ comfort and connection with faculty and others. A typical survey question related to comfort asked “How comfortable did you feel speaking to and interacting with faculty and staff at this event?”

Of the 153 responses, 148 rated their agreement on a scale of 1 to 5 or a range of Strongly Agree to Strongly Disagree. Five students simply answered “yes”. In all, 91% agreed with the statements about comfort interacting with faculty and staff in their STEM community.

A typical survey question about connection asked students, “How helpful do you think this social event was in connecting you to First2 faculty and Institutional Team?” Some surveys used the term “useful” rather than “helpful.” Some asked for a rating from 1 to 5, others a standard 5-point Likert Agree/Disagree scale. Some used “extremely/very” instead of “strongly” for the scale. Altogether, 165 responses were tallied. Fully 88% of respondents agreed or strongly agreed that the social event was helpful in connecting them with faculty and other members of their STEM community.

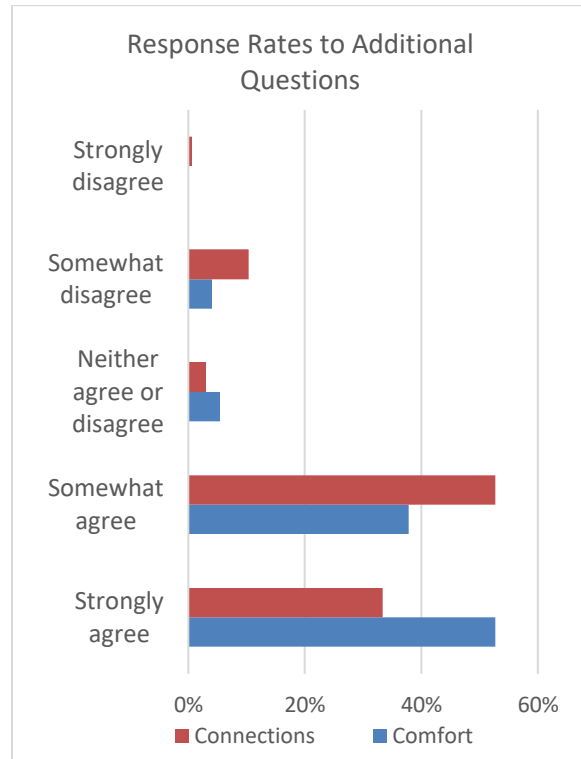


Figure 3: Responses to Survey Questions about comfort with and connection to faculty

*Future research on deeper student-faculty-administration collaborations*

An area for future study is to examine the extent to which these types of social events build student leadership and subsequent collaborations with faculty, and administrators.

While the primary goal of student-faculty social events is to increase students’ sense of belonging in their STEM communities, a secondary goal is that students’ increased feelings of comfort will lead to deeper collaborations between students, faculty and administrators to affect beneficial changes affecting STEM student success

To explore the likelihood of future meetings, we began asking students on the post-event surveys how likely they would be to participate in such meetings. Of the 43 responses we have collected so far, 41 (95%) expressed likelihood to participate in a future meeting. The remaining 2 responses were “neither agree nor disagree.”

Although the responses were positive, we have yet to connect results on the number and kinds of subsequent meetings that have taken place with prior participation in these kinds of faculty-student social interactions.

## Discussion

First2 Network campus clubs and social events aim to change the STEM culture on our college campuses, and improve students' sense of belonging in a STEM Community. In order to promote continuous improvement, campus teams document club activities, and social events, sharing their results with others in the Network.

There are several limitations to this study. A significant hurdle for our teams has been in collecting data. Although participation in faculty-student social events has been quite large, the survey response rate has been quite low. In early years, data was captured by sending invitations to complete surveys after the event had concluded. More recently, these events attempt to collect survey responses during the event itself. In early years, pre-post surveys may have been used. These have been replaced with reflective post surveys.

Although survey respondents included students who were not part of the First2 student leadership group, these data may show confirmation bias. We cannot know if the students who completed the surveys were those who were already highly engaged in STEM and general campus activities, more likely to attend meetings and events and more likely to feel a strong sense of belonging regardless of participation in First2 activities. Nonetheless, these data, imperfect though they are, show a possible relationship between student participation in these interventions and belonging in a campus STEM community.

The stated goal of the First2 Network is to double the graduation rate of first-generation students in STEM fields of study. Research shows that increasing feelings of belongingness, especially in first-generation and other underrepresented students, can lead to higher success in their STEM fields. Our research so far suggests that two of our major activities toward this goal – Campus Clubs and student-faculty social interactions – are successful in building this sense of belonging.

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## Literature Cited

American Association for the Advancement of Science. (2023). STEM students & their sense of belonging: S-stem programs' practices & empirically based recommendations.

Brady, S. T., Cohen, G. L., Jarvis, S. N., & Walton, G. M. (2020). A brief social-belonging intervention in college improves adult outcomes for black Americans. *Science advances*, 6(18), eaay3689.

Engle, J., & Tinto, V. (2008). Moving beyond access: College success for low-income, first-generation students. Pell Institute for the Study of Opportunity in Higher Education.

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of personality and social psychology*, 102(4), 700.

Hansen, M. J., Palakal, M. J., & White, L. J. (2024). The importance of STEM sense of belonging and academic hope in enhancing persistence for low-income, underrepresented STEM students. *Journal for STEM Education Research*, 7(2), 155-180.

Hausmann, L. R., Schofield, J. W., & Woods, R. L. (2007). Sense of belonging as a predictor of intentions to persist among African American and White first-year college students. *Research in higher education*, 48, 803-839.

Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res*. 2005 Nov;15(9):1277-88. doi: 10.1177/1049732305276687. PMID: 16204405.

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, 42(8), 846-854. <https://doi.org/10.1080/0142159X.2020.1755030>

Wilson, D., Jones, D., Bocell, F., Crawford, J., Kim, M. J., Veilleux, N., ... & Plett, M. (2015). Belonging and academic engagement among undergraduate STEM students: A multi-institutional study. *Research in Higher Education*, 56, 750-776.