



Original Research Paper

Empowering Marginalized STEM Students: A Case Study of the First2 Network’s Impact on Persistence, Belonging, and Success in Higher Education

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Article history

Received: 6 May 2025

Revised: 15 October 2025

Accepted: 23 October 2025

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Abstract: The First2 Network student-led organization at Marshall University aims to support first-generation, underrepresented, and rural STEM (Science, Technology, Engineering, and Mathematics) students through a variety of professional development opportunities. The club supports minoritized STEM students throughout their undergraduate careers, increasing the likelihood of these students’ graduation. By creating a sense of belonging, the club ensures students feel empowered to persist in their academic journeys despite systemic challenges. This case study will investigate the club’s impact on student success through the benefits of a student-led organization. This paper will also discuss the way the campus club transforms the academic landscape by deconstructing barriers to persistence through the fostering of academic allyship, development of soft and technical skills, and promotion of an inclusive campus culture. This transformation begins by offering avenues for students to form connections with other STEM students and faculty, as well as creating opportunities for them to explore the career paths they intend to follow. These connections serve as a vital network of mentorship and support, bridging the gap between academia and real-world STEM applications. Furthermore, the importance of marginalized students’ involvement as professional consultants and leaders in critical decision-making spaces act as a tool for sustainable growth and prosperity within the higher education realm. By leveraging these strategies, the club not only strengthens the community, but also builds a pipeline for future STEM talent. Findings from this research will inform strategic campus leadership practices to improve the overall experience of and support for marginalized student persistence and success in STEM degree programs.

Keywords: STEM; first-generation; rural; retention; leadership; campus club

Introduction

The demand for skilled professionals in science, technology, engineering, and mathematics (STEM) continues to rise, yet many students from underserved backgrounds face systemic barriers that hinder their success in these fields (Gibbons and Woodside 2014). First-generation and rural students encounter unique challenges that affect their ability to persist in STEM education. Limited academic support, financial constraints, and imposter syndrome are among the most significant obstacles that contribute to lower retention rates (Cokley *et al.* 2013). Traditional academic structures, while designed to support a broad range of students, often fail to address the specific needs of rural and first-generation learners. In states like West Virginia, where geographic isolation and economic disparities create additional hurdles, students may lack access to research opportunities, mentorship, and the professional networks that are critical to STEM success (Zhang 2018). Without targeted interventions, these barriers can lead to decreased retention and graduation rates, ultimately reducing the number of skilled STEM professionals entering the workforce. Without access to these resources, students frequently find it difficult to adjust to the rigorous academic and professional pathways required for STEM careers.

Addressing these challenges requires a multifaceted approach that goes beyond the classroom. Campus clubs and student-led organizations play a vital role in fostering persistence by creating inclusive communities that support students academically, professionally, and socially (Estrada *et al.* 2018). Organizations like the First2 Network at Marshall University directly respond to the needs of first-generation and rural STEM students by providing a structured support system that includes mentorship, leadership development, skill building workshops, and exposure to research and professional opportunities. By fostering a sense of belonging and offering resources tailored to the unique struggles of these students, the First2 Network helps bridge the gap between academic challenges and long-term STEM success.

Educational challenges for first-generation and rural students are particularly difficult due to the rigid structures of traditional academic institutions, which often lack the necessary resources to fully support these students (Gibbons and Woodside 2014; Zhang 2018).

Limited funding for support programs, a lack of faculty trained in mentoring underserved students, and an absence of accessible research opportunities contribute to the difficulties rural and first-generation students face in STEM. Recognizing these gaps, the First2 Network has made itself a critical support system that directly addresses these challenges. The organization's mission is to increase retention and graduation rates for students in STEM fields by providing them with academic, financial, and professional development support, ensuring they are educated on the skills needed to thrive in higher education and beyond.

The First2 Network campus club at Marshall University is structured to maximize student engagement and leadership development. The club is student-led, empowering members to take ownership of their academic and professional journeys. Leadership positions within the club provide students with the opportunity to develop organizational, communication, and advocacy skills while contributing to a larger movement aimed at increasing STEM persistence. The club hosts mentorship events, skill-building workshops, networking events, and connects students to research opportunities designed to enhance both technical and soft skills (Estrada *et al.* 2018). Through these initiatives, students gain hands-on experience in their fields while also developing competencies necessary for long-term career success.

Beyond individual student development, campus organizations like the First2 Network serve as catalysts for institutional change. These student-led organizations advocate for policy reforms, curriculum enhancements, and expanded academic support structures that better serve the needs of underrepresented students. By amplifying student voices in university decision-making spaces, campus clubs influence policies that shape the broader educational landscape. Through innovative programming, resource allocation efforts, and faculty collaborations, the First2 Network has demonstrated how student organizations can drive systemic improvements in higher education.

Additionally, by fostering a culture of student leadership and advocacy, organizations like the First2 Network contribute to the development of self-efficacy, agency, and confidence among their student members, preparing them for the demands of professional life.

This study examines the role of a First2 Network campus club in supporting first-generation and rural STEM students by evaluating its impact on academic persistence and leadership development. Through an analysis of student surveys, this research aims to highlight best practices for student-led organizations seeking to improve STEM retention rates, and provide insights that inform strategic leadership practices for universities seeking to better support underserved STEM students. Ultimately, the findings will contribute to a broader understanding of how campus clubs serve as powerful tools for student success, institutional reform, and the creation of a more equitable STEM education system.

Campus Club Description

Stakeholders and Organizational Structure

As a learning network dedicated to improving outcomes for undergraduate STEM students, First2 Network strongly adheres to the idea that students should be co-creators and instigators of activities designed to improve their campus experience. First2 Network provides financial support to undergraduate students on its member campuses to become “Student Directors” and “Assistant Student Directors”. The Network provides leadership training for each cohort of Directors, and ongoing support through regular virtual meetings where student leaders can crowd-source solutions to issues they face. Student Directors are also mentored by campus faculty who attend club meetings. Leadership transition planning is prioritized, with Assistant Student Directors actively mentored by Student Directors. This approach prepares them to take on leadership roles in subsequent years, ensuring continuity of the club.

The Student Director of the campus organization has the same role as a club president. Assistant Student Directors are students that assist in leading the campus club. Faculty and First2 staff provide critical guidance and support in developing and executing the campus club’s activities, ensuring alignment with the overarching mission of supporting first-generation and rural STEM students.

The Marshall campus club meets twice each month. The meetings usually include opportunities for

fellowship and fun, planning for upcoming events, study group or tutoring, and peer-mentoring. Club meetings are where students can voice concerns, seek guidance, and contribute suggestions for improvement. Frequent email updates remind students of available resources and reinforce the ongoing support provided by mentors. Communication among club members, mentors, and faculty is facilitated through Slack Messenger and Outlook emails, ensuring timely updates and collaboration.

In 2024-25, club members included all paid student leaders of First2, as well as any students that expressed interest in the club. On average, 6-8 students attended each meeting.

Promoting Resilience and Student Development

Resilience was promoted through a multifaceted approach that emphasized strong support networks, academic and career resources, leadership development, reflection, and persistence. A strong support network allowed students to build meaningful relationships, fostering a sense of belonging within the STEM community. Students who were ready to engage in research opportunities were connected with faculty mentors, while social events and regular meetings reinforced community support.

Academic and career resources played a crucial role in student success. Members were encouraged to utilize university tutoring services and participate in career development events featuring STEM professionals. These events were open to all students, maximizing the impact beyond club membership. Leadership and advocacy development were also crucial to the club’s mission, as students were given opportunities to take on leadership roles, advocate for themselves and others in academic and professional settings and contribute to decision-making processes that shaped the club’s direction.

Reflection and personal growth were promoted through structured activities such as end-of-semester reflection journal entries, where students documented their challenges, highlights, and accomplishments. Check-in meetings provided a space for students to openly share struggles and successes, while achievements were highlighted on institutional social media accounts and the First2 Network website to celebrate progress. The club fostered a culture of persistence by normalizing challenges and encouraging

problem-solving, risk-taking, and perseverance in STEM fields.

Event Planning and Execution

In addition to leading the campus club, in 2024-2025, Marshall Student Directors and Assistant Directors, organized two large events designed to promote social interactions and build better relationships between students and the administration and faculty of the College of Science and College of Engineering and Computer Science.

Outreach efforts were designed to target first-generation, rural, and research-seeking STEM students, with engagement tracked through event attendance and participation rates.

SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) goals (Figure 1) were developed and structured to be scalable, ensuring that outreach initiatives could expand within available resources. All objectives aligned with the mission to connect students with academic and professional opportunities. Events and initiatives followed defined timeframes, allowing for evaluation and improvement. By integrating SMART goals, outreach efforts were intentional, data-driven, and adaptable, leading to sustained engagement and institutional impact.

Called “Donuts with the Deans”, fall and spring events were organized through the campus club. Upwards of 80 students attended each event. The Student Directors took lead on these initiatives and utilized these opportunities to mentor Assistant Student Directors – promoting skill development and confidence. Feedback from each event was analyzed to inform future planning. This iterative approach allowed the club to continue to refine its events and activities to better serve student needs.

The events organized through the Marshall campus club are subjects of study in their own right and data collected from these events are not described in this study.

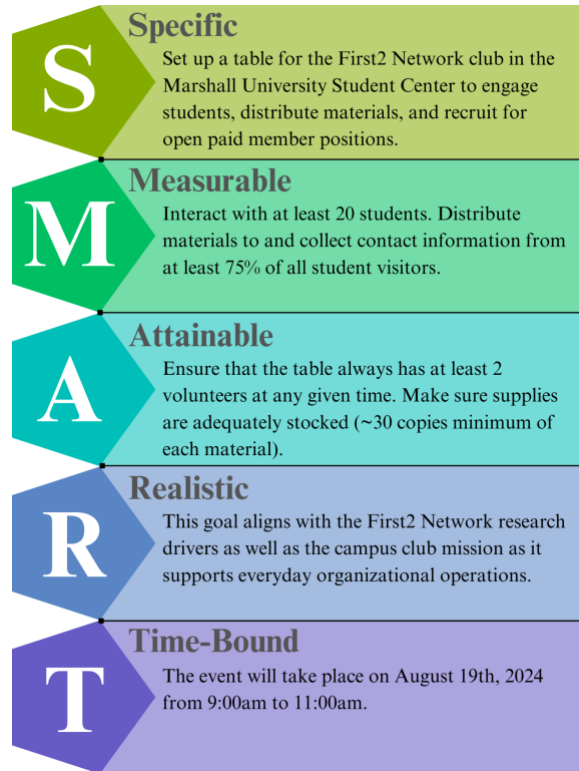


Figure 1: SMART Goals for Club Outreach Table.

Materials and Methods

Improvement Science and Iterative Testing

The study employed improvement science principles to assess the effectiveness of the campus club. Unlike traditional research, which focuses primarily on generating new knowledge, improvement science emphasizes the application of iterative testing, feedback, and refinement to solve real-world problems. The “Plan, Do, Study, Act” (PDSA) cycle was the core methodology for implementing small, measurable changes, assessing their impact, and refining to improve the campus club, and the events hosted by the club. This cyclic approach promotes a culture of collaboration, adaptability, and evidence-based decision-making – ensuring that interventions are sustainable and responsive to the evolving needs of students, faculty, and stakeholders.

Primary and Secondary Drivers for Change

The primary driver for the campus club initiative was to create meaningful connections between STEM students, faculty, and staff, fostering a sense of belonging, wellness, resilience, and financial responsibility. The secondary driver involved

collaboration with STEM department chairs and faculty to develop a welcoming campus climate for First2 students. This was achieved by increasing the frequency, duration, type, and quality of supportive interactions between students and institutional teams, which encompasses the entire group of individuals who assist in and advise on maintaining the club. This includes everyone in the campus club, along with STEM faculty members, Student Success advisors, Deans of STEM programs on campus, etc.

Learning Questions

To assess the impact of the campus club, several research questions guided PDSA process. The questions examined processes-- how many first-generation, first- and second-year STEM majors regularly participated in campus club events and meetings—and outcomes--the extent to which regular participation increased students’ sense of belongingness, self-efficacy, and grit in their STEM fields, as measured by a survey.

Additional learning questions asked whether involvement in the club influenced students’ perceptions of their own leadership abilities and whether regular participation helped students remain in good academic standing, avoiding probation. The study also sought to determine whether club participation contributed to students remaining enrolled in their intended STEM majors and whether being part of the First2 Network campus club helped students achieve their personal and professional goals

A PDSA template, provided by the First2 Network, was used to document, plan, and study the campus club change idea.

Data Collection and Communication Tools

A structured data collection approach was implemented to track student engagement and assess the club’s effectiveness. Student attendance at meetings was recorded through a Google Form, with the data automatically transferred to an Excel spreadsheet for analysis.

A survey was given to the students at the end of the semester to measure their perceived impact of the campus club on their sense of belonging, grit, and self-efficacy, as well as their leadership capabilities and the impact on their short-term and long-term goals. This survey was provided via a QR code to the students at a

campus club meeting. The link was also sent out to students later on if they had not completed it. Survey statements related to belonging, self-efficacy, grit and leadership were taken from a bank of priority common questions recommended by First2 Network, and are shown in Table 1. Student selected responses based on the extent to which they agreed with each statement using a 5-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree”.

Table 1: Categories of Survey Items

| Belonging |
|--|
| I feel respected in my campus's STEM community. |
| I feel comfortable in my STEM community and classes. |
| I feel that I belong in my campus's STEM community. |
| Self-efficacy |
| I'm confident I can understand the basic concepts taught in the STEM classes I'm currently taking. |
| I believe I will receive excellent grades in the STEM classes I'm currently taking. |
| I'm certain I can master the skills being taught in the STEM classes I'm currently taking. |
| Grit |
| I am a hard worker. |
| I finish whatever I begin. |
| I am diligent. |
| Leadership |
| I am confident of my ability to influence a group I lead. |
| I know a lot more than most students about what it takes to be a good leader. |
| I am able to allow most group members to contribute to the task when leading a group. |

In addition, we asked students the extent to which campus club participation influenced their leadership, their academic standing, their persistence in STEM and their goals using a 3-point scale ranging from “Major Impact” to “Little or No Impact”. An “I’m not sure” response choice was included. Finally, we added survey data from two prior semesters, fall 2023, Spring 2024 to see if there were differences between cohorts.

Results

The findings from the survey data collected from students engaged in the First2 campus club during the Fall 2024 semester highlight students' attendance and participation, sense of belonging within the STEM community, self-efficacy, leadership confidence, academic standing, and the perceived impact of the campus club on students' academic and professional goals. Ten survey responses, although not every student answered every question, were analyzed to assess students' attitudes toward their experiences in the club and their broader academic journey. The ten students surveyed included all paid members, as well as a couple of students who consistently attended the campus club meetings throughout the semester. The data indicate strong engagement among a core group of students, with positive trends in belonging, leadership, and academic success. Additionally, while participation in the club was linked to students' short-term academic progress, fewer students reported a significant impact on their long-term goals. Figures 2-7 illustrate these findings.

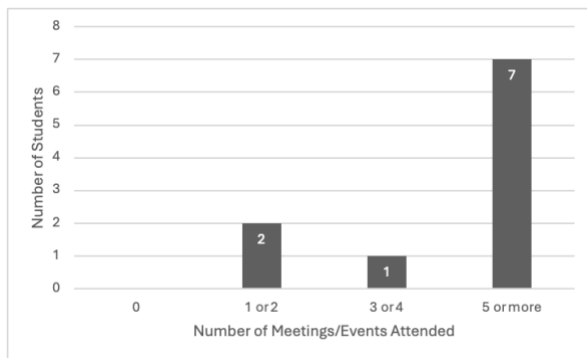


Figure 2. Attendance of campus club participants to the total of six club meetings held throughout the semester.

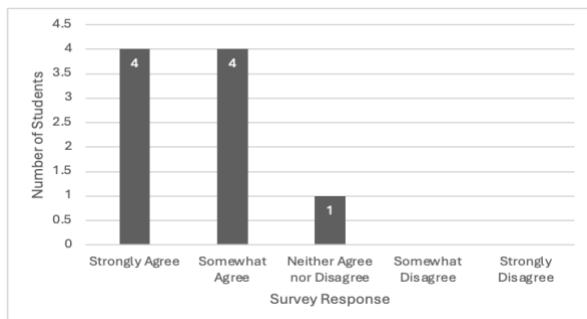


Figure 3. Survey responses to the following question: "I am confident of my ability to influence a group I lead."

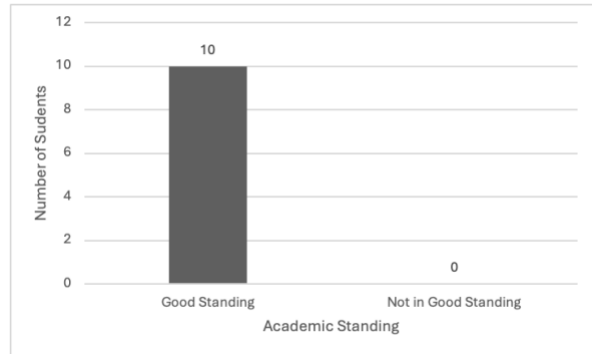


Figure 4. Academic standing of students in the campus club.

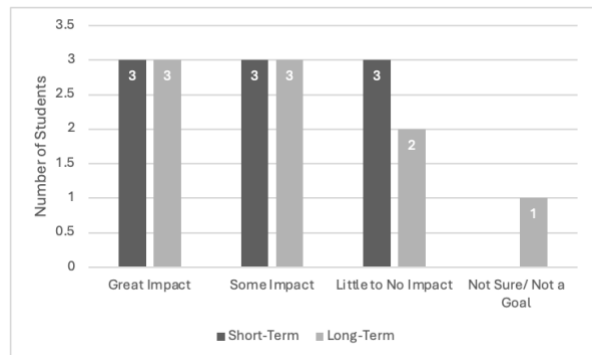


Figure 5. Survey Responses to the following questions: "Marshall's First2 Campus Club in the most recently completed semester contributed to attaining your short-term academic goals (e.g., attaining your desired grades in your course, or progress in your major toward completing your degree)?" and "Impact on expectations of attaining long-term goals - Graduation in 4 years in my current major."

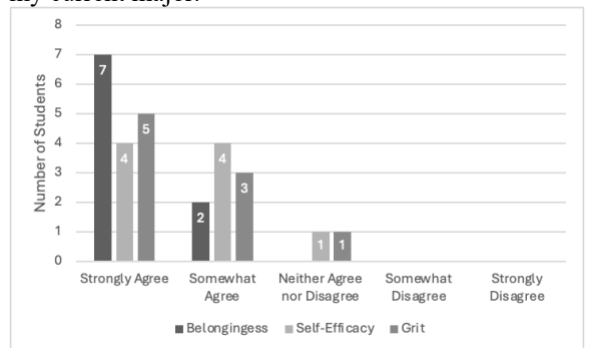


Figure 6. Responses to the following survey questions: "I feel that I belong in my campus' STEM community," (belongingness) "I'm certain I can master the skills being taught in the STEM classes I'm currently taking," (self-efficacy) and "I finish whatever I begin" (grit)

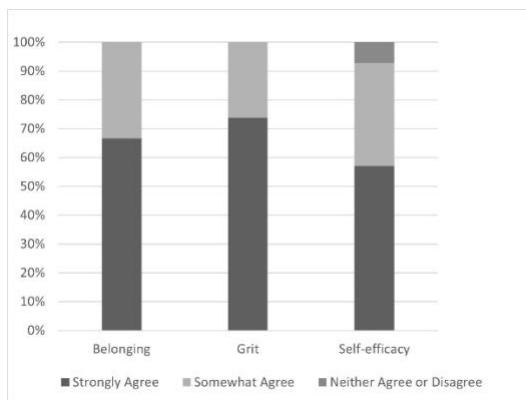


Figure 7. Club member responses to survey, Fall 2023+Spring 2024 (N=14)

Attendance and Participation

As shown in Figure 2, the majority of students who participated in the campus club attended five or more meetings or events. A smaller number attended one to four events/meetings, with only one student participating in three to four events. Four first and second-year STEM students engaged in at least one club event or meeting per month during the Fall 2024 semester. However, first-generation status was not collected, limiting our ability to assess the engagement of this demographic.

Leadership Development

Leadership confidence was also assessed, as illustrated in Figure 3. The majority of students (eight out of nine respondents) expressed confidence in their leadership skills, with four students strongly agreeing and another four somewhat agreeing that they could effectively lead a group. One student responded neutrally, and no student disagreed with the statement. Interestingly, those who expressed lower confidence in their leadership abilities were not in paid leadership positions, indicating that structured leadership roles may contribute to the development of these skills.

Academic Standing and Persistence

Figure 4 displays students' academic standing, showing that all students remained in good standing throughout the semester. This supports the interpretation that engagement in the club may have had a positive influence on academic persistence and success. While survey questions did not directly ask whether students remained in their STEM major, no

responses indicated a change in academic direction, suggesting continued commitment to STEM fields.

Impact on Short- and Long-Term Goals

Figure 5 details students' perception of how the club impacted their academic and professional goals. Most students reported that participation in the club had a positive impact on their short-term goals, such as academic performance and progress towards graduation in their intended STEM major. Fewer students indicated that the club had a significant impact on their long-term goals, such as graduating within four years. A small subset of students indicated little to no impact, while one student reported uncertainty regarding the impact on their long-term goals.

Sense of Belonging, Self-Efficacy, and Grit

Survey results shown in Figure 6 indicate that all student respondents reported feeling a sense of belonging within the STEM community. Every student either strongly or somewhat agreed with statements related to their belongingness. No students selected responses indicating disagreement for any characteristics. One student indicated neutrality for both self-efficacy and grit characteristics. These results suggest participation in the campus club positively contributed to students' perceptions of inclusion and confidence in their academic abilities.

Comparing the results with survey data reported in Fall 2023 and Spring 2024, Figure 7 shows similarly strong responses for each of the three categories. For belonging and grit, all responses were either strongly agree or somewhat agree. However, as with the most recent data, self-efficacy did not receive such high marks, indicating that students don't feel as strongly that the club influenced growth in academic self-efficacy.

Discussion

The results of this study held at Marshall University highlight key findings related to student engagement, belonging, self-efficacy, leadership, and academic standing within the First2 Network campus club. Findings suggest that students who regularly participated in club events reported a strong sense of belonging, confidence in their academic abilities, and leadership skills. These trends align with prior research that emphasizes the importance of mentorship, peer

support, and structured extracurricular activities in fostering student success in STEM fields (Estrada *et al.* 2018).

One of the most notable findings was that all students either strongly or somewhat agreed with survey questions related to their sense of belonging in the STEM community. This aligns with Tinto's framework on student retention, which suggests that a strong sense of community and academic integration significantly impact persistence in higher education (Tinto 1993). Similarly, our results indicated that students who had attended more club events over time expressed stronger feelings of belonging. This supports the idea that consistent engagement in structured support systems can contribute to students' academic and social integration (Tinto 1993).

Self-efficacy was another critical component examined in this study. The majority of students reporting confidence in their ability to master STEM coursework aligns with the findings in Bandura's theory of self-efficacy, which states that confidence in one's abilities is a key determinant of motivation and performance (Bandura 1997). Furthermore, students who participated in leadership roles demonstrated high levels of confidence in their leadership abilities, but those who did not hold paid positions were more likely to express uncertainty in said abilities. This suggests that leadership experience, particularly those with formal responsibilities, play a role in developing self-efficacy in leadership (Bandura 1997).

Limitations of this Study

Despite the findings of the study, it also had some limitations. The sample size was relatively small, and a retrospective survey was used instead of a pre/post format as originally intended, which may have more objectively assessed changes in student perceptions over time. Future research should implement longitudinal data collection to evaluate the long-term impact of the First2 Network club. Additionally, while most students indicated that club participation positively impacted their short-term goals, fewer expressed that it had an impact on their long-term goals. This suggests that further program development may be needed to provide clearer pathways for career preparation and professional development.

Finally, the survey, as structured, did not allow for an investigation of which categories- grit, self-efficacy,

leadership or belonging, were correlated to outcomes like persistence in STEM.

Conclusions

Overall, the results of this study reinforce the importance of student organizations in fostering a supportive academic and social environment for STEM students. By providing opportunities for engagement, networking and leadership, clubs like the First2 Network campus club can play a vital role in improving student retention, self-efficacy, and overall academic success.

Acknowledgements

We would like to express our sincere gratitude to the members of Marshall University's First2 Network campus club for their active participation and contributions to this study. Their engagement in club events and willingness to share their experiences were crucial for our work.

We extend our appreciation to Marshall's Institutional Team for their guidance and support throughout this change idea. Their encouragement and expertise were invaluable in shaping our study and fostering a strong academic community within the First2 Network campus club.

Additionally, we acknowledge the support of Marshall University and the College of Science for providing resources and institutional backing that facilitated this research.

This work was supported in part by the National Science Foundation under collaborative award Nos. HRD-1834586, 1834595, 1834601, 1834575, 1834569. Any Opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the National Science Foundation.

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