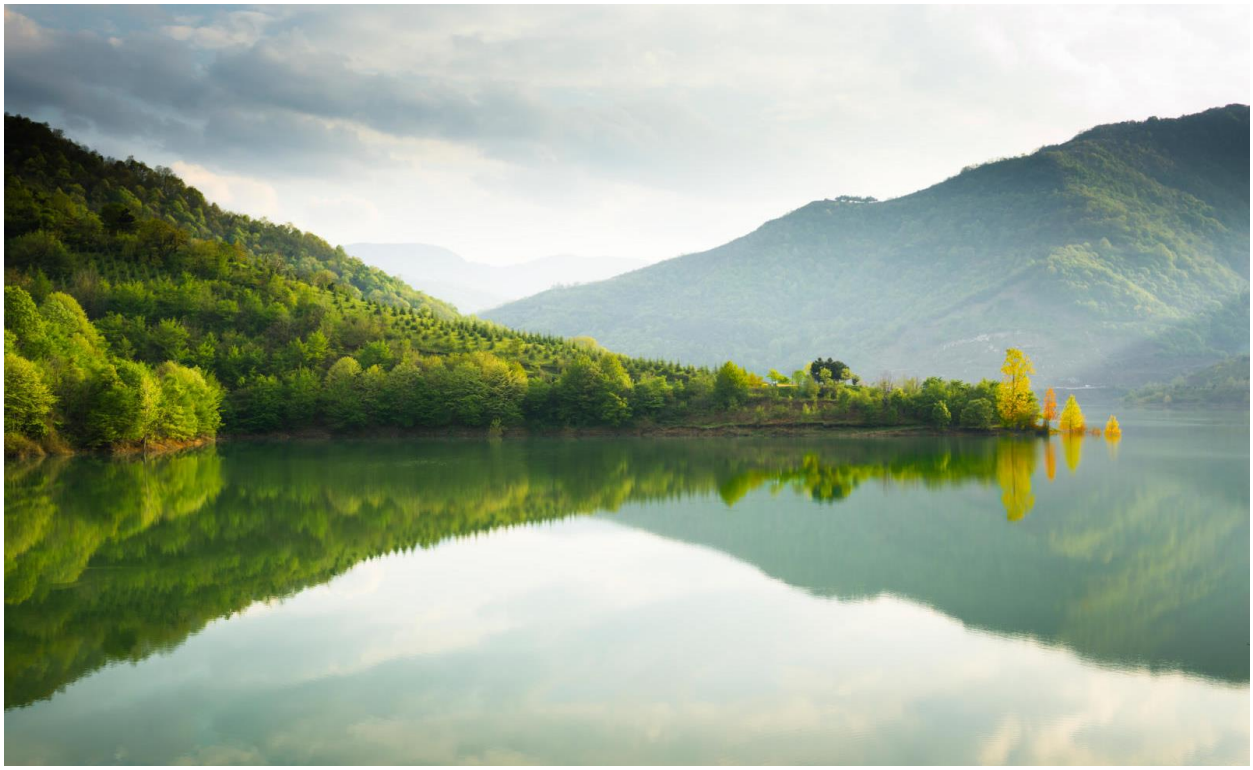

Evaluation of the First2 Network

Year 4 (2021–2022)

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I. Executive Summary

First funded in 2016, the First2 Network is a West Virginia alliance seeking to improve the early persistence of rural, first-generation science, technology, engineering, and mathematics (STEM) students in their programs of study. The network was established as a means by which to address a troubling problem identified by research, namely that attrition from STEM majors is most likely to occur during students' first 2 years of college.[1] Research also suggested that first-generation students—students whose parents did not attend college—majoring in STEM disciplines face considerable obstacles to their college success.[2] Accurate estimates of how many West Virginia students could be characterized as first generation are difficult to obtain. However, given that fully 70% of adults in the state do not have a postsecondary degree,[3] many West Virginia STEM students matriculating to college are likely to be the first in their families to attend.

Supported by a five-year National Science Foundation (NSF) grant from the program called Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES), the First2 Network engages a wide range of state STEM stakeholders in *improvement science* activities to test ways to improve STEM persistence. To augment the learning afforded by improvement science cycles, the network facilitates research studies, investigating subjects including major selection and persistence among rural, first-generation students and identifying community factors associated with STEM success. Other core network features include immersive research experiences for rural, first-generation, or other underrepresented minority (OUM) students during the summer before their freshman year, STEM outreach conducted by network students to promote STEM to younger students and to build support for the network among state education leaders, and campus clubs to ensure ongoing student support.

Another hallmark of the First2 Network is its adherence to the principle that students—those with the *lived experience* of barriers to STEM persistence—should inform the search for ways to improve STEM persistence. Given this commitment, network students serve in Network leadership roles, participate as full peers in improvement science activities, and conduct

Key Findings from Year 4 Evaluation

- 501% increase in membership from Year 1, from 144 to 866
- Students represent 32% of network membership
- 57% of Year 4 summer interns identified as first-generation college students and 40% as rural.
- Year 4 interns were more racially/ethnically diverse than the overall WV student population
- Members have conducted 141 Plan-Do-Study-Act cycles since Year 1 to test practices hypothesized to improve STEM persistence
- STEM social capital among members continues to expand
- Following First2 Network internship participation, Year 4 summer interns demonstrated statistically significantly higher mean scores on measures of school belonging, knowledge about research, and personal skills.
- Among First2 Network students providing consent for progress tracking, the overall STEM persistence rate for first-time freshman is 76% (19 of 25 students).
- The overall STEM persistence rate among First2 Network sophomores and higher who consented to tracking is 85% (39 of 46 students).

outreach to STEM-interested high school students and to state legislators. Students also participate in authentic STEM research experiences with network professors and at industry sites.

ICF serves as the external evaluator for the First2 Network. The evaluation employs a longitudinal, multi-method design to understand the project from various stakeholder perspectives and via an array of data collection and analysis techniques. This report summarizes evaluation findings, conclusions, and recommendations from the network's fourth year of operation (October 1, 2021 through September 30, 2022). Conclusions, organized by four analytic levels, are summarized below, followed by an analysis of several quandaries the network has confronted as it continues to evolve. Finally, recommendations for First2 Network leaders and members to consider as they begin Year 5 are offered.

First2 Network Members

- Year 4 interns are diverse
  - 21% identify as Black/African American, 8% as Hispanic/Latinx, 3% as Asian/Asian American, with 76% identifying as White
  - 51% are eligible for federal Pell grants (a proxy measure of low-income status)
  - 57% are first-generation college students
  - 49% hail from rural communities and 24% from towns
- Network members represent a wide array of West Virginia STEM stakeholder entities
  - 32% are students
  - 22% are university faculty or staff
  - 5% are K-12 educators
  - The remainder hail from industry, foundations, nonprofits, other state entities, or have unknown affiliations

1.1 Context in which the First2 Network Operates

Much about the context in which the First2 Network operates remains consistent since its launch. West Virginia continues to be poorer, less diverse, and less educated than the nation in general. West Virginia is still designated as an EPSCoR state, one indicator of limited STEM capacity. On the other hand, new efforts to improve and support STEM education have emerged. For instance, policymakers passed several STEM education bills during the 2022 legislative session and the state boasts new STEM education improvement initiatives.

1.2. First2 Network Structures and Processes

The First2 Network included 866 members, an increase of 78% from 487 in Year 3, 206% from 283 in Year 2, and 501% from 144 in Year 1. Students now comprise about a third of the membership (32%), compared to Year 3 at 43%. Faculty/staff membership remained fairly stable (33% in Year 4, 35% in Year 3). The percentage of members with unknown institutional roles rose dramatically, from 6% in Year 3 to 33% in Year 4.

The number of interns declined from Year 3 to Year 4, similar to the decline from Year 2 to Year 3. A total of 183 interns have participated in First2 Network summer experiences since 2019 (and completed a pre or post intern survey): 37 in Year 4, 50 in Year 3, 69 in Year 2, and 27 in Year 1. The representation of conventionally underrepresented racial/ethnic students in the Year 4 research internships is higher than their representation in the state at large (21% Black/African American and 8% Hispanic/Latinx, compared to state averages of 4% Black/African American and 2% Hispanic/Latinx). More than half of Year 4 interns (57%) self-identified as first-generation and female (57% each), 51% reported being Pell-eligible, and 49% hail from rural places.

The First2 Network made substantial progress in tightening its focus on improvement science. Not only was the driver diagram revised, but PDSA change ideas were aligned to those revised drivers and a PDSA coaching team was established to support First2 members in their improvement science efforts.

The network continued its progress toward fully implementing all five elements of collaborative infrastructure. Network documents and member feedback indicate that members continue to promote a shared vision through an array of communication and outreach activities. These include hosting three network events; promoting social media (website, newsletter, Twitter); and presenting at six local or state conferences. Previous network partnerships were maintained and new partnerships established in Year 4, including its first community and technical college and five new industry partners, as well as becoming the mentor backbone for the WV Jobs Network. Efforts for obtaining and reporting shared metrics continued in Year 4: (1) an agreement with NSF to use WVU first-generation data as a proxy for statewide data, (2) to pursue a change in statewide data collection to establish a common definition and collection strategy for first-generation status, (3) enhanced coaching and support for network PDSA efforts, and (4) establishing a secure system for tracking First2 students' persistence data through HEPC.

During Year 4, First2 students continued their leadership efforts within the network through their paid service roles, their participation in the Student Leadership working group, and their efforts to create a policy on First2 student expectations. Changes in network leadership included transition of co-chair positions and a transition from working groups to institutional teams. Sustainability and scale-up efforts focused on implementation of the strategic plan, including planning to dissolve the Leadership Team and transfer authority to the Steering Committee, establishing a new partnership with the CINSAM at Northern Kentucky University, securing other funding, and continuing the transition toward institutional teams.

In terms of working group functions, the November 2021 administration of the Working Group Self-Assessment had the largest number of respondents (67) since the survey was first administered in May 2019, and nearly two-thirds of those respondents were student members. These results seem to mirror the growing pains experienced by the network during Year 4, with mean subscale scores reflecting a mix of higher and lower ratings than the previous two November administrations (2019 and 2020). The Do and Act subscales showed constant improvement in ratings for each November administration (2019, 2020, and 2021); Plan, Collaborate, and Building Capacity showed higher ratings in 2021 compared to 2019; and Study, Disseminate, and Equity remained identical or nearly identical between 2019 and 2021. Further, for the five items focused on individuals' contributions to the working group, four showed slight but consecutive decreases for each November administration (2019, 2020, and 2021).

Steering Committee survey feedback presented a mix of increasing and decreasing ratings compared to Year 3 but most perceptions still fall in the range of the "Making Progress" category. However, these results do seem to reflect a degree of flux as network transitions occurred during Year 4. Most promising were perceptions that the right people were on the Steering Committee, that individuals were leading a working group or keeping abreast of working group activities, and that individuals communicated with others about network efforts.

The First2 Network hosted multiple events for members during Year 4, including a virtual fall conference, a winter virtual PDSA workshop, and a spring virtual and in-person conference. Feedback was very positive for the fall and spring conferences, with average ratings close to or above 4.0 on a 5-point agreement scale. For both conferences, the most common theme for future improvement was to adjust the schedule, i.e., more transition time between sessions,

more breaks, more time for discussion and networking. The virtual PDSA workshop was also well received, but again participants noted a need for more time for the breakout room discussions.

1.3. Systems Targeted by the First2 Network

Members of the First2 Network undertook a number of efforts to improve the systems that can enable or constrain the early STEM persistence of rural, first-generation students in West Virginia. During Year 4, these included pathway improvements such as FSU securing an S-STEM award, the network becoming the backbone for the WV Jobs Network, and securing additional education and industrial partners. Structural improvement efforts in Year 4 included the network's contribution in developing and advocating for passage of West Virginia SB 228, which provides students with a year of tuition waiver for every year of AmeriCorps service completed, and serving as a partner in West Virginia HEPC's Science and Technology Plan, which sets a 5-year vision for state investment and action in scientific research, innovation, and capacity building.

Two specific examples of systems change were showcased in greater detail in the report—a three-phase initiative at Marshall University to ease transition challenges for incoming freshmen and the state legislation (SB 228) that grants tuition waivers for AmeriCorps service. The Marshall initiative has led to identification of several major information gaps and the production of a Frequently Asked Questions document to share with high school seniors and college freshmen to address those issues. The AmeriCorps initiative provides 1-year tuition waivers for every 1,200 hours of service. The idea for SB 228 grew out of First2 leaders' work with STEM students and high-need youth and adults. After initially stalling as a West Virginia State House bill in 2021; the network continued advocating for this legislation and sought out a senate sponsor in 2022. Slated to launch in fall 2022, students can earn up to a maximum of 4 years of enrollment.

One systems change sought by the First2 Network is the establishment and operation of a fully functional, sustainable backbone organization housed at HEPC DSR. Both the mentor (SRI) and backbone (HEPC DSR) organizations continued this work in Year 4, both in building HEPC DSR capacity and in HEPC DSR carrying out those responsibilities. Mentor and backbone activities focused heavily on improvement science and sustainability planning this year. An improvement science team will be providing support for institutional teams completing PDSAs, following coaching on this support strategy by SRI staff. There was general consensus that capacity had been built in the areas of network communications and conferences and in initial steps to track first-generation status statement, remaining needs were identified. These included cross-network sharing of institutional information, conducting and tracking PDSA efforts, a sustainability plan that included streamlined leadership responsibilities, and additional funding and staffing. Staffing was also raised as a remaining area of need in Year 3; both years highlighted the need for more support in the area of grant writing and data analysis.

Another systems change pursued by the network is the development of a sustainable statewide collective that ultimately helps members make changes to their institutions that better support the STEM persistence of rural, first-generation students. As networks develop and their collaborative efforts mature, what members value about their participation evolves, progressing from the value of networking itself to valuing the ways network involvement enables institutional change. First2 members in Year 4 continued to most value networking and community-building, followed by gaining new knowledge and applying learning and practices. Year 4 reflected the highest number of respondents to the Network Value Survey, but all five subscale scores showed slight decreases from Year 3.

1.4. Impact of the First2 Network

During Year 4, the First2 Network continued to expand, growing to 866 members. At the same time, the strength of connections among members improved, with mean ratings suggesting that relationships are at a Coalition level (characterized by frequent communication, shared resources, and shared decision-making). Building STEM social capital throughout the state to pursue improved STEM persistence is an important impact of the First2 Network.

Summer research internships for rising freshmen are one of the network's key change ideas. Students participating in the six internships for which data were available at the time of this writing rated their experiences highly. All respondents agreed that the experience positively influenced how they feel about their chosen college. The most highly rated aspects of internships were opportunities to collaborate with faculty members and the research training provided by faculty members. Participants made statistically significant improvements in their sense of school belonging, knowledge about research, and personal skills, according to mean pretest and posttest scores.

Intern focus groups indicated that students valued summer research experiences and opportunities to network with other students and with faculty, although a few students reported that the research component of summer internships did not meet their expectations. Students noted that the internships played little role in their decision to declare a STEM major; most reported that the summer research experiences improved their confidence in their ability to do STEM coursework. Several also said that the internship strengthened their sense of themselves as future scientists or mathematicians and continued to support their progression through their STEM major. Participants strongly supported the First2 Network's commitment to engaging students as co-creators of solutions to the problems contributing to STEM attrition but had diverse views about how much voice and power students actually had in the network. Some students have been actively engaged in network PDSA activities, but that was not a universal experience for all student members. Finally, students identified several areas for network improvement, including communications, respect for student obligations, and clearer power sharing with students.

The First2 Network sought informed consent for the network to use their Social Security numbers to obtain verified HEPC data about their progress. The overall STEM persistence rate among First2 Network, first-time freshman who provided consent for tracking is 76% (19 of 25 students). The overall STEM persistence rate among First2 Network sophomores and higher who consented to tracking is 85% (39 of 46 students).

WVU, the largest First2 Network institution, tracked the STEM persistence of its students involved in the network directly or indirectly (through participation in a network PDSA). Of the 421 students with a STEM major who participated in the network in any manner, 68% remained enrolled in a STEM major, while 32% switched to a non-STEM major.

WVU also regularly collects data about students' first-generation status and rurality, enabling comparisons of STEM persistence among these subgroups. Data from WVU beginning with the 2005 cohort indicate clear disparities in the STEM persistence of first-generation and non-first-generation students. In addition, the gap between the two groups has widened since the 2016 cohort; the largest disparity appeared among the 2018 cohort with a difference of 17 percentage points (49% among first-generation students and 66% among non-first-generation students).

On the other hand, the role of rurality is less clear among WVU cohorts. Rural STEM persistence rates, with a few exceptions, were higher than non-rural STEM persistence rates between 2005 and 2016. But among the 2017 and 2018 cohorts, rural students persisted in their STEM majors at

lower rates than non-rural students. The gap grew to eight percentage points in the 2018 cohort, with only 55% of rural students persisting in STEM compared to 63% of non-rural students.

Although data are limited due to the small number of First2 Network students consenting to tracking, estimates suggest that First2 Network students persist in their STEM majors at higher rates than both their first-generation and non-first-generation peers at WVU. Between 2005 and 2018, first-generation WVU students persisted at rates ranging from 49% to 64%, whereas the overall persistence rate for First2 Network first-time freshmen is 76%.

As in prior years, statewide analyses in which Pell-eligibility is employed as a proxy for first-generation status indicate that Pell-eligible STEM students have lower STEM readiness scores and lower STEM persistence and graduation rates. Although rural STEM students earned lower STEM readiness scores and had lower persistence rates across the state, STEM graduation rates tended to be similar for rural and non-rural students.

2. Recommendations

As the First2 Network begins its fifth year and progresses toward sustainability, network leaders and members may want to consider the following recommendations.

- Continue to build the capacity of institutional teams to engage in First2 Network activities, including collaborating with students as full partners in co-creating solutions to the challenges of STEM attrition, using improvement science processes and tools to test and iterate identified solutions, and scaling up solutions that are demonstrated as effective.
- Offer members opportunities to learn about systems change (as distinct from changes at the individual or classroom levels) so that the First2 Network members can envision the larger scales on which they might focus their improvement efforts. Provide examples of systems changes that might be amenable to PDSAs.
- Complete sustainability planning and implement sustainability activities so that the First2 Network can evolve as INCLUDES funding comes to an end. Needs include transitioning leadership responsibility from the Leadership Team to the Steering Committee, pursuing additional funding, and determining and addressing backbone and other staffing needs. Continue documenting formal decisions about how to structure, fund, and communicate about the First2 Network once INCLUDES funding is expended.
- Revisit the roles of the backbone and the mentor backbone to ensure a smooth transition of responsibility for backbone support of the First2 Network to HEPC DSR.
- Recommit to the role of students as full partners in the First2 Network. Provide guidance to institutional teams about practices and processes that can amplify student voice. Continue providing accommodations for student participants to ensure their full participation in the network, such as planning meetings around significant college calendar dates. Encourage non-students in the network to engage regularly with students during regular Student Leadership meetings, on institutional teams, and at conferences to discuss relevant issues, understand student perspectives, and co-create collaborative action.
- Continue efforts to ensure that state public higher education institutions consistently collect data about students' first-generation status. Plan for regular data disaggregation by first-generation status so stakeholders have access to information about academic outcomes among first-generation students as well as about any disparities between first-generation and non-first-generation students.

- Celebrate and communicate widely about Year 4 successes. Create opportunities to share success stories from the network with new audiences. Devote some time during network conferences to highlight what the network has learned about improving STEM persistence among first-generation students, how the network has put its learnings into practice, and what has resulted from such endeavors. As the network progresses toward full implementation of its strategic and sustainability plans, leaders and members should consider ways to communicate about its new structures (e.g., institutional teams) so that others interested in its work know how to become involved.

II. Introduction

First funded in 2016, the First2 Network is a West Virginia alliance seeking to improve the early persistence of rural, first-generation science, technology, engineering, and mathematics (STEM) students in their programs of study. The network was established as a means by which to address a troubling problem identified by research, namely that attrition from STEM majors is most likely to occur during students' first 2 years of college.[4] Research also suggested that first-generation students—students whose parents did not attend college—majoring in STEM disciplines face considerable obstacles to their college success.[5] Accurate estimates of how many West Virginia students could be characterized as first generation are difficult to obtain. However, given that fully 70% of adults in the state do not have a postsecondary degree,[6] many West Virginia STEM students matriculating to college are likely to be the first in their families to attend.

ICF serves as the external evaluator for the First2 Network. The evaluation employs a longitudinal, multimethod design to understand the project from various stakeholder perspectives and via an array of data collection and analysis techniques.

This report summarizes evaluation findings from the project's fourth year, with data collected from October 2021 through the end of July 2022.

1. Overview of the First2 Network

The First2 Network is supported by a 5-year National Science Foundation (NSF) grant from the program called Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES). The INCLUDES program supports projects that improve access to STEM education and career pathways, particularly for groups that are underrepresented in STEM. First2 was one of the first 37 such projects, which were 2-year design and development launch pilots (DDLP) to develop prototypes for new models that broaden STEM participation.

First2 Network Lead Organizations

The following organizations were awarded NSF INCLUDES collaborative grants to broaden the participation of underrepresented groups in STEM by improving persistence rates among rural, first-generation college students in STEM programs of study:

- Green Bank Observatory
- Fairmont State University
- West Virginia University
- High Rocks Educational Corporation
- West Virginia Higher Education Policy Commission

In 2018, following completion of the 2-year DDLP, the First2 Network was awarded one of five grants to expand pilot projects into alliances. Alliances are *collective impact* projects, bringing together programs, people, organizations, technologies, and institutions to achieve results at scale, providing new research and leveraging NSF's broadening participation investments. In its role as an INCLUDES-funded alliance, First2 Network facilitates collaboration among university STEM faculty, rural first-generation STEM undergraduates, National Laboratory STEM professionals, state department of education staff, informal STEM educators, and industry representatives, among others, to study and address the problem of undergraduate attrition in STEM majors that occurs during the first 2 years of college.

To achieve its aim, and in addition to pursuing a collective impact approach, the First2 Network employs *improvement science* tools and processes, such as developing driver diagrams to

conceptualize how to address dimensions of the problem at hand, and Plan-Do-Study-Act (PDSA) cycles to test improvements.

Another hallmark of the First2 Network is its adherence to the principle that students—those with the *lived experience* of barriers to STEM persistence—should inform the search for ways to improve STEM persistence. Given this commitment, First2 Network students serve in First2 Network leadership roles (as Steering Committee members, working group co-chairs, campus club leads, and mentors), participate as full peers in PDSA working groups, and conduct outreach to STEM-interested students at their former high schools and to state legislators. In addition, students have opportunities to participate in authentic STEM research experiences, for the purposes of building students' STEM knowledge and skill and enabling students to experience the practice of STEM.

Based in West Virginia, this project reflects increasing state needs for STEM workers and increasing concern that the often rural and first-generation college students in the state may struggle to complete their programs of study. Key First2 Network activities include:

- Facilitating working groups to iterate and study improvements to practices and programs using improvement science processes and tools (current topics include summer immersive STEM experiences, faculty-student engagement, and college transition).
- Facilitating additional, sometimes ad-hoc, teams or committees to address important emerging issues (such as the ongoing First2 Measurement Team and the ad-hoc Established Program to Stimulate Competitive Research [EPSCoR] conference planning team).
- Integrating students into First2 Network leadership and facilitating a student leadership group in which students test improvement strategies.
- Conducting early STEM experiences for rural, first-generation STEM students via summer research internships while simultaneously subjecting such internships to PDSAs to continuously improve them.
- Operating a support network, including campus clubs, for students.
- Facilitating a STEM Ambassadors program component to prepare students to return to their home communities to engage younger students' interest in STEM and to harness teachers' and school board members' support for STEM education, and to engage with legislators and other state education leaders about the network's vision and efforts.

To implement these activities in the context of collective impact, the First2 Network provides several leadership and management structures:

- **Leadership Team:** This team consists of principal investigators (PIs) and representatives from the five lead institutions (Green Bank Observatory [GBO], Fairmont State University [FSU], West Virginia University [WVU], High Rocks Educational Corporation [High Rocks], and the West Virginia Higher Education Policy Commission Division of Science and Research [HEPC DSR]), as well as key subcontractors, such as SRI.
- **Steering Committee:** This committee includes Leadership Team members, co-chairs of working groups, and students in First2 Network leadership roles.
- **Backbone organization** (and its mentor)**:** To pursue ambitious goals across the cross-sector networks characteristic of collective impact projects, backbone organizations provide centralized coordination and support of day-to-day operations and implementation of collaborative work. In general, backbone organizations are responsible

for (1) guiding vision and strategy, (2) supporting aligned activities, (3) establishing shared measurement practices, (4) building public will to solve a difficult problem, (5) advancing policy to remedy the problem in question, and (6) mobilizing funding. HEPC DSR serves as the First2 Network backbone organization. Because HEPC DSR has not previously undertaken such a role, however, SRI is subcontracted to FSU to provide capacity-building and mentorship support to HEPC DSR.

During Year 4, the First2 Network engaged in a variety of efforts to prepare itself for sustainability following the close of the INCLUDES grant. One of these initiatives was the establishment of a new structure: **institutional teams**. These teams are campus-based and will become the primary locus for improvement science and systems-change activity after the INCLUDES grant ends. Institutional teams include members from various role groups, such as students, administrators, faculty, and student support services staff. Some members also serve as key points of contact for aspects of First2 Network activity, including a summer immersion program lead, an academic year research lead, STEM faculty First2 Network student campus club sponsor, First2 Network campus club student leaders, a student support services liaison, and a campus administration lead. A total of six institutional teams are established on the following campuses: Blude Ridge Community and Technical College, FSU, University of Charleston, Marshall University, WVU, and West Virginia University Institute of Technology (WVUIT).

III. Findings

This section summarizes analyses of data collected during Year 4 of the First2 Network. Data sources include network documents, the Elements of Collaborative Change interviews, the Working Group Self-Assessment, the Steering Committee survey, conference evaluation questionnaires, interviews with staff of the First2 Network backbone and mentor backbone organizations, the Network Value Survey, pre- and post-tests of 2022 interns, focus groups conducted with First2 Network students, social network analysis, and student outcome data. (Details about the evaluation design and specific instruments can be found in the appendices to this report.)

1. First2 Network Context

1.1 Socioeconomic, Political, and Historical Context

The only state falling entirely within the federally designated Appalachian region, West Virginia is the second-poorest state in the region after Kentucky. A total of 18 (33%) of the state's 55 counties are considered *distressed*, with high unemployment, low per-capita income, and high poverty rates; 15 (27%) are *at risk* of economic distress; and 21 (38%) are *transitioning* between strong and weak economies. Only one county ranks between the best 10–25% of the nation's counties and is considered *competitive*—able to compete in the national economy.[7] Average per-capita income in 2019 was $27,346,[8] below the national average of $35,384[9], with 16% of the state population falling below the federal poverty line.[10] A quarter of the state's children under age 18 live in poverty and 16% of households are food insecure.[11] At the same time, while 88% of West Virginia residents 25 years of age and older are high school graduates,[12] in 2019, 69% of adults did not have a postsecondary credential.[13] In school year 2019–20, slightly more than half (51%) of public school students qualified for free/reduced-priced school meals.[14]

Reasons for the state's social and economic woes are many but can generally be characterized as resulting from a "resource curse." Appalachia's "resource curse" means the region is rich in natural resources but its people are, ironically, poorer on average than those in less resource-rich areas.[15] Dynamics contributing to this circumstance include industry manipulation of state policy and legislation to protect the interests of natural resource extraction (e.g., coal, timber), economic instability arising from cycles of economic boom and bust, low tax bases arising from deals that limit corporate taxes, and the export of profits to the often out-of-state owners of industry.[16]

The state is notably racially/ethnically homogenous compared to other states. With a 93% white population,[17] only 4% of the population is Black, and 2% is Hispanic (and the overall population in the state has decreased by 3% from 2010 to 2020). Of its 253,930 K–12 public school students,[18] 89% are white, 4% Black, and 2% Hispanic[19]; 1% are English language learners (ELLs)[20]; and 18% are students with disabilities.[21]

More than half (51%) of the state population live in rural areas[22] and 21% of rural school-aged children live in poverty.[23] Additionally, 42% of West Virginia students attend public K–12 schools in rural places,[24] with half (50%) of the state's schools located in rural communities.[25] Only roughly one quarter (22%) of West Virginia students attend schools in towns,[26] and earnings in households in rural school districts average barely more than twice the poverty level.[27] The average salary for teachers in the state's rural districts is $4,000 below the national average, and although the graduation rate for rural students is just above the national rural average, students in rural districts score well below the national average in the areas of reading and mathematics.[28] Because of the state's demographics, West Virginia's rural students are more likely to be white and English-speaking and at the same time more likely to be working under individualized education programs (IEPs) than the national average. In addition, the state's consolidation efforts have resulted in large county districts and schools and high transportation costs for rural districts.[29]

1.2 Education Context

State trends in student achievement are mixed. Based on the West Virginia General Summative Assessment, reading performance for grades 4 and 8 declined between 2017 and 2021—with fewer than half of students scoring proficient or higher in reading. While reading performance for grades 4 and 8 increased slightly between 2018 and 2019, fewer than half of students scored proficient or higher in reading. Reading performance for grade 11 remained relatively stable from 2017 to 2021, with about half of students scoring as proficient or higher. Despite improvement from 2014 to 2018 in grades 4, 8, and 11 for West Virginia General Summative Assessment math performance, slightly more than one-third of 4th graders and slightly fewer than a quarter of students in grades 8 and 11 demonstrated proficiency in math.[30] [i] West Virginia National Assessment of Educational Progress (NAEP) results from 2009 to 2017 reveal a slight increase in

[i] Note the following from the West Virginia Department of Education's website: "Although West Virginia tested a large percentage of students during the 2020–2021 school year, direct comparison to previous years should be approached cautiously as participation rates, learning modes, and learning disruptions might have varied across districts during the school year. For these reasons, West Virginia received a federal waiver from the use of assessment results in school accountability because of the COVID-19 pandemic. Student results should be used to assist schools in determining individual student learning gaps and to help in COVID-19 recovery efforts." See https://zoomwv.k12.wv.us/Dashboard/dashboard/7301

grade 4 reading over time, but in 2019 that number decreased slightly, with only about one-third of students scoring at or above proficient. From 2009 to 2017, grade 8 math performance increased slightly but declined in 2019 with just 24% of 8th-grade students scoring at or above proficient. In both reading and math, a large gap between West Virginia's performance and that of the nation overall has remained relatively stable over time. As in other states, achievement gaps persist between low-income students and their more advantaged peers, and between Black and white students.[31]

The state shows some growth in its efforts to ensure college and career readiness, however. Although West Virginia does not require dual enrollment courses to be offered in high school, the state does offer multiple ways for students to earn postsecondary credit and public postsecondary institutions are required to accept credits.[32] From 2009 to 2019, the number of students taking Advanced Placement tests has increased 48% and the percentage of those tests with scores of 3 or higher has increased.[33] Graduation rates for 4-year high school students have improved over time (85% in 2013–2014 to 91% in 2020–2021), while the rate of white and African American 4-year high school students graduating on time increased (90% and 86% respectively, in 2017–2018, and 91% and 87%, respectively, in 2020–2021).[34] The average ACT score of 2019 West Virginia high school graduates was 20.8, similar to the 2018 average of 20.3.[35] Roughly two-thirds (67%) of state high school graduates achieved the ACT English Benchmark, up from 61% in 2018. Only 33% of West Virginia high school graduates scored at or above the ACT Math Benchmark, but that is up from 30% the prior year. A total of 34% of state high school graduates scored at or above the ACT Science Benchmark, up slightly from 32% in 2018. [36]

The 2019 high school dropout rate for West Virginia was in line with the national average (5% and 5%, respectively),[37] and the college-going rate for state public high school graduates steadily declined between 2010 (56%) and 2014 (52%) and increased only slightly in 2015 (52%) and 2016 (53%). College-going rates in 2017, 2018, and 2019 remained relatively unchanged (52%, 51%, and 52%, respectively) but decreased slightly in 2020 (50%), and even further in 2021 (46%).[38]

West Virginia's postsecondary students are served by 12 public 4-year institutions,[39] nine public community and technical colleges,[40] and eight independent 4-year colleges.[41] A higher education collaborative in southern West Virginia also offers postsecondary students "the convenience of taking a variety of college classes offered by different state colleges and universities in one location."[42] In terms of persistence and degree completion, the state falls below national and regional averages. In the 16-state Southern Regional Education Board (SREB) region, the 1-year persistence rate for the 2015 cohort of full-time, first-time bachelor's degree-seeking freshmen at public 4-year institutions was 85%.[43] West Virginia is in last place among SREB states in overall first-year persistence with a rate of 75% for 2018.[44] West Virginia's HEPC DSR reports a 31% on-time graduation rate for first-time freshmen pursuing bachelor's degrees, compared to 41% nationally.[45] In West Virginia, low-income students, many of whom are also first-generation college students, graduated at a rate of just 22% in both 2013 and 2014. From 2010 to 2014, the graduation rate for low-income students increased by 6 percentage points.[46]

Throughout the 2021–2022 academic year, COVID-19 continued to influence the state's education context.[47] Although schools reopened in the fall of 2020, students and employees continued to become infected, leading to absences and the use of hybrid teaching for those isolating at home during recovery. Some indicators suggest that in the pandemic context, West Virginia children and youth are experiencing higher rates of anxiety and depression than previously and have some of the lowest levels of overall health and well-being in the nation.[48]

1.3 STEM Education Context

West Virginia high school students indicate higher levels of interest in STEM than nationally, according to a 2019 report by ACT—60% versus 43%.[49] Only 35% of test takers achieved the Mathematics Benchmark and only 41% the Science Benchmark. Even more concerning, just 14% achieved the STEM Benchmark (a derived score combining mathematics and science scores and correlated with success in STEM courses that STEM students commonly enroll in). Completing 3 years or more of math courses appeared to be associated with an increased likelihood of meeting the Mathematics Benchmark: 35% of 2019 West Virginia graduates with 3 years or more of math met the benchmark, compared to 12% among students taking fewer than 3 years of math. Similarly, completing a physics course in high school appeared to be associated with higher average scores on the math portion of the ACT: 41% of 2019 West Virginia graduates taking physics met the Science college readiness benchmark compared to 28% for students who did not take physics.[50]

Policymakers, education leaders, and advocates have sought to improve STEM education across the state in various ways. The West Virginia Department of Education (WVDE), for instance, has implemented a comprehensive statewide approach to improving science, technology, engineering, arts, and math (STEAM) education (STEAM-minded WV), and advocacy organizations such as WV Forward, the Education Alliance, and the West Virginia Public Education Collaborative have undertaken initiatives to promote STEM. In addition, young people have access to various STEM enrichment opportunities, including STEM summer camps at state institutions of higher education, the governor's STEM Institute, and programs sponsored by the National Aeronautics and Space Administration (NASA) and GBO. Due to public health provisions—such as social distancing—associated with the COVID-19 pandemic, however, many summer 2020 STEM experiences were canceled or were offered as online-only opportunities.

West Virginia is designated as eligible for EPSCoR—that is, the state is one in which the NSF has determined the need for special investment because it has received less than or equal to 0.75% of NSF research funding. EPSCoR eligibility is one indicator of limited STEM capacity, a circumstance EPSCoR funding seeks to ameliorate.

The senate and house education committees of the West Virginia legislature introduced several bills related to STEM education during the 2022 session, three of which have been signed. The remaining bills are pending.

- SB 168 Establishing vocational-technical programs in middle schools (pending)
- SB 178 Relating to vocational and technical education programs (pending)
- SB 529 Encouraging additional computer science education in West Virginia (signed)
- SB 533 Relating to funding for health sciences and medical schools (signed)
- SB 629 Supplementing and amending appropriations to Department of Education, State Board of Education, Vocational Division (signed)
- HB 4080 To create an apprenticeship program for students and local companies in West Virginia to increase hiring and retention (pending)
- HB 4510 To provide that 3rd-grade students be competent in reading and math before moving on to 4th grade (pending)

On top of this, several additional efforts are underway across the state to improve STEM education. For example, the Education Alliance, an education nonprofit, supports STEM Works,[51] a collaboration with industry and business partners to enhance student STEM skills and STEM career readiness. A partnership between the WVU Center for Excellence in STEM Education and

the West Virginia Department of Education established in 2018 has provided professional development and other supports for computer science instruction in the state's schools. As a result, by 2021 76% of West Virginia's public high schools offered at least one computer science course, up from 46% in 2018–2019.[52] The NSF awarded a grant to a founding member of the First2 Network to operate the Mountaineer Mathematics Master Teachers program, a network of math teachers collaborating to engage in continuous improvement of math teaching and learning.[53]

Nationally, despite the rapid growth of enrollment in STEM disciplines in recent years, the number of students graduating with a STEM degree has remained relatively stagnant due to diminishing student retention rates. While these results indicate the success of elementary and secondary education in cultivating interest in STEM fields, more work is needed to understand dwindling retention rates at the postsecondary level. Recent studies have found that among students who enrolled as a major in a STEM field within their first year of postsecondary education, 37% had completed a degree or certification in a STEM field within 6 years, 7% maintained enrollment in a STEM field, and 55% had either switched to a non-STEM field or left postsecondary education.[54] Improving STEM retention nationally—and in West Virginia in particular—is thus crucial to ensuring a stable STEM pipeline and guaranteeing underrepresented young people's fair access to STEM educational opportunities.

2. First2 Network Structures and Activities

2.1 Participants

As of August 2022, the First2 Network included 866 members (see Table 1), an increase of 501% from 144 in Year 1. Nearly a third (32%) of members are students, approximately one-fifth (22%) are higher education faculty or staff, and 5% are educators in the state's K–12 public education system. The organizational type with which a third (33%) are affiliated is unknown.

Table 1: First2 Network Member Institutional Roles

Role	N	Percent
Student	279	32%
College/university faculty or staff	189	22%
Unknown	283	33%
K–12	40	5%
State government/state education agency	19	2%
Education nonprofit	19	2%
Industry	18	2%
National lab	10	1%
Backbone mentor	5	1%
Foundation	3	0.3%
Independent consultant	1	0.1%
Total	**866**	**100%**

Note: Percentages may not equal 100% due to rounding.

An important component of First2 Network efforts is the facilitation of multiple summer internships for rising college freshmen who are rural, first-generation, and/or belong to other groups underrepresented in STEM. These 2-week internships engage students in authentic STEM research experiences with faculty and peers as well as opportunities for networking and building relationships with similar students. Interns are also offered opportunities in the upcoming academic year for the following.

- Join a campus club for rural, first-generation, and other underrepresented students
- Participate in academic-year leadership programs
- Become a STEM ambassador by visiting hometown communities, legislators, and school administrators
- Join academic year research programs to begin or continue STEM research activities
- Participate in professional meetings and conferences

At the time of this writing, 37 interns had responded to a survey about their demographics and internship experiences (see Table 2 for intern demographics across years). More than half (57%) of 2022 interns who responded to the survey were young women, and a majority (76%) identified as white. A total of 21% identified as Black/African American and 8% as Hispanic or Latinx. Readers should note that interns were offered the opportunity to select more than one racial category, so percentages total more than 100%. The percentage of racial/ethnic minorities represented among network interns is higher than the percentage represented in West Virginia. As noted earlier in this report, 4% of the state population is African American or Black, and 2% is Hispanic.

Approximately half (51%) of 2022 interns were eligible for a federal Pell Grant, nearly a fourth (24%) were not Pell eligible, and another quarter (24%) were uncertain about their Pell eligibility status. More than half (57%) of interns self-identified as a first-generation college student. Nearly half (49%) of 2022 interns hail from rural places.

Table 2: First2 Network Intern Survey Respondent Demographics, 2019–2022 (Based on Pretest Demographic Responses)

	2019 Intern Respondents N = 27		2020 Intern Respondents N = 69		2021 Intern Respondents N = 50		2022 Intern Respondents N = 37		Total Intern Respondents N = 183	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
Male	8	30%	22	32%	14	28%	11	30%	55	31%
Female	15	56%	46	67%	33	66%	21	57%	115	64%
Other	0	0%	1	1%	0	0%	2	6%	3	2%
Nonbinary[!]	--	--	--	--	1	2%	3	8%	4	2%
Prefer not to provide[!]	--	--	--	--	2	4%	0	0%	2	1%
White*	18	67%	56	81%	43	86%	28	76%	145	76%
Black/African American*	5	19%	4	6%	8	16%	8	21%	25	13%
Hispanic/Latinx*	0	0%	2	3%	2	4%	3	8%	7	4%
Asian/Asian American*	0	0%	5	7%	1	2%	1	3%	7	4%

	2019 Intern Respondents N = 27		2020 Intern Respondents N = 69		2021 Intern Respondents N = 50		2022 Intern Respondents N = 37		Total Intern Respondents N = 183	
American Indian/ Alaska Native*	1	4%	0	0%	2	4%	0	0%	3	2%
Middle Eastern or North African*	0	0%	0	0.	1	2%	0	0%	1	1%
Native Hawaiian or other Pac. Islander*	0	0%	0	0%	1	2%	0	0%	1	1%
Other*	0	0%	2	3%	1	2%	0	0%	3	2%
Pell eligible	8	30%	33	48%	21	42%	19	51%	81	49%
Not Pell eligible	7	26%	22	32%	16	32%	9	24%	54	33%
Don't know	8	30%	0	0%	13	26%	9	24%	30	18%
First generation	22	82%	40	58%	28	56%	21	57%	111	62%
Non-first gen.	1	4%	29	42%	22	44%	16	43%	68	38%
Rural	8	30%	33	48%	20	40%	18	49%	79	44%
Town	11	41%	18	26%	21	42%	9	24%	59	33%
Suburb	3	11%	15	22%	8	16%	7	19%	33	18%
City	1	4%	3	4%	1	2%	3	8%	8	4%

[!]Demographic response options were refined in 2021 to be more inclusive.

*Racial/ethnic identity percentages may not round to 100% because students had the option to select all categories that applied.

2.2 Improvement Science Activities

Engaging in improvement science activities for the purpose of continuous improvement is a core First2 Network activity. Members of working groups participate in activities such as developing a driver diagram of the problem they aim to address and conducting PDSA cycles to investigate whether new or modified practices improve the outcomes in question. Each working group focuses on one aspect of the STEM dropout problem. During Year 4, working group members launched 14 PDSAs. Since the network was established, members have conducted or are conducting a total of 141 PDSAs, according to a datafile developed and maintained by the backbone and its mentor. PDSAs were conducted during Year 4 on a variety of change ideas, including peer mentoring efforts, exam interventions to support student success, study habits training, an intervention for students in college algebra corequisites, and an academic preparedness workshop for freshmen.

In addition, the First2 Network's backbone and backbone mentor undertook an intensive effort to improve the network's improvement science infrastructure. This began with an audit and quality review of PDSAs, which identified several areas for improvement. These included the need to more clearly align change ideas to the First2 Network driver diagram and to research that supports their value, to improve and standardize PDSA metrics, and to provide ongoing improvement science coaching. Over the course of Year 4, the backbone organization and its mentor engaged network membership in revising the First2 Network's driver diagram, ensuring that drivers were clearly coordinated to focus on systems change work. The backbone also removed ineffective and incomplete change ideas from the PDSA database and aligned the remaining practices with the refined drivers and relevant research. Additionally, members

identified shared measures and metrics for all change ideas to enable data sharing across the network. To ensure members have ongoing improvement science support, the network established a PDSA coaching team to improve the quality of tests of change and established the backbone organization and its Improvement Science Team as the locus for network PDSA data collection, analysis, and communication.

2.3 Document Review

The First2 Network supports its core activities via several key structures to make progress toward its goal of improving the early persistence of rural, first-generation STEM students. Review of First2 Network documents—such as quarterly reports to NSF, meeting notes, and records from the Carnegie Foundation for the Advancement of Teaching's Networked Improvement Learning and Support (NILS) platform in which network members document their PDSAs—illuminates the ways in which the network has made progress toward implementing its core activities. Such data also provide evidence of the extent to which the network has established and implemented the five elements of collaborative infrastructure critical to the effectiveness of collective impact efforts to broaden STEM participation:

1. **Vision:** Engaging the community in a shared vision
2. **Partnerships:** Providing a platform for collaborative action
3. **Goals and Metrics:** Allowing for evidence-based decision-making
4. **Leadership and Communication:** Increasing communication and visibility
5. **Expansion, Sustainability, and Scale:** Establishing the capacity to grow and sustain[55]

2.3.1 Shared Vision

To engage West Virginians in the First2 Network's shared vision, network lead organizations, participants, and students communicated widely using an array of media. This included updates to the First2 Network's website, publication of a monthly network newsletter, additions to the network YouTube channel, and tweets from the network Twitter account.

The First2 Network also facilitated three convenings during Year 4 to reinforce its vision and engage new and existing members in collaborative work.

- Improving STEM Persistence in West Virginia: Reshaping the Narrative. October 19–20, 2021. Approximately 200 attendees participated in 12 online sessions on topics such as diversity, equity, and inclusion in STEM; First2 Network research findings; and new approaches to math learning and teaching for STEM student support. The conference also featured a panel discussion about systems change with state leaders and the director of the INCLUDES hub.
- Applying Improvement Science Workshop. January 6, 2022. This workshop for First2 Network Members engaging in Improvement Science focused on the study phase of the Plan-Do-Study-Act cycle and served about 60 participants.
- Recognizing, Measuring, and Sustaining Success. May 16, 2022, (virtual) and May 23–24, 2022 (Roanoke, WV). Institutional teams from seven of First2 Network's partner institutions of higher education discussed their successes and challenges in support of rural, first-generation, and underrepresented STEM students during the virtual conference day. Institutional teams from different campuses then convened in online breakout rooms to act as "consultants" to each other with counsel about how to address challenges. The in-person conference included approximately 75 attendees. Conference sessions focused on research, evaluation and measurement, development of PDSA

cycles by institutional teams, sustainability, awareness of privilege, and industry partner perspectives on STEM education.

In addition, members of the First2 Network presented information about the network's efforts at a range of public events hosted by other state STEM organizations and partners, including the following:

- West Virginia Science Teachers Association Annual Conference, October 28–30, 2021
- West Virginia Association of Collegiate Registrars and Admissions Officers Fall Conference, October 6–8, 2021
- Fairmont State University Professional Development Week, November 29–December 4, 2021
- West Virginia Science and Technology Conference, July 18–20, 2022
- West Virginia Council of Teachers of Mathematics Annual Conference, March 18–19, 2022
- Student Success Summit hosted by HEPC Division of Student Affairs, July 13–14, 2022

2.3.2 Partnerships

Partnerships provide a "platform for collaborative action,[56] and underwrite the power afforded by collective action. Review of First2 Network documents—including quarterly reports to NSF, Leadership Team meeting minutes, and other project data—indicates that the network continued to expand and to formalize its relationships with other entities.

The First2 Network formalizes its relationships with institutions of higher education in the state through Memoranda of Understanding (MOUs). Currently these include Davis and Elkins College, FSU, GBO, Glenville State College Marshall University (MU), the University of Charleston (UC), the West Virginia School of Osteopathic Medicine (WVSOM), West Virginia State University (WVSU), WVU, and WVUIT. During Year 4, the First2 Network established an agreement with its first community and technical college partner, Blue Ridge Community and Technical College.

These agreements describe how each institution will contribute to the network (e.g., assigning two liaisons to the network, providing data on the progress of first-generation STEM students, participating in network conferences and working groups) and how the network will support institutional membership (e.g., through data analysis, information-sharing, access to learning and networking opportunities). An important feature of these MOUs is that they are signed by high-level administrators (such as a dean or provost) or faculty (such as a department chair) as one means of ensuring institutional buy-in and continuity.

The network also maintained existing partnerships with several other STEM entities in the state, including with the West Virginia IDeA Network of Biomedical Research Excellence (WV-INBRE), the Education Alliance, and the West Virginia Space Grant Consortium. Additionally, representatives from several new industry partners joined the First2 Network industry advisory board: InspectionGo, Leidos, Stockmeier Urethanes, Mountain Leverage, and Green Analytics. These companies join existing industry partners such as Chemours, Solvay, Matric, and Toyota.

Finally, the First2 Network became the mentor backbone for a new coalition in the state: the West Virginia Jobs Network, funded by the Appalachian Regional Commission to build a "power skills" workplace competencies curriculum and training program with certification and then connect workers with jobs.

2.3.3 Goals and Metrics

Clear shared goals and metrics enable network members to gauge their progress over time and to make decisions informed by evidence. Review of Leadership Team meeting notes, Measurement Team minutes, and evaluator participant observation of meetings of the

Leadership and Measurement Teams indicated that the First2 Network engaged in efforts to address several measurement challenges during Year 4.

First, in response to feedback following the First2 Network's second reverse site visit with NSF about the insufficiency of using Pell eligibility as a proxy measure for first-generation status in analyses of statewide STEM persistence rates, the First2 Network reached an agreement with NSF to employ data from WVU in place of statewide data. Because many institutions in the state do not yet collect information about students' first-generation status, analyses of first-generation students' STEM persistence is challenging. HEPC DSR is pursuing a change to statewide data collection policy to establish a common data definition and data collection requirement for West Virginia public institutions, but in the meantime NSF and the First2 Network agreed to rely on data from WVU (which enrolls roughly half of the state's undergraduate population) because the school has collected first-generation status data for years.

Second, the First2 Network devoted substantial effort in Year 4 to strengthening the quality of and support for measurement associated with PDSA cycles. This included review and realignment of the First2 Network's driver diagram and associated change ideas, identification of standard measures for key change ideas to ensure consistency across PDSA cycles and sites, and additional improvement training and other supports for members.

Finally, the First2 Network resolved an issue that had been impeding the acquisition of verified STEM persistence data from HEPC—the need to transmit the Social Security numbers of students who consent to their use to verify persistence status safely and securely. The First2 Network is now able to upload Social Security numbers via a secure portal to HEPC so that a data coordinator can merge them with the state's data and extract reports about persistence.

2.3.4 Leadership and Communication

Leadership development of members—including students—enables the First2 Network to build the capacity to pursue change and support the next generation of leaders taking up the cause of rural, first-generation STEM student persistence. Communication supports this agenda, with network outreach across the state to policymakers, schools, and interested organizations. Quarterly reports to NSF, meeting minutes, and working group documentation provide evidence that the network continues to present leadership opportunities to members and to communicate about its efforts to leaders and potential advocates.

During Year 4, First2 Network students developed their own governance structure and created a Student Expectations Policy to clarify their roles, responsibilities, and requirements. The network continued to offer students leadership roles through their paid service as scholars, directors, and co-chairs and through participation in the Student Leadership working group. Support for STEM leadership included opportunities for students to present original research, meet with policymakers to discuss the needs of first-generation students, and conduct PDSAs.

The First2 Network also facilitated several leadership changes to ensure that members continued to have new opportunities to learn and pursue change as network leaders. This included transitions among working group co-chairs and Steering Committee co-chair positions from First2 PIs to others. These changes were accompanied by leadership sustainability planning efforts that included the development of a long-term organizational chart, transition to new campus-based leadership opportunities in institutional teams and plans to dissolve the Leadership Team and transfer authority and responsibility for post-grant First2 Network decisions to the Steering Committee.

2.3.5 Expansion, Sustainability, and Scale Up

Planning for expansion to other EPSCoR states and for self-sustenance after the grant's end were priorities during the First2 Network's fourth year. Document review indicates that the network leadership implemented various components of its strategic plan to pursue these goals.

For example, the network sought to expand its work by establishing a new partnership with the Center for Integrative Natural Science and Mathematics at Northern Kentucky University (CINSAM), partnering with their team to build their own network using similar practices. In addition, network representatives will serve as advisors to Southside Virginia Community College, which is seeking to increase the percentage of underrepresented students in its information technology major.

The First2 Network also supported work to fund components of its approach on partner campuses beyond the end of NSF INCLUDES funding. For instance, FSU was awarded a $749,693 S-STEM award in February of 2022. The funded project, "Bridging the STEM Gap in Appalachia: Engaging with students to iteratively improve faculty practices in support of student success," is built in part on First2 Network processes for using improvement science methods and ensuring that students are at the center of problem solving. The project will engage faculty from FSU's math, computer science, and engineering technology departments.

The establishment of institutional teams on six campuses represents another effort to ensure the network's sustainability. Institutional teams are campus-based and will become the key locus of activity following the end of the INCLUDES grant. Teams consist of students, STEM faculty members, student support and advising staff, and campus decisionmakers. The network provided targeted support to these teams throughout Year 4, including formal agreements, virtual workshops, and PDSA training and support.

2.3.6 Document Review Summary

Review of Year 4 documents indicates that members of the First2 Network continued to communicate their vision for improving the persistence of rural, first-generation STEM students in their majors through a variety of channels, including presentations at in-person and virtual conferences within the network and at other STEM educator gatherings. The First2 Network sustained existing working relationships and formed new ones with other STEM-interested entities in service of the network's aim, and became the backbone for a new workforce development network supported by a grant. The First2 Network's shared metrics efforts involved planning to include a question about students' first-generation status on all state college applications to support consistent statewide data collection about the experiences and performance of first-generation students. In addition, the network devoted considerable energy to improving the quality of PDSAs and associated measures. Network members took advantage of new leadership opportunities, including with the Leadership Team itself and within newly-established institutional teams. Students, too, took initiative, developing their own policy detailing expectations for their First2 Network participation. Finally, the First2 Network continued sustainability and expansion work, implementing components of the strategic plan by, for instance, developing a relationship with an institution in Kentucky interested in similar efforts and nurturing institutional teams on campuses.

2.4 Elements of Collaborative Change Interviews

In March 2022, evaluators invited randomly-selected members of the First2 Network to participate in 30- to 45-minute telephone interviews about the ways in which elements of

collaborative change were evident across the network. The interview protocol was organized into two main sections. The first section focused on interviewees' assessments of network progress (e.g., learning how to broaden STEM participation, largest achievements to date) and the second section solicited information about interviewees' perceptions of how network members are collaborating. Interviewees were also asked to assess ways the network adapted its work to address challenges stemming from the coronavirus disease 2019 (COVID-19) pandemic.

2.4.1 Interviewees

Among the interviewees participating in the Elements of Collaborative Change interviews during April and May were four college students, a university faculty member, and a district-level staff member. Unfortunately, because the download of one audio file associated with a college student interview was interrupted, transcription was not possible; therefore, findings from only five interviews are included in this analysis.

I think most of them do [share a vision], but I think that a lot of the times the vision gets construed in different ways so it needs to be a little more clear as to what exactly is expected and isn't expected. — Network member

2.4.2 Shared Vision and Common Agenda

Interviewee responses were mixed when asked if network members embraced a shared vision and common agenda. Two of the five interviewees readily agreed. As one such network member stated, "I feel like we have a good central goal, which is improving retention of first-generation STEM students in West Virginia." This member was able to describe additional goals such as supporting underrepresented groups and "trying to make the system better for future students." While another interviewee also agreed that network members have a shared vision, this member said that "a lot of the time, the vision gets construed in different ways" and that "it needs to be a little more clear as to what exactly is expected and isn't expected." This interviewee went on to describe the network's vision in this way:

> *I would say that the vision is to build networks within minority groups, such as women and people of color, into networking in a STEM field.*

The two remaining interviewees shared a belief that there is a common vision but spoke further about how they view the network's progress in making that vision a reality. One such interviewee stated:

> *I think there is a vision, but I don't think it is happening and I don't know if that's part of the pandemic or what.*

The other interviewee spoke in even greater detail about the "extraordinary passion" and "shared understanding" among members but also described the lack of a common focus or understanding of change needed at the institutional level:

> *I think that this is one place where we have a real agreement on the horizon but maybe not sufficient common focus. So, I do believe that there is just extraordinary, shared vision about a need to diversify and make more robust the STEM pipeline and a shared understanding that [it] is not an issue of just supporting students in a broken system, but that the system itself needs to change.*

This interviewee further pointed out that while the need for change at an institutional level could be a little better understood among members, another contributing factor to the lack of

common focus may be that the guidance and direction from "that reverse site visit … really sent a lot of our work in a different … place that was not directly about supporting and retaining students in their first 2 years."

2.4.3 Partnerships

Asked about the ways in which, and to what extent, the First2 Network engages partners with diverse perspectives, organizational affiliations, and roles, all five interviewees responded that the network engages a variety of partners. One respondent noted that although there is good representation among the various role groups, there is "always room for improvement." Another respondent simply noted that the network engages a "good mix of people." When responding about the engagement of partners, two interviewees described the various role groups that are involved in the network (e.g., students, teachers, and also representatives from industry, higher education, nonprofit, and K–12 education), with one of those interviewees also sharing the following about diversity among those partners:

> *I actually think we do that [creating partnerships] quite well. I think that's a particular strength of this organization. I think as we've grown, we've become more mindful of who the players are—trying to invite them, trying to support them, trying to learn from them. —* Network member

> *… we've got everyone from, like, different parts of the different counties in the states. So, we've got big schools and little schools … lots of perspectives.*

Another interviewee also commented on the diversity of role groups but shared that the diversity may not be as obvious as it was in the network's earlier years since meetings may not occur as frequently.

> *Again, it's like when we first started the network, there was a lot of that because there were companies … as diverse as West Virginia could be. Let's put it that way. There were lots of companies involved, there was K–12 involved, higher ed involved, nonprofits involved. And they're all still involved, but I don't think it's as obvious now because folks aren't getting together as regularly and you see a lot of the same people at all the meetings and things. And I don't think that's any fault of the network or any fault of the team. I just think it's just where we are right now.*

Another respondent commented on the network's activities during Black History Month, stating that "they had a lot of talks about it and roles that Black scientists have played in our lives and I thought that was really nice and really a diverse way of thinking."

Another respondent commented on a need for the increased involvement of first-generation students in terms of the network's representation across the state, particularly in certain areas and including those areas defined as rural:

> *… our representation follows our university centers and so we, in that way, are not reaching the most underserved, highest-density of first-generation students. We're not reaching the coal fields. We're not reaching, you know, really even my region of the state super well … if we're housing sort of our backbone and our main folks that do that kind of outreach at bigger universities, then anyone who is farther from a university is by nature not getting reached. But there's not as much … you know that map that they made about rurality and crossing over with, you know, how many STEM opportunities there are, it's real—like, rurality is a real thing that's very hard to reckon with.*

Interviewees were also asked how, and to what extent, the First2 Network engages partners in meaningful change activities. Although one interviewee shared that they were not able to respond to this question, two interviewees shared that the Plan-Do-Study-Act (PDSA) process was a meaningful change activity in which members participate.

A third interviewee commented on the engagement of members using a "fishbone exercise" and through the sharing of ideas among members:

> *So, when we have student director meetings or all-student meetings, we usually have different activities that different members come up with. … They usually do a fishbone exercise or sometimes a "notes" kind of thing and I think those are really nice because we can see people's ideas from all around the state.*

Another respondent spoke more in depth on this question, noting that one way the network is "inching forward policy-wise" is by getting "everyone from policymakers to legislators to faculty to administrators of universities … to listen to 19-year-old first-generation students." This respondent shared that they hope "we don't undersell how important that is" and commented further about engaging students in meaningful change activities and how students can effect change:

> *… almost without fail, any high school teacher who got an ambassador visit from a student said they learned something that they didn't know that will help them better prepare students.*

This same respondent also noted that a shift after the first few years in the project's focus may be limiting meaningful change:

> *What kinds of activities or support systems [are in place to help] freshmen to get acclimated to the systems that they need to be using …? I don't think yet that we're doing [that] piece … I think some really cool individual things have happened but in terms of putting the might of the organization behind "Look at this very simple change idea for doing exam review and giving it a grade" and "Look at what happened with course retention and pass rates" … we haven't done that …*

2.4.4 Shared Metrics

Interviewees were asked how partners use common measures (shared metrics) across the network to identify and determine outcomes and to what extent the network's shared metrics system has sufficient resources and capacity to operate as intended. All but two interviewees commented on the use of shared metrics to support shared learning and improvement. One of those interviewees was "not sure" how to respond while the other noted, "I think there's an attempt to do that and an attempt to do the same shared measures that they're looking at nationally, but I just don't have a feel for that because I'm just not directly involved." Two respondents mentioned the First2 Network website, with one noting that the website is "pretty good" and that the network does a good job with it. One respondent commented on the use of another communication tool, Slack, noting that "it doesn't really work well" and "a lot of us have never heard of that" but that "they helped

> *I think one of the big ones that we all kind of go back to are the fishbone diagram, the driver diagram, the whole encyclopedia of our goals. That's always like a growing kind of source of information.* — Network member

me out and they helped me get" an account. The respondent also noted that the network may be reviewing other methods of communication in the future.

The fishbone diagram was mentioned by one respondent who described the diagram as "the whole encyclopedia of our goals" and a "growing source of information." The respondent continued:

> *I think it helps us kind of stay on track and make sure we're all going back and saying, "How does this goal or how does this thing that we're doing affect the central goal," so we're all kind of focusing on one thing through some little things.*

Another respondent expressed a belief that the use of common measures across the network was an area of weakness and suggested that the number of changes in mentor backbone leadership and the changing "spin on what it meant to train people for improvement science and use metrics effectively" may have contributed to this weakness. The respondent noted that "there are really meaningful common metrics, but we never use them" and that although first-generation status and institutional retention/pass rates are not being captured, the sharing and "sense-making" of data will "get better with institutional teams, which is the direction we're driving a year later than we meant to."

When asked whether there are sufficient resources and capacity for those kinds of metrics and tools, one respondent simply agreed to this point and two respondents shared comments:

> *I know it's a little difficult to go into the driver diagram because it's a big document … I think that some introduction to the different tools that we have would be helpful to incoming people because it is a lot of information all at once.*
>
> *Not all. Not sufficient resources. Not sufficient capacity …*

2.4.5 Leadership and Communication

Interviewees were asked to describe how the network builds leadership among partner organizations or individual members. All five respondents agreed that the network provides members with leadership and service opportunities, as well as support in those areas, although one respondent also shared that there have been times where members who have been asked to assume a leadership role were unclear about what was expected and expressed some frustration. One respondent shared, however, that a social network analysis revealed the emergence of leaders, whereas at the beginning of the project there were "just a few people from the PIs and the leadership team." Two respondents viewed the scholar and student director programs as opportunities to develop leaders. One such member shared the following:

> *I do think it's been really wonderful the structured way that people take over being working group chairs, so we kind of have that scaffolded that there's always one co-chair repeating and one co-chair and then they have to push out [as] a new person comes in.* — Network member

> *I would say that the network builds leadership probably through things like their student director programs because you have responsibilities you have to hold up to and gives you some kind of responsibilities—that way of how to be a reasonable leader … Leadership roles are extremely important, even if you are the treasurer or a photographer or something. It's always great to have some kind of role. You need to know how to work well with others.*

Yet another shared the following:

> *… we have a lot of opportunities to go to the other working groups and speak on behalf of the students, so there are a lot of leadership opportunities for us. There's plenty of opportunities within student directors who are like leadership of the student working group[s]. There is like club leaderships. Lots of little projects that we're able to lead, which some of those are kind of coming from other working groups. So, for the students at least, there are quite a few opportunities.*

Another respondent noted that the First2 Network encourages members to "seek out leadership" and that "because of First2, even though scholar isn't a huge leadership role in the club, because of that I sought out leadership in other clubs."

Interviewees were then asked to share their perceptions of the extent, and in what ways, the network works to ensure cross-communication to build trust, assure progress toward the achievement of shared goals, and sustain collective momentum across the network. All five respondents expressed a belief that the network works to ensure cross-communication; however, one respondent was not able to provide a specific example of cross-communication to assure progress toward shared goals.

One respondent noted that the all-student meetings helped to build trust among that role group and that activities such as trips that involved students from multiple campuses were an effective means of cross-communication.

> *And my campus, we just went on a trip to Lewisburg [WV] … and we arranged it so that students from First2 Network chapters on other college campuses in the state [attended] … and I thought that was really cool because I had never met that many different people ever.*

First2 Network structures such as annual conferences and quarterly reporting were mentioned by another respondent as a means for assuring cross-communication among members. This respondent noted that the need to participate in these types of activities "really forces you to pause and hear how one another see things." They stated a hope that conferences can be held in person in the future because "this work felt really different when we were together." Another respondent shared a similar sentiment related to how First2 structures and processes contribute to the achievement of goals:

> *They always have kind of a target they want you to hit for however many hours to complete or something like that. So, I think that there are ways for people to meet goals.*

And yet another interviewee suggested that the First2 Network's requests for feedback on various processes and activities were helpful in terms of ensuring cross-communication to sustain momentum:

> *I would say they do a lot of exit slips, kind of like a Google [Docs] document, where they ask you questions about what they could do better, what they could do more, did you find this video to be informative, did you think it was not worth your time, or something along those lines.*

2.4.6 Expansion, Sustainability, and Scale

Interviewees' responses were generally positive when asked about their perceptions of the ways the network adapted its work to address the challenges stemming from the COVID-19

pandemic. Only one respondent indicated being "not able to share much," yet still commented as follows:

> *I didn't know much about First2 until I got into college and by the time I got into college all you had to do was wear a mask. You could still go to the meetings. You could still do trips. You could still do normal stuff … you just had to wear a mask. So, I can't really comment on that one.*

Remaining respondents shared sentiments such as "I think they did well" and "I think we did better than a lot of other people" and "I think they're doing a good job of that actually." One such respondent also noted that a backbone staff member "has really done a lot to try to bring everybody together" and has "been a positive addition in trying to move everything forward because of the pandemic and I think she's doing a super job at that." Still another respondent spoke to the "nimbleness" of being able to support students through the pandemic in various ways, not having to "jump through hoops" to do so, and being "very, very proud of what we did on behalf of our students" during that time. They commented further that it was "remarkable what we've been able to do with students." Another respondent spoke about the virtual conferences that replaced in-person conferences during the pandemic and noted that "we didn't quite get the same effect for those things and students are kind of disconnected," but shared also that "we're getting back together now that COVID is slowing down."

I think opening the umbrella to different majors of what to cover … how they have not just STEM majors but they have things like psychology majors and criminal justice majors. I think opening the network up to different majors is definitely helpful. — Network member

Interviewees also shared their perceptions of the ways in which the network is expanding the reach of its efforts and working to scale the network's promising practices across the state and elsewhere. As one respondent said, the network is working with additional campuses to establish clubs and summer immersion sites from the "eight or nine" sites that were in place last year. This respondent also discussed "going back into high schools and trying to expand locally," as did another respondent:

> *… their outreach ambassador programs are really good, which—if you're a scholar or director—you have to do. And I actually just completed one over spring break. I went back to my old high school and gave them a presentation on it, told them what First2 is and all that and I think that's really good because when I was in high school no one told me about First2. No one told me about, like, the summer opportunities you could do or what you could do in college and had someone told me about that I would have had more money going into college.*

Three respondents shared strategies (current and possible) for expanding the reach of the network's efforts:

> *I think opening the umbrella to different majors of what to cover … how they have not just STEM majors, but they have things like psychology majors and criminal justice majors. I think opening the network up to different majors is definitely helpful.*
>
> *I think there are several things that are ready to scale, and one is a way of doing work with students at the center and there are other things that may be promising, but they're not like institutional change … We need to know from universities "what are you doing" and "where is your data to prove this is*

> *promising" and then how can we scale and improve upon that? That's where we need to move next.*
>
> *I know that [the university has] worked at getting other federal grants that piggyback off the First2 Network. So, it's been an impetus for them to get other STEM-related grants and so I think that is positive.*

Network members who participated in an interview were next asked how the network plans to sustain its work after INCLUDES funding ends and maintain the current momentum. A respondent shared a planned strategy for maintaining momentum in the campus club in which they participate:

> *I think [the club president] is graduating next fall … there isn't going to be a time where [the club president] graduates and then we have to scramble to find new leadership within the club. [The club president] will already have that lined up …*

Another respondent expressed being unaware of plans to sustain the network, including any additional funding, while yet another suggested "just doing some work with the deans, the presidents, the provosts, that kind of thing" or establishing a "first-generation" office similar to the one at the campus they attend. Continuing to hold annual meetings and taking advantage of technology were suggested by another interviewee as strategies for sustaining the network's goals. Another interviewee shared the following:

> *I do think there have been some interesting conversations with a few campuses about how to think creatively [about] how the mentorship program could be funded for students. I hope we take more steps in that direction next year, but in terms of funding, the kind of organizing and learning across contexts, I don't think we're there yet.*

This respondent also spoke about the possibility of additional funding:

> *We certainly have a lot of interest from our legislature—I don't think it's out of the question that in another 5 years we could have a line item and this thing could really work because we built some really cool relationships.*

2.4.7 Network Progress: Learning about Broadening STEM Participation

Asked what they were learning about broadening STEM participation because of their involvement in the First2 Network, four respondents cited new or increased knowledge about underrepresented groups in STEM, opportunities in STEM, interest in STEM, STEM participation among first-generation students, and the need to share STEM stories and change systems. As these four First2 members explained:

> *I feel like I've learned so much about just this system, the institutional systems and everything which I never would have picked up otherwise. Like I took a class with [a teacher] who is a professor at [institution] … and learned a lot about, like, underrepresented groups in STEM and how to make institutional changes. I've done a lot of work with PDSAs and finding, like, what's the best way to actually make a change and kind of keep it going, not just, "Hey, we want to do something, and we think it's going to … like, we want to do this and it's because we want to." And it's like there's like a scientific, empirical way to do it which has been pretty cool to learn about.*
>
> *… I have learned so much through shared stories … there are certain anecdotes that kind of come forward and speak to the whole thing. One is our advisor … is*

> *a first-generation student herself and the way in which she was able to serve that group of students and the meaning that group of students has to her, and the degree to which she really found meaning in, you know, knocking down doors when that group of students needed her to … and you share that with an 18-year-old and that 18-year-old becomes the person who needs to do it for the next person. I know that the systemic barriers to broadening STEM participation are serious and unless and until we … focus our efforts … relentlessly making small doable shifts consistently in those systems, in part, I really believe by talking to people or the general population for whom the system least serves.*
>
> *What am I learning about STEM participation? Well, again, as I said, as we look at the network, there is more interest in STEM, so we see that growing. We see people talking to each other about STEM opportunities and what's available and changing their majors based on the climate of the state, so I think those things are happening.*
>
> *Well, at first, I didn't even know that STEM participation was that low in first-gen students. I didn't even know that.*

2.4.8 Additional Comments

Finally, interviewees were asked to share any final comments about their perceptions of the network that may not have been addressed in the formal interview protocol. One respondent expressed appreciation for the wide range of opportunities the First2 Network has provided to interact with and learn from other first-generation students (who may not have been able to experience this type of interaction or activity otherwise). This person expressed appreciation for the network's encouragement—not only in the areas of education and career, but in the area of personal growth.

Two respondents offered suggestions for improving the network:

> *If I could say there was any weakness in the network, it would be that the groups really needed training on how to measure their PDSAs better.*
>
> *I would say if the students have any questions about the First2 network, there needs to be a place where we can ask that anonymously, if that makes sense, of how to deal with problems within the network with somebody who is unbiased.*

2.4.9 Elements of Collaborative Change Interview Summary

In sum, networked members who participated in the Elements of Collaborative Change interviews generally perceived that the five elements of collaborative infrastructure were present and in continuous development. Respondents were unanimous in their agreement that network members embrace a shared vision, although there may not be "sufficient common focus," or the vision may be "construed in different ways." Respondents agreed that the network engages partners with diverse perspectives, organizational affiliations, and roles, although one interviewee was not aware of the ways and the extent to which the network engages these partners. All five respondents agreed that the network provides members with leadership and service opportunities, as well as support in those areas, and were generally positive in their perceptions of the ways the network adapted its work to address challenges stemming from COVID-19. Interviewees also provided positive feedback on the network's efforts to expand its reach and four respondents cited new or increased knowledge about broadening STEM

participation. However, while just three of the five network members who were interviewed described how partners use shared metrics across the network to identify and determine outcomes, one expressed a belief that the use of common measures was an area of weakness for the network. Overall, perceptions of the network's progress were positive this year.

2.5 Working Group Self-Assessment

The Working Group Self-Assessment seeks to answer key questions about working group activity and progress. It is intended for all First2 Network members, co-chairs, coordinators, and students who participate in a working group. In November 2021, the instrument was administered to participating working group members using an online survey link sent directly to the First2 Network members in the portal as well as to working group chairs for dissemination to members of their respective groups: Immersive Experiences, Faculty and Student Engagement, College Readiness, and Student Leadership. During Year 3, surveys were conducted semiannually in November 2020 and May 2021. Prior to 2020, the survey was administered three times annually, in May, July, and November 2019.

The evaluation team developed the Working Group Self-Assessment with 39 indicators designed to assess participants' perceptions of their working group's collaboration, dissemination, and capacity building activities, as well as their ability to move through PDSA cycles—all components the First2 Network has identified as important for its collective impact work. Dimensions 2 to 5, below, each represent one phase in PDSA cycles. Respondents use the following rating scale to indicate the extent to which each item is a weakness or strength for their working group.

1 = *This is a weakness for our working group.*

2 = *This is more of a weakness than a strength for our working group.*

3 = *This is neither a weakness nor a strength for our working group.*

4 = *This is more of a strength than a weakness for our working group.*

5 = *This is a strength for our working group.*

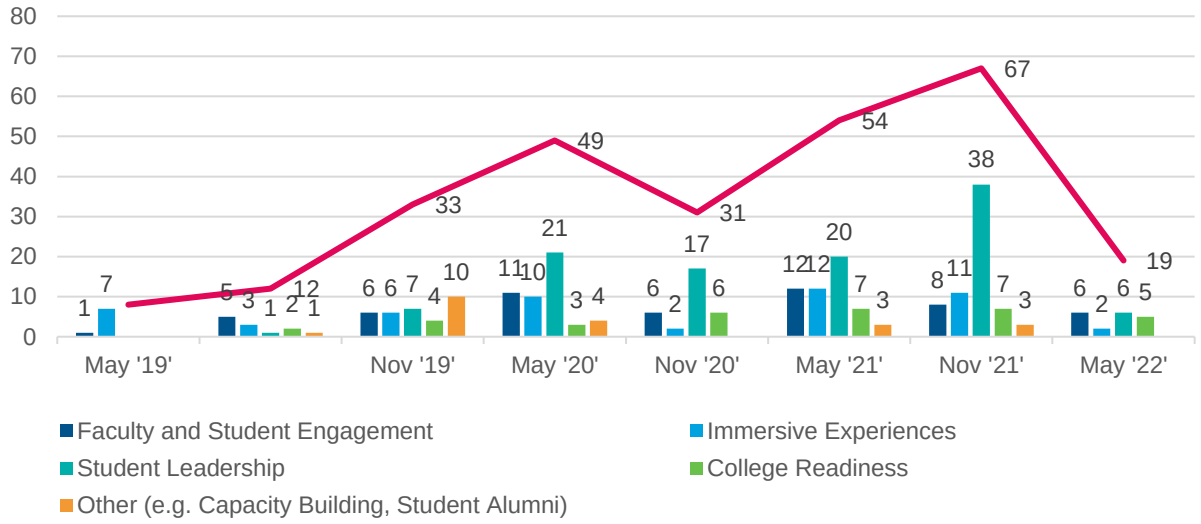
Analysis of mean ratings over time provides valuable information on changes in working group effort and progress as the network develops, meaning growth should be observed through increasingly higher ratings on the 5-point response scale. Analyses include descriptive statistical approaches (means and percentages).

Additionally, each component provided opportunities for respondents to offer feedback via two open-ended questions: (1) What policies, organizational structures, environmental factors, events, or other issues do (or could) support this dimension of collaboration? and (2) What policies, organizational structures, environmental factors, events, or other issues do (or could) jeopardize this dimension of collaboration? Evaluators conducted inductive thematic analysis of replies to open-ended items.

Nearly half of working group members completed the self-assessment in November 2021 (known as Q7) (49% of the 137) but only 14% completed it again in May 2022, member numbers are based on the First2 Network portal and confirmed by the chairs. Additionally, in November 2021, three of those respondents self-identified as student alumni. Figure 1 below presents the number of total respondents by their working group identification. In most data collections, the largest number of responses (57% of 67) came from the Student Leadership working group. When considering their total membership, student leadership respondents were also most represented in November 2021. Specifically, 38 respondents out of 45 student leadership

members responded (84%).[ii] The second largest represented working group for Q7 in responses were generated by the College Readiness working group (37% out of 19), followed by the Faculty and Student Engagement working group (32% out of 25). The smallest numbers came from the Immersive Experiences working group (29% out of 38). During the most recent data collection in May 2022, only six respondents identified as part of Student Leadership, the same number as Faculty and Student Engagement (32% each). The largest number of respondents by percentage or members came from the College Readiness working group (26% of 19). For this reason, data reported below is based upon the annual November 2021 data collection, as this is the most recent administration with a representative sample of respondents.

Figure 1. Annual May and November Response Levels by Working Group

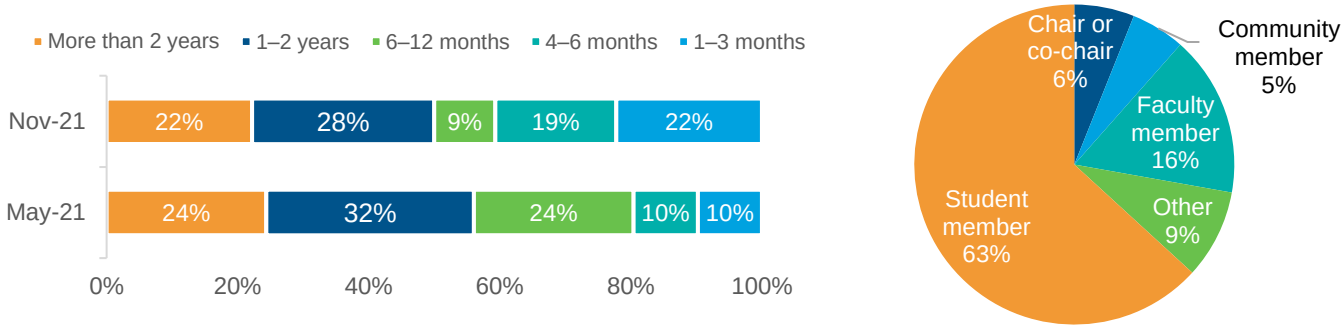


2.5.1 Respondents

Eighty-one percent of respondents (54 of 67) answered the question about how long they have served as a member of the working group (see Figure 2), and 56 responded about their role in the working group. Half (50%) of respondents had more than 1 year of participation in the working group, and over half (63% of 56) identified as student members (see Figures 2 and 3 below).

[ii] Totals based on member attendance during at least one meeting during November 2020–November 2021.

Figures 2 and 3. Member Years of Participation and Role in Working Group, Nov. '21 (Q7)

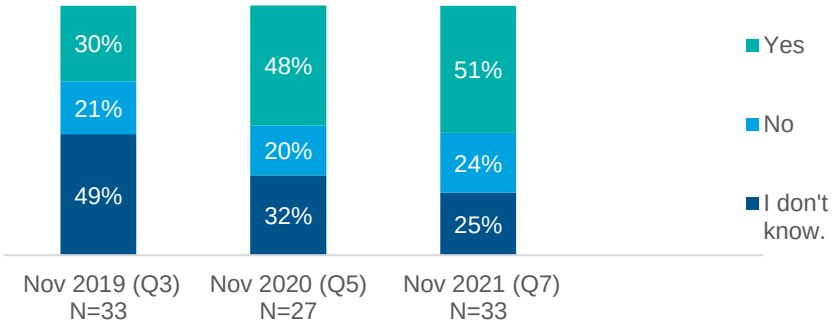


Note: Both Figures 2 and 3 are based on November '21 N=54 and May '21 N=41 response levels

2.5.2 Change Activity Participation

The self-assessment first asked members to state whether they were working on a "change activity" and if so, to explain further details. Of the 67 Q7 member respondents to this question, most replied that they were participating in a change activity. Figure 4 shows the distribution of responses to illustrate the status of working group members' change activity participation across the last three November administrations (Q3-November 2019, Q5-November 2020, and Q7-November 2021). Working group participation appears to have steadily increased since the Q3 administration of the instrument. When asked if the change activity was entered in NILS, 27% of the 34 responded affirmatively.

Figure 4. Percentage of Respondents Reporting Engagement in Change Activity, 2019–2021



2.5.3 Longitudinal Analysis of Dimension Mean Ratings

The evaluation team analyzed Working Group Self-Assessment mean dimension ratings across 3 years, focusing on the following quarters: Nov 2019 (Q3), Nov 2020 (Q5), Nov 2021 (Q7). The resulting dimension means represent the extent to which network members rated each dimension as a strength or weakness in their working groups using a scale of 1 = *This is a weakness for our working group* to 5 = *This is a strength for our working group*. Thus, a score of approximately 3.5–4.5 represents more of a strength than a weakness and a score of 1.5–2.5 represents more of a weakness than a strength. Respondents also had the opportunity to select a *Not Applicable* response option; such responses are excluded from this analysis.

Figure 5 shows results across Q3, Q5, and Q7. Working group members rated all eight key dimensions as more of a strength than a weakness across all three time periods. But the figure

also demonstrates slight changes in growth over time, with steady mean ratings across all dimensions in November 2021. The exception is the Collaborate dimension, which is consistently highly rated: 4.2 in Q3, 4.4 in Q5, and 4.3 in Q7.

The Building Capacity dimension posted the next highest mean growth in ratings during the most recent cycle, from 4.0 in Q5 to 4.2 in Q7. One item, *The working group members develop professional identities that value engaging in sustained collaborative inquiry with one another to address problems of practice* (4.4, +0.38 from Nov 2020) *and The working group members assume new roles and develop the capacity to conduct network activities* (4.3, +0.66 from Nov 2020) reflect the largest growth from this time last year, reflecting ongoing capacity-building efforts through partner collaboration (see Figure 5). While strides were made to be inclusive, as one respondent explained, "members of network have reached out to provide materials and guidance," one member still acknowledges the need for greater organization, saying, "We need more roles on board at each participating institution. We also need a better way to document and share 'successful' change ideas that are generated by students."

Figure 5. Average Working Group Self-Assessment Ratings by Dimension and Quarter

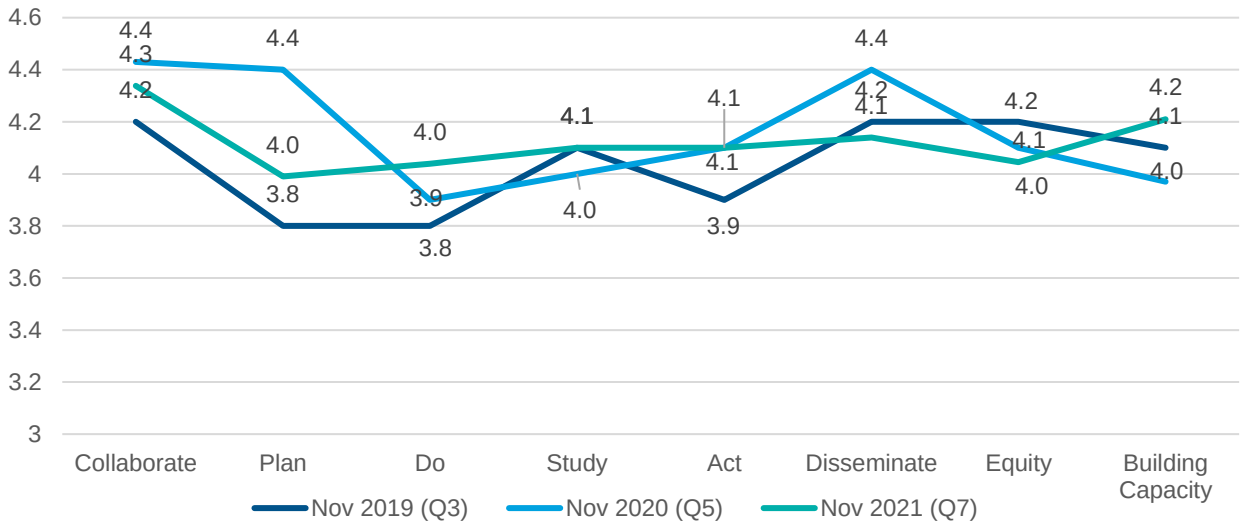


Table 3 displays mean ratings from Nov 2019, Nov 2020, and Nov 2021 for each Working Group Self-Assessment dimension as well as for each individual indicator within each dimension.

Table 3. Working Group Self-Assessment Dimension and Indicator Mean Ratings

Dimension	Indicator	Nov 2019 Mean	Nov 2020 Mean	Nov 2021 Mean
Plan	The working group agrees to focus upon a shared aim.	4.50	4.60	4.33
	The working group conducts research to clarify and further specify problems of practice prior to identifying and assessing strategies for addressing those problems.	3.46	4.29	4.07
	The working group develops a driver diagram to depict its theory of change.	3.92	4.25	3.69
	The working group uses PDSA cycles to spur improvement in testable iterations.	3.77	4.46	3.84

Dimension	Indicator	Nov 2019 Mean	Nov 2020 Mean	Nov 2021 Mean
	The working group makes decisions about PDSA measurement that balance rigor and feasibility.	3.54	4.40	3.87
	Average Dimension Rating:	3.84	4.40	3.99
	Number of Respondents:	**14**	**15**	**60**
Do	The working group uses PDSA forms to record expected outcomes of each improvement strategy implemented.	4.33	3.94	4.15
	The working group establishes processes for collecting, organizing, analyzing, and synthesizing data during PDSA cycles.	3.78	4.12	3.94
	The working group helps participating institutions implement improvement strategies for addressing problems of practice.	3.44	3.56	3.96
	The working group consistently collects data on a short list of indicators to measure results from the improvement strategies implemented at participating institutions.	3.44	3.81	4.00
	Average Dimension Rating:	**3.75**	**3.86**	**4.04**
	Number of Respondents:	**9**	**17**	**51**
Study	The working group members ask questions of those affected by the work about what the data mean.	4.50	4.14	4.27
	The working group analyzes data collected about improvement strategies and compares them to projections developed in the Plan step.	4.00	3.86	4.10
	The working group shares findings in ways that take account of the needs of the network and its members.	4.00	4.14	4.04
	The working group considers the extent to which the analyzed data do or do not represent progress toward the overall aim.	4.00	3.86	4.00
	Average Dimension Rating:	**4.13**	**4.00**	**4.10**
	Number of Respondents:	**2**	**7**	**49**
Act	The working group determines whether the improvement strategy being tested should be adopted, adapted and re-tested, or abandoned.	3.67	4.33	4.23
	The working group decides what should be adjusted and studied next, if the improvement strategy needs to be adjusted.	3.83	4.00	4.19
	The working group decides whether the improvement should be tested in new contexts and/or at larger scales if the improvement strategy is successful.	4.17	4.00	3.98
	The working group iteratively tests what related processes or supports are needed to ensure that effective improvement strategies produce improvements reliably.	4.00	3.89	3.94
	Average Dimension Rating:	**3.92**	**4.06**	**4.11**
	Number of Respondents:	**6**	**9**	**49**
Collaborate	The working group members represent the demographic and geographic diversity of our state.	3.95	4.30	4.26
	The working group includes rural, first-generation students.	4.05	4.50	4.20

Dimension	Indicator	Nov 2019 Mean	Nov 2020 Mean	Nov 2021 Mean
	The working group includes STEM professionals who were themselves rural, first-generation students.	4.76	4.23	4.47
	The working group members meet together regularly.	4.43	4.61	4.60
	The working group ensures that student perspectives are considered.	4.18	4.61	4.16
	The working group establishes routines that promote collaborative decision-making and guard against power imbalances.	4.05	4.18	4.33
	The working group members establish norms of interaction that support collaborative decision-making and equitable participation in all phases of the work.	4.05	4.26	4.50
	The working group members recognize and respect one another's perspectives and diverse forms of expertise.	4.41	4.70	4.42
	Average Dimension Rating:	**4.24**	**4.43**	**4.34**
	Number of Respondents:	**22**	**23**	**61**
Disseminate	The working group develops and shares knowledge and theory that furthers the research base.	4.00	4.22	4.09
	The working group contributes to network dissemination efforts.	4.57	4.44	4.20
	The working group shares results in ways that take into account the needs of relevant audiences.	4.43	4.56	4.10
	The working group develops and shares new tools and/or routines that can be adapted to support improvement work in other settings.	3.71	4.22	4.22
	Average Dimension Rating:	**4.18**	**4.36**	**4.14**
	Number of Respondents:	**7**	**9**	**53**
Reflect on Equity	The working group activities take into account members' work demands and roles in their respective organizations.	4.25	3.92	3.87
	The working group focuses attention on policies, practices, and culture that are reinforcing patterns of inequity in the state.	4.13	4.33	4.21
	The working group develops targeted strategies that specifically and differentially take into account underlying advantages that some people have, as well as challenges that other groups face.	4.13	4.15	4.08
	Average Dimension Rating:	**4.17**	**4.13**	**4.05**
	Number of Respondents:	**8**	**13**	**54**
Building Capacity	The working group members develop professional identities that value engaging in sustained collaborative inquiry with one another to address problems of practice.	4.09	4.00	4.38
	The working group members assume new roles and develop the capacity to conduct network activities.	4.10	3.63	4.29
	The working group's work contributes to changes in participating education institutions' norms, culture, and routines around the use of research.	4.09	4.25	4.22

Dimension	Indicator	Nov 2019 Mean	Nov 2020 Mean	Nov 2021 Mean
	The working group establishes conditions in participating institutions that lead to sustained impact beyond the life of the network.	4.09	4.00	4.20
	The working group establishes conditions in participating institutions that lead to sustained impact beyond the life of the network.	4.09	4.00	4.04
	Average Dimension Rating:	**4.09**	**3.98**	**4.20**
	Number of Respondents:	**11**	**8**	**45**

2.5.4 Plan-Do-Study-Act (PDSA) Cycles

Four dimensions of the Working Group Self-Assessment focus on each of the four phases of PDSA cycles, an important tool process associated with improvement science employed by the First2 Network to test improvement practices iteratively. Respondents from each working group reported varied experiences with activities associated with each phase of PDSA cycles. These included activities such as identifying strategies for addressing problems of practice, refining practices in testable iterations, analyzing data collected, and determining whether to adopt tested practices.

2.5.4.1 The *Plan* Phase

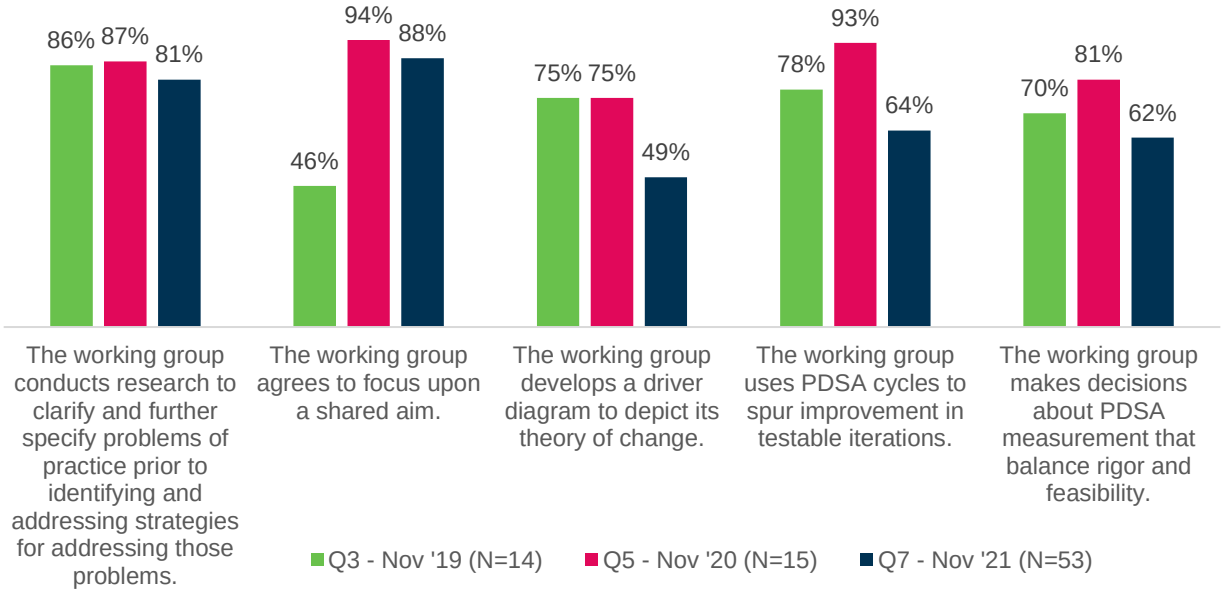
According to evaluation findings from the First2 Network's first year of operation, working group PDSAs were under development as members engaged in various learning opportunities on improvement science and how to conduct PDSAs. By Year 2, working groups had begun planning change activities, using PDSA cycles to *spur improvement in testable iterations*. In the most recent administration of the Working Group Self-Assessment, data suggest that, while the COVID-19 pandemic slowed PDSA activity, the percentage of respondents who considered planning phase activities as strengths has increased since the network's inception.

Figure 6 shows the percentage of respondents (across all working groups) rating each indicator of the Plan phase as a strength in their working group at three points in time: November of 2019 2020, and 2021. While no activities associated with the Plan phase had higher mean ratings in November 2021 than in the prior year, 83% of member respondents agreed they are still conducting research to clarify and further specify problems of practice to identifying and addressing strategies to ameliorate those problems, the strongest activity in this phase. One member explained, "Our working group completed a book study on first-gen college students and has used our knowledge to outline areas for creating change activities."

Almost two-thirds of working group members (62% of 53 respectively) agreed *mak[ing] decisions about PDSA measurement that balance rigor and feasibility* is a strength for their working group, a decline from 81% in 2020. Another notable change was in respondents' assessment that their working group *uses PDSA cycles to spur improvement in testable iterations*, with 93% reporting this as a strength in November 2020 compared to 64% in the most recent cycle.

A few members described challenges associated with conducting the Plan phase, including the ongoing need to find regular meeting times to discuss implementation in the middle of busy schedules. One respondent also described how it would help during planning if facilitators would "revisit our driver diagram."

Figure 6. Percentage of Respondents Rating Indicators of the Plan Phase of PDSA Cycles as a Working Group Strength, 2019–2021

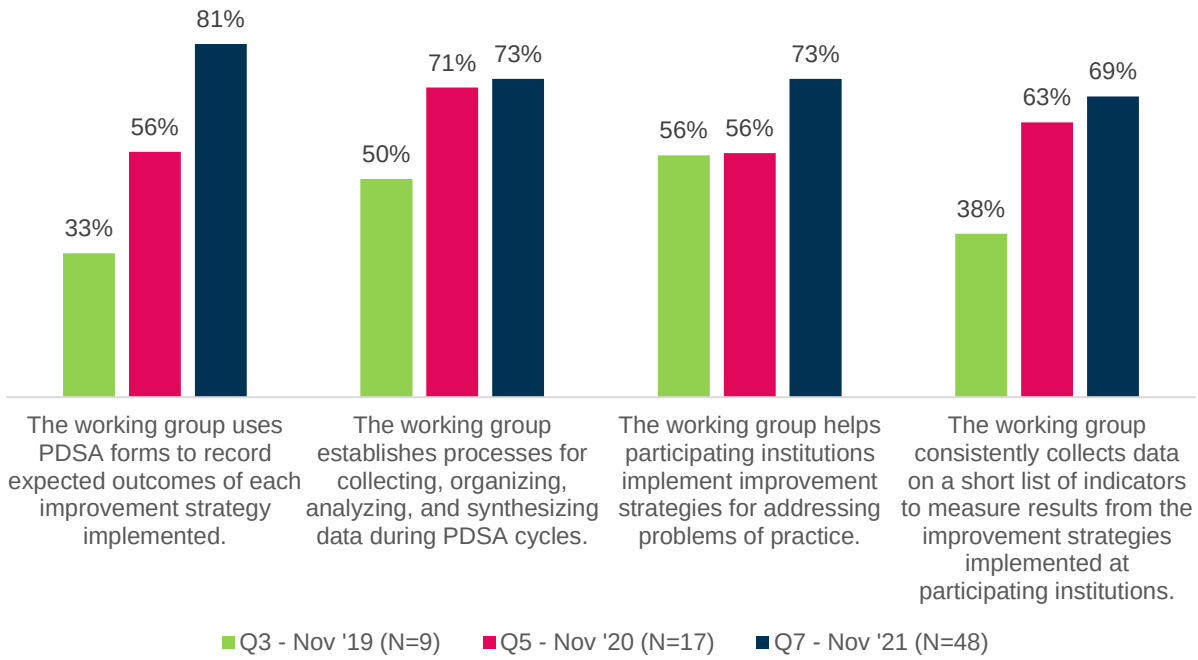


2.5.4.2 The *Do* Phase

The percentage of respondents who considered Do phase activities as strengths has steadily grown since this time last year. Mean ratings for all activities associated with this Do phase increased between 2019 and 2021 (see Figure 7). For example, whereas only 33% of respondents in 2019 reported that *The working group uses PDSA forms to record expected outcomes of each improvement strategy*, a majority (81%) did so by 2021. Similarly, mean ratings of *The working group helps participating institutions implement improvement strategies for addressing strategies of practice* also improved from 56% in 2020 to 73% in 2021.

Several respondents mentioned that more data collection is occurring in NILS. "I like the current structure of completing the 'Do' section of PDSA's," one noted. Another respondent asked, "What is happening with the information stored in NILS? How is that driving the next steps for the network?" Other respondents suggested the findings can help to "really help provide insight."

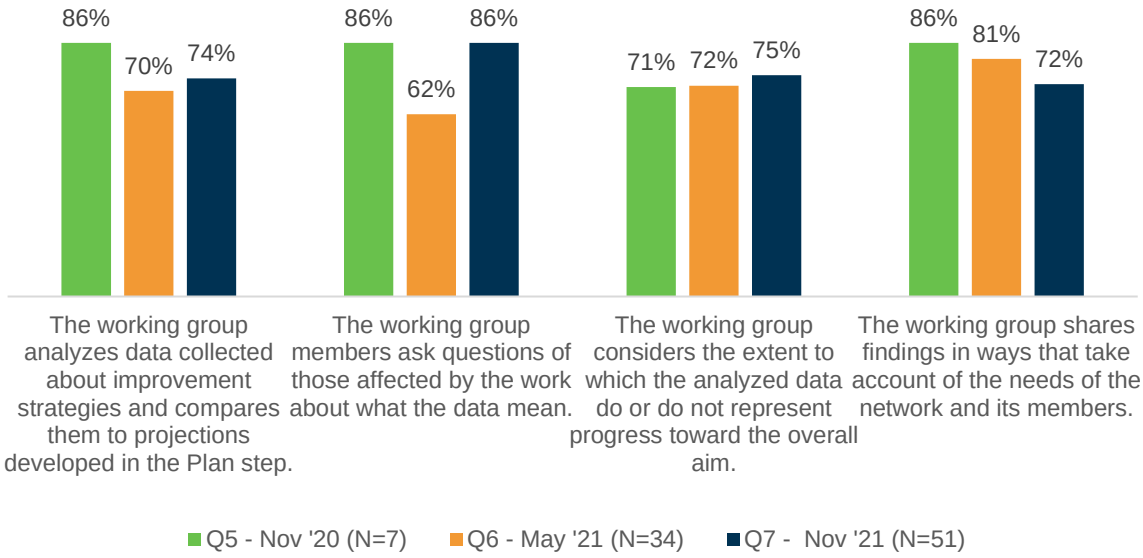
Figure 7. Percentage of Respondents Rating Indicators of the Do Phase of PDSA Cycles as a Working Group Strength, 2019–2021



2.5.4.3 The *Study* Phase

Given the limited data related to the Study phase activities in 2020, this section does not include November 2019, but rather the May 2021 survey cycle for additional longitudinal comparison. Figure 8 shows working group activity conducted as part of the Study phase activities from November 2020 to November 2021. One area worth noting, the percent of respondents reporting that *The working group asks questions of those affected by the work about what the data mean* increased from 62% to 86% between May 2021 and November 2021, the activity with the largest gain in the Study phase. Over three out of four members from 2020 to 2021 consistently agreed to participating in Study phase activities, and one respondent shared that "starting a PDSA cycle increased manpower." When comparing across survey cycles, one activity showed a steady decline from 2020 to 2021: *The working group shares findings in ways that take account of the needs of the network and its members*.

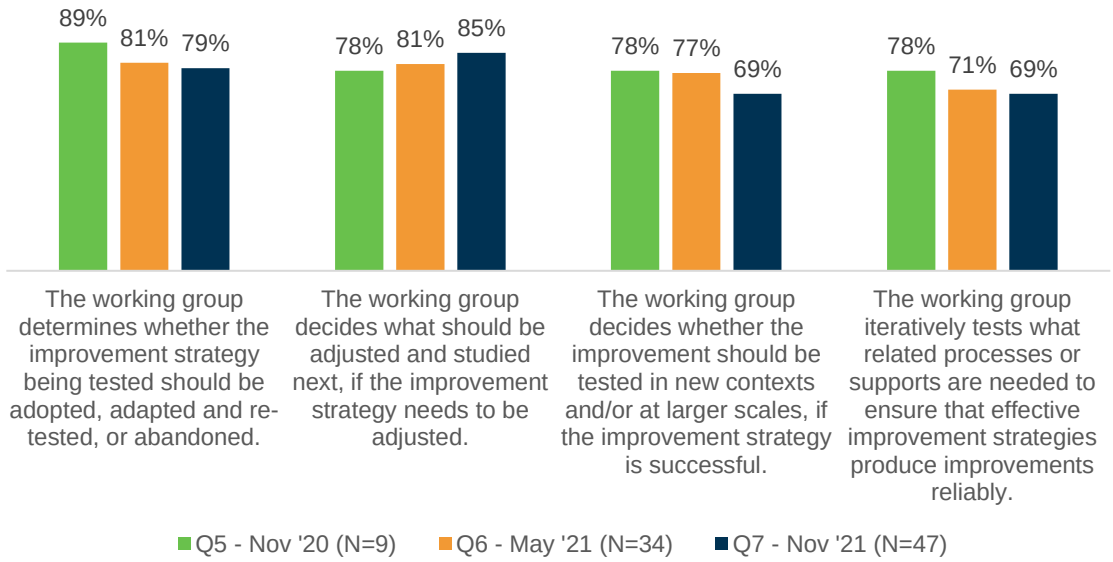
Figure 8. Percentage of Respondents Rating Indicators of the Study Phase of PDSA Cycles as a Working Group Strength, 2020–2021



2.5.4.4 The *Act* Phase

While mean ratings have slightly declined in three of the four activities, the majority of respondents (between 69% and 86%) indicated that the activities associated with the Act phase were strengths (see Figure 9). The one increase in the percentage of respondents rating an activity as a strength was for *The working group decides what should be adjusted and studied next, if the improvement strategy needs to be adjusted,* showing a steady incline from November 2020. Asked to provide additional information about this phase, one working group member reported that they think "this is something that will be improved as the group gains more experience in attempting change ideas."

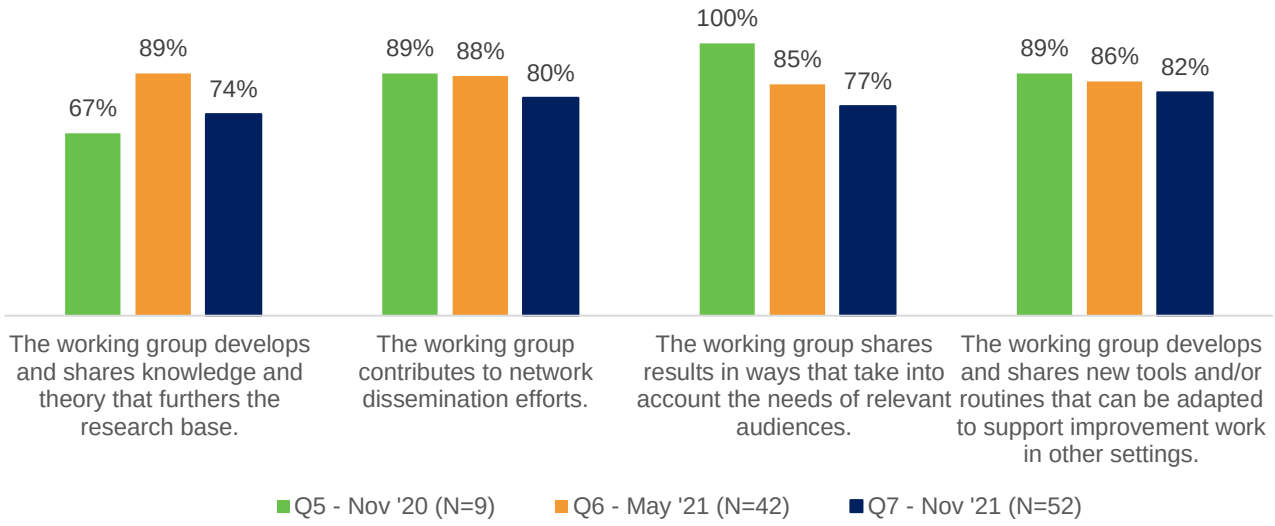
Figure 9. Percentage of Respondents Rating Indicators of the Act Phase of PDSA Cycles as a Working Group Strength, 2020–2021



2.5.5 Disseminate

As shown in Figure 10, the most highly-rated indicators of this dimension, at 82% in 2021, were for *The working group develops and shares new tools and/or routines that can be adapted to support the improvement work in other settings*. The percent of respondents rating the remaining three items, including *The working group shares results in ways that take into account the needs of relevant audiences,* as a strength decreased marginally between 2020 and 2021, from 100% in Q5 to 85% in Q6 to 77% by Q7. Overall, most respondents indicated that dissemination had improved, and with an almost 50% survey response rate, the most recent data are likely to be the most representative to date.

Figure 10. Percentage of Respondents Rating Indicators of the Disseminate Dimension as a Working Group Strength, 2019–2021



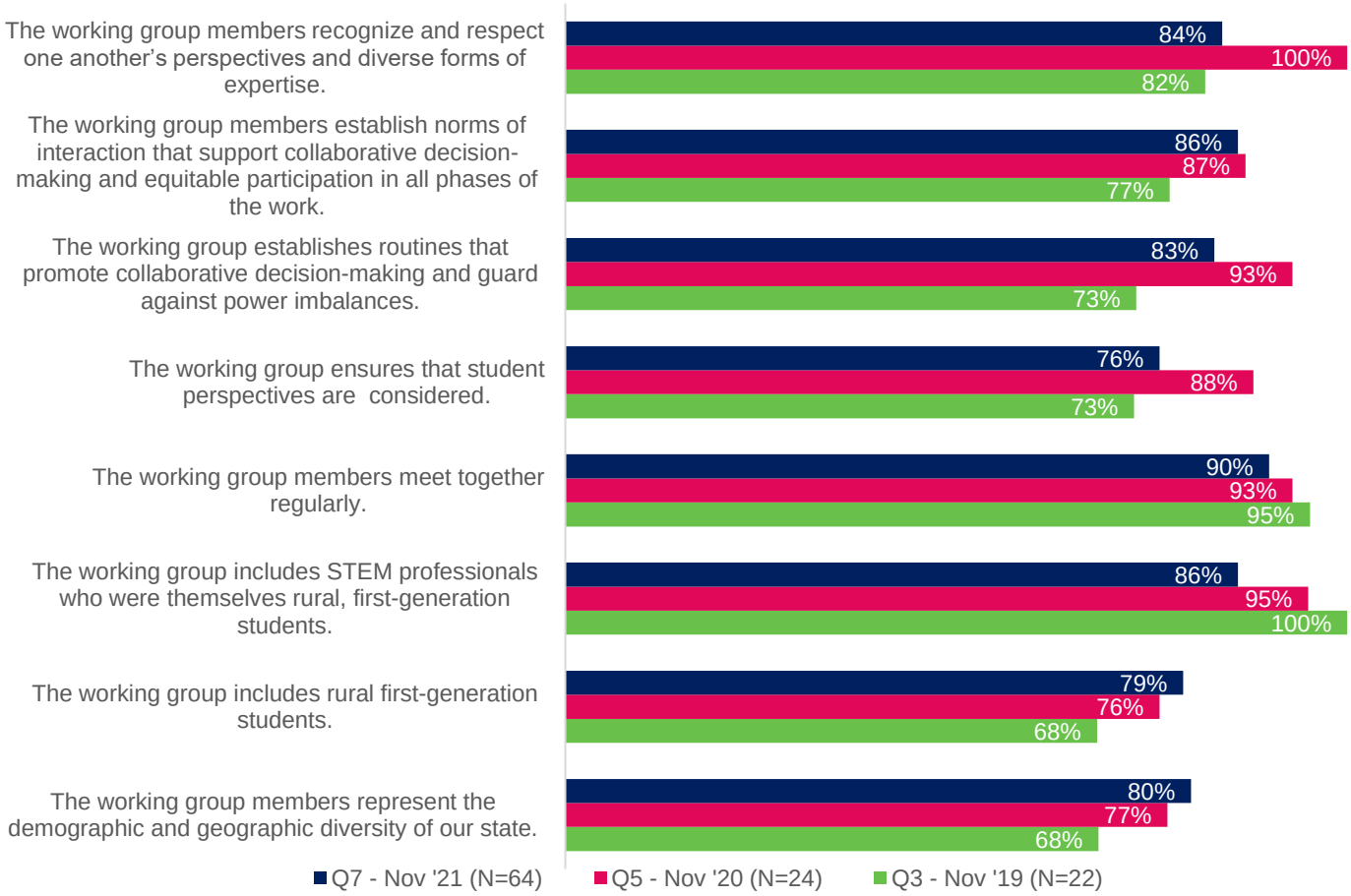
2.5.6 Collaborate

As shown in Figure 11, large percentages of Working Group Self-Assessment respondents have rated activities associated with collaboration highly across all years of First2 Network operation.

In 2021, the Collaborate activity perceived as working groups' greatest strength was *The working group members meet together regularly*, with 90% of respondents in agreement. Notably, there was growth between 2019 and 2021 in *The working group includes rural, first-generation students* with percentages agreeing that this was a steady incline in strength, rising from 68% to 76% to 79%. Ratings of *The working group members represent the demographic and geographic diversity of our state* also improved over time, growing from 68% in 2019 to 80% in 2021, an increase of 12 percentage points.

Overall, in six of the eight Collaborate indicators, mean ratings decreased between 2020 and 2021. Although, with a majority of respondents (over 80%) still rating the items as a strength, concerns over these declines between 2020 and 2021 seem unwarranted.

Figure 11. Percentage of Respondents Rating Indicators of the Collaborate Dimension as a Working Group Strength, 2019–2021



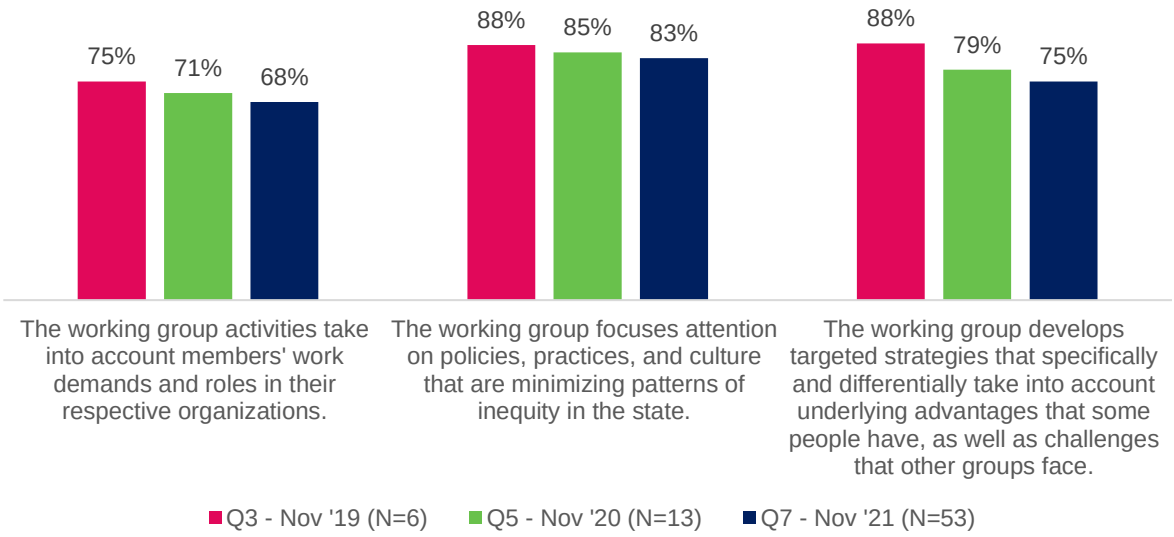
2.5.7 Reflect on Equity

Figure 12 shows respondent ratings for the three items associated with the Reflect on Equity dimension. Most (84%) respondents in November 2021 reported that *Working group activities take into account members' work demands and roles in their respective organizations*. The pattern for all three items showed a slight decline across the 3 years. The percentage of respondents rating *The working group develops targeted strategies that specifically and differentially take into account underlying advantages that some people have, as well as challenges that other groups face* as a working group strength fell below 80% in 2021. In addition, the percentage of respondents reporting that *The working group focuses attention on policies, practices, and culture that are reinforcing patterns of inequity in the state* fell just below 70% in 2021. Shifts from 2020 to 2021 may be associated with increased clarification by leadership on the First2 Network focus of social equity issues and overall responsiveness during the global pandemic.

One working group member reported that the improved working group focus on equity was supported by "drop-in working sessions, which [are] a great way to accommodate different work schedules and collaborate. [A] virtual work environment also supports this dimension of working group efforts." Another respondent commented, "The Steering Committee voting

structure provides equal voice to various members of the network. This is a strength that should be maintained as the network thinks about sustainability."

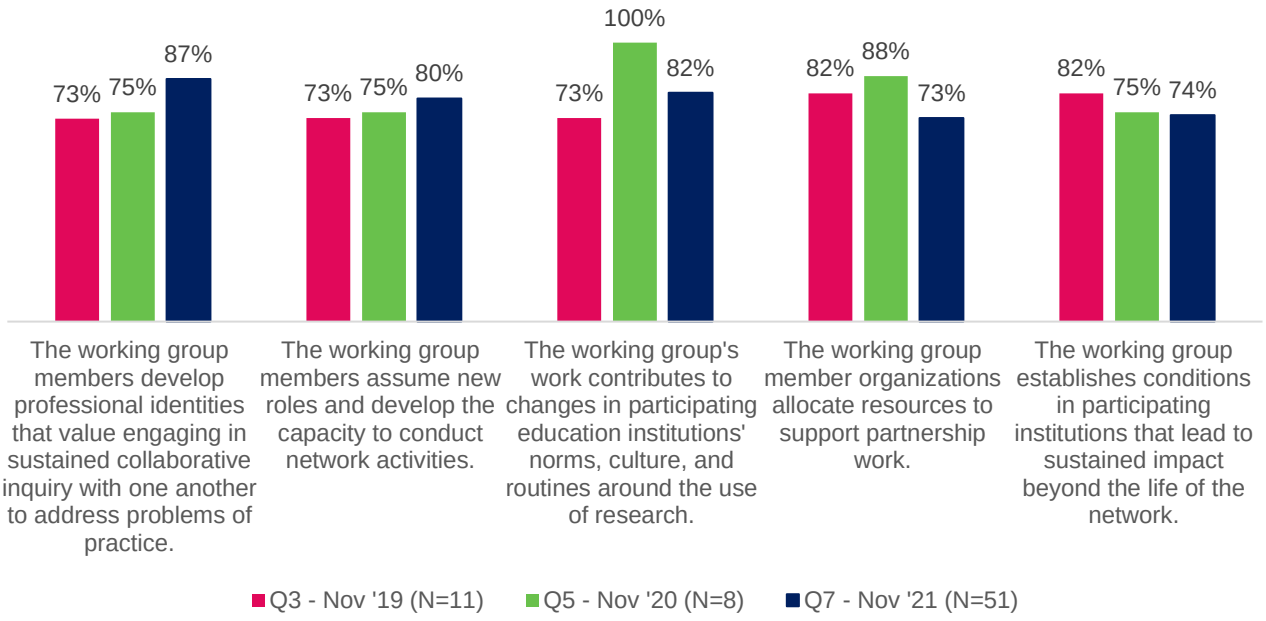
Figure 12. Percentage of Respondents Rating Indicators of the Reflect on Equity Dimension as a Working Group Strength, 2019–2021



2.5.8 Building Capacity

As shown in Figure 13, most respondents rated three of the five statements associated with the Building Capacity dimension as strengths in November 2021, compared to previous cycles. Specifically, 80% of respondents reported *The working group members assume new roles and develop the capacity to conduct network activities* as a strength, an increase from 73% in 2020. Likewise, the percentage of respondents who reported that *The working group members develop professional identities that value engaging in sustained collaborative inquiry with one another to address problems of practice* was a strength also improved over time, from 73% to 87% across the 3 years of First2 Network operation.

Figure 13. Percentage of Respondents Rating Indicators of the Building Capacity Dimension as a Working Group Strength, 2019–2021



2.5.9 Additional Questions

Respondents rated their level of agreement with five statements about their working group experiences. As shown in Figure 14, the highest mean ratings were 3.9 for *The support I have received in this working group is of high quality, relevant, and useful* and *I meaningfully participated in this working group with other colleagues*. The lowest mean rating was 3.6 for I *provided useful resources for other members of this working group*.

Figure 14. Mean Rating of Respondents by Additional Supports for 2020–2021

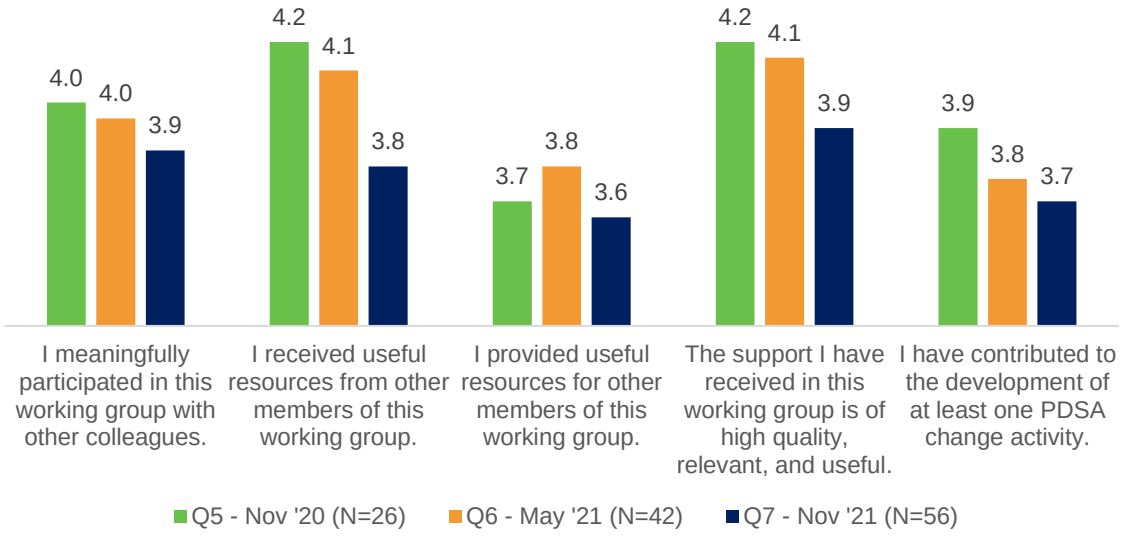
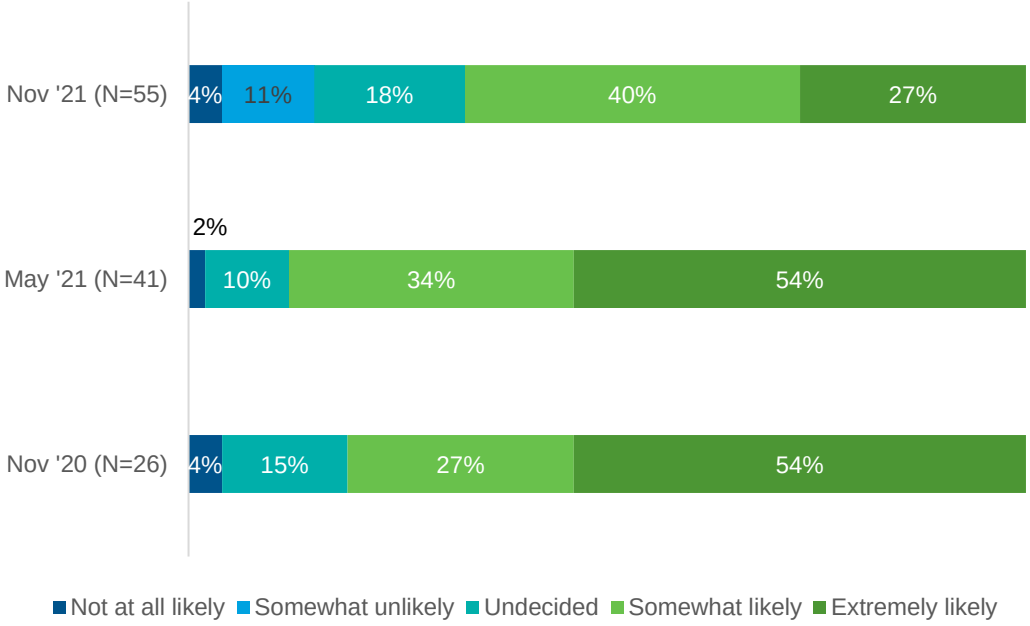


Figure 15 shows respondent ratings for the final item asking respondents how likely they are to invite a colleague to the working group meetings of which they are a member. Most (67%) respondents in November 2021 determined they are somewhat or extremely likely to recommend the experience to a colleague. However, this is a stark decline from 88% in May 2021 and 81% in November 2020.

Figure 15. Mean Rating of Respondents by Additional Supports for 2020-2021



Nearly half of respondents elaborated upon their rating and most shared positive sentiments about their experience overall. Several respondents shared how much they enjoy their network working group and the relationships developed through this effort. A few illustrative comments are below.

> *I love my work in the network and will highly recommend it to a friend.*
>
> *I will invite any student to help collaborate and become involved in ANY working group.*
>
> *I enjoy working in this working group.*

Even so, several respondents had apprehensions about inviting colleagues to a working group meeting or to be members of the network. One said, "I feel like things feel thrown together and kind of stressful to understand what's going on and to know what to do." Another said, "I don't have many colleagues outside of First2 that I would want to invite to the meetings." One student member shared that they were concerned about inviting someone because it can be time-consuming. "As a student, it's difficult to allocate proper time to each portion of my roles. I would share F2N but also let them know about the time commitment–that it's really up to them."

A few other comments embodied not knowing what the future holds for First2 Network, but seeing the value in having a strong group of people to support it. "We'll have to see where the network goes in the near future," one member shared. "I can see the value of different perspectives, especially from teachers, counselors and current first-gen students" another member shared.

2.5.10 Working Group Self-Assessment Summary

Findings from the November 2021 administration of the Working Group Self-Assessment indicate growth in some areas and slight declines in others. Specifically, the Do cycle of PDSAs showed some strength. Additionally, the number of respondents grew from 8 respondents during the first administration of the instrument to 67 respondents in the most recent November cycle, making a more representative sample.

Respondents are still concerned with scheduling challenges, with one respondent sharing that during their group there was "not enough time to complete activities." Mostly, participant respondents were encouraged by the amount of effort and results they have been able to see to date. "While I don't have much experience with PDSA, I have seen what the network can do," one respondent said.

The First2 Network working groups made some progress during 2021 toward establishing a system for improvement science activity. In 2022, efforts should continue to reflect strength in dissemination and building capacity as groups seem more likely to be focused on Do and Study phase activities while they move through the iterative PDSA cycle, which is likely the cause of lower Plan strength ratings. Specifically, only 28% of member respondents indicated they participated in a change activity and, of those, 31% had entered it in NILS. Even so, working group members continue to want to learn and groups are making strides to remain flexible with attendance and improve collaboration on PDSA activities. In fact, three out of four respondents requested additional resources to better support their engagement in the PDSA efforts of their working group (75% of 32). Finally, students once again comprised the largest group of respondents, representing more than 50%, an important indicator of student engagement with improvement science in the network. Respondents attributed their capacity to conduct PDSAs to support received from the Measurement Team and great group leadership.

2.6 Steering Committee Survey

The evaluation team administered a comprehensive Steering Committee Survey in March 2019, March 2020, June 2020, April 2021, and March 2022. The March 2022 administration asked members to rate the status of the Steering Committee through 24 statements about its functions, processes, and results. The survey also includes five open-ended items to solicit feedback from respondents about what works well on the Steering Committee, what issues the Steering Committee is facing, how Steering Committee processes and structures could be improved, how the COVID-19 pandemic is affecting the work of the Steering Committee, and what suggestions or recommendations respondents might provide to help Steering Committee members better respond to member needs during the pandemic. Respondents were asked to use a scale of 1 = *Not Started,* 2 = *Beginning/Early Stage,* 3 = *Making Progress,* and 4 = *Fully Achieved* to indicate progress associated with each statement.

As shown below in Tables 4 and 5, in the March 2022 mean column, **green** font indicates an increase in average ratings of progress since April 2021, **red** font indicates a decrease, and **black** indicates no change. Asked about the Steering Committee overall, respondents reported more decreases than increases since 2021, with one exception. Mean ratings of *The right people serve on the Steering Committee* increased from 3.50 (SD .53) to 3.70 (SD .48). Although the remaining items concerning overall Steering Committee progress declined, only three achieved statistical significance. The *Steering Committee meets sufficiently regularly* decreased from 4.00 (SD .00) to 3.90 (SD .32), *The Steering Committee has developed a clear vision for the First2 Network* decreased from 3.50 (SD .53) to 3.00 (SD .00), and *Steering Committee*

members have a clear understanding of the network's next steps declined from 3.30 (SD .67) to 2.90 (SD .32).

Mean ratings of items concerning Steering Committee members' roles on the committee tended to be lower in March 2022 than in April 2021. Those that increased included *I lead a working group* (increasing from 3.8 to 4.0, with respective SDs of .41 and .00), *I keep abreast of working group activities* (from 3.40 to 3.60, with SDs of .70 for both means), and *I champion the First2 Network by communicating with others in the state and elsewhere about its work* (from 3.60 to 3.67, with respective SDs of .70 and .50). Although mean ratings of most items in this section of the survey were lower by March 2022, only one item was statistically significantly lower: *I help the Steering Committee determine how to track the network's progress* decreased from 3.20 to 3.00 (SDs of .79 and .00).

2.6.1 Steering Committee Survey Summary

In general, respondents rated various aspects of the Steering Committee's progress lower in 2022 than they had in 2021, although few declines were statistically significantly lower. On the other hand, respondents were more likely to agree that the right people serve on the committee and that they communicated with others in the state about the First2 Network's work in 2022 than 2021.

Table 4. Steering Committee Survey Section 1 Mean Ratings

	March 2019			March 2020			June 2020			April 2021			March 2022		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
The right people serve on the Steering Committee.	11	**3.37**	0.65	13	**3.31**	0.48	11	**3.36**	0.51	10	**3.50**	0.53	10	**3.70**	0.48
The Steering Committee meets sufficiently regularly.	11	**3.91**	0.30	13	**3.77**	0.44	11	**3.91**	0.30	10	**4.00**	0.00	10	**3.90***	0.32
The Steering Committee has developed a clear vision for the First2 Network.	11	**2.82**	0.42	12	**3.17**	0.58	11	**3.18**	0.60	10	**3.50**	0.53	10	**3.00***	0.00
The Steering Committee provides oversight and governance of the First2 Network.	11	**2.73**	0.65	13	**3.46**	0.78	11	**3.45**	0.52	10	**3.50**	0.53	10	**3.10**	0.57
The Steering Committee has agreed upon a decision-making process.	11	**2.91**	0.70	13	**3.38**	0.87	11	**3.45**	0.82	10	**3.70**	0.48	10	**3.20**	0.79
Steering Committee members trust each other.	11	**3.27**	0.65	13	**3.46**	0.66	11	**3.64**	0.51	10	**3.70**	0.48	10	**3.30**	0.68
Communication within the Steering Committee is constructive.	11	**2.91**	0.70	12	**3.42**	0.67	11	**3.82**	0.41	10	**3.60**	0.52	10	**3.20**	0.79
Steering Committee communications are timely.	11	**3.09**	0.83	13	**3.23**	0.60	11	**3.27**	0.65	10	**3.50**	0.53	10	**3.10**	0.74
Steering Committee members have a clear understanding of the network's next steps.	11	**2.64**	0.51	13	**2.77**	0.60	11	**3.18**	0.75	10	**3.30**	0.67	10	**2.90***	0.32
The Steering Committee is successfully adapting programmatic efforts to meet COVID-19 challenges.	na	**na**	na	na	**na**	na	na	**na**	na	10	**3.70**	0.48	10	**3.30**	0.68

Table 5. Steering Committee Survey Section 2 Mean Ratings

	March 2019			March 2020			June 2020			April 2021			March 2022		
In my role as a Steering Committee member …	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
I understand the responsibilities associated my Steering Committee membership.	11	**3.00**	0.45	13	**3.38**	0.65	9	**3.56**	0.54	10	**3.70**	0.48	9	**3.56**	.73
I lead a working group.	11	**3.36**	1.36	9	**3.78**	0.44	6	**4.00**	0.00	6	**3.80**	0.41	4	**4.00**	.00
I keep abreast of working group activities.	11	**2.82**	0.60	13	**3.92**	0.28	9	**3.56**	0.53	10	**3.40**	0.70	10	**3.60**	.70
I keep up to date on what working groups are learning.	11	**2.73**	0.47	13	**3.23**	0.44	9	**3.22**	0.67	10	**3.10**	0.74	10	**3.10**	.57
I help the network determine how to coordinate the work of Improvement Teams.	11	**2.18**	0.87	11	**2.82**	0.60	9	**3.00**	0.71	9	**3.22**	0.97	9	**3.22**	.67
I help the network determine how to coordinate the new knowledge that working groups generate.	11	**2.27**	0.91	13	**3.00**	0.58	10	**3.00**	0.67	9	**3.00**	1.00	10	**2.80**	.42
I help make decisions about the direction of the network.	11	**3.09**	0.70	13	**3.54**	0.52	8	**3.38**	0.52	8	**3.50**	0.53	9	**3.00**	.71
I help make decisions about the processes the network uses to conduct its work.	11	**3.09**	0.70	13	**3.31**	0.63	8	**3.50**	0.54	9	**3.33**	0.71	9	**2.89**	.93
I help to keep network members accountable to one another.	11	**2.91**	0.54	12	**3.00**	0.60	9	**3.22**	0.67	10	**3.00**	0.67	9	**2.89**	.60

	March 2019			March 2020			June 2020			April 2021			March 2022	
In my role as a Steering Committee member …	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
I help the Steering Committee determine how to track the network's progress.	11	**2.73**	0.65	13	**2.85**	0.69	10	**3.40**	0.70	10	**3.20**	0.79	9	**3.00***	.00
I contribute to decisions about how to onboard new First2 Network members.	11	**2.64**	0.92	13	**3.00**	0.58	11	**3.36**	0.81	9	**3.33**	0.71	7	**2.86**	.69
I help to onboard new First2 Network members.	11	**2.64**	1.03	12	**3.17**	0.58	10	**3.20**	0.92	9	**3.33**	0.87	8	**2.88**	.84
I champion the First2 Network by communicating with others in the state and elsewhere about its work.	11	**3.36**	0.51	13	**3.85**	0.38	8	**3.75**	0.46	10	**3.60**	0.70	9	**3.67**	.50
I help to support First2 Network programming adjustments to address COVID-19 challenges.	na	**na**	na	na	**na**	na	na	**na**	na	10	**3.50**	0.71	8	**3.38**	.52

2.7 Conference Evaluation Questionnaires

2.7.1 October 2021 Virtual Conference: Improving STEM Persistence in West Virginia: Reshaping the Narrative

The First2 Network held a virtual conference October 19–20, 2021. A total of 46 respondents completed the online survey. About three-fourths (76%) were already members of the First2 Network; 35% reported they served in a leadership position with the network, 22% reported they were a member of at least one working group, and 17% reported they were a member of the network but not involved in any working group. Twenty percent indicated they were new to the network, and 6% indicated they were aware of but not involved with the network. Nearly a third (30%) described their role as educator, followed by 28% each for student and staff/administrator; the remaining 13% selected industry/nonprofit/government/other.

Participants were asked to rate three items about the First2 Network and 12 items about the conference. Responses related to the network were very positive, with mean scores ranging from 3.96 to 4.30 on a 5-point scale of Strongly Disagree (1) to Strongly Agree (5): They are enthusiastic about participating in the First2 Network (4.30), they are committed to doing the work associated with the network (4.24), and they understand their role in the network (3.96). Of the 12 conference items, 11 had mean scores at or above 4.00. The highest-rated item at 4.62 was that the conference provided opportunities for students to share their perspectives in a meaningful way. The lowest-rated item at 3.84 was that sufficient time was provided for general networking with other First2 Network members. Figure 16 below shows the item response percentages (organized as on the feedback form) and Figure 17 shows the item mean scores (organized by mean value). The three network items are depicted with green bars on the second figure to differentiate them from the conference items.

In the final section of the feedback form, respondents were asked to provide comments for five open-ended prompts. When asked to identify the high point of the conference, 34 individuals responded, with about 40% referring to the inclusion of student voices in the sessions, including as "equal partners." A couple of illustrative quotes include:

> *I really like the student voices—this really brings value and meaning to what we are doing. I love how it started with the recognition that it is not about "for" or "to" but "WITH." The Social Hierarchies presentation was extremely powerful. I really enjoyed hearing the different approaches to teach math, that will benefit a much wider range of students.*
>
> *I think the high point was seeing First2 students as equal partners in giving the presentations. The network has come a long way and is finally at the point where people who are involved can share their learning for others to use (i.e., the presentations on the clubs and immersion experiences).*

When asked to identify what did not work as well, 31 individuals responded. Nearly half (45%) focused on some aspect of timing, either conflicts with individual schedules or with session scheduling (no transition time between sessions, too few breaks, not enough time for discussion).

When asked what additional information was needed related to work within the network, 21 individuals responded, with more than half (57%) noting no additional information was needed. Similarly, 21 individuals provided responses when asked what support was needed from the network for them to become more involved, with nearly half (48%) noting no additional support was needed.

The last prompt provided an opportunity for final comments about the conference. Twenty-five individuals responded, with about half (48%) providing positive comments. One person said:

> *I was very impressed by the supportive nature of the group. I saw a lot of selfless and dedicated people really working to help each other. It was a great experience.*

Figure 16. October 2021 Conference Evaluation Survey Item Response Percentages

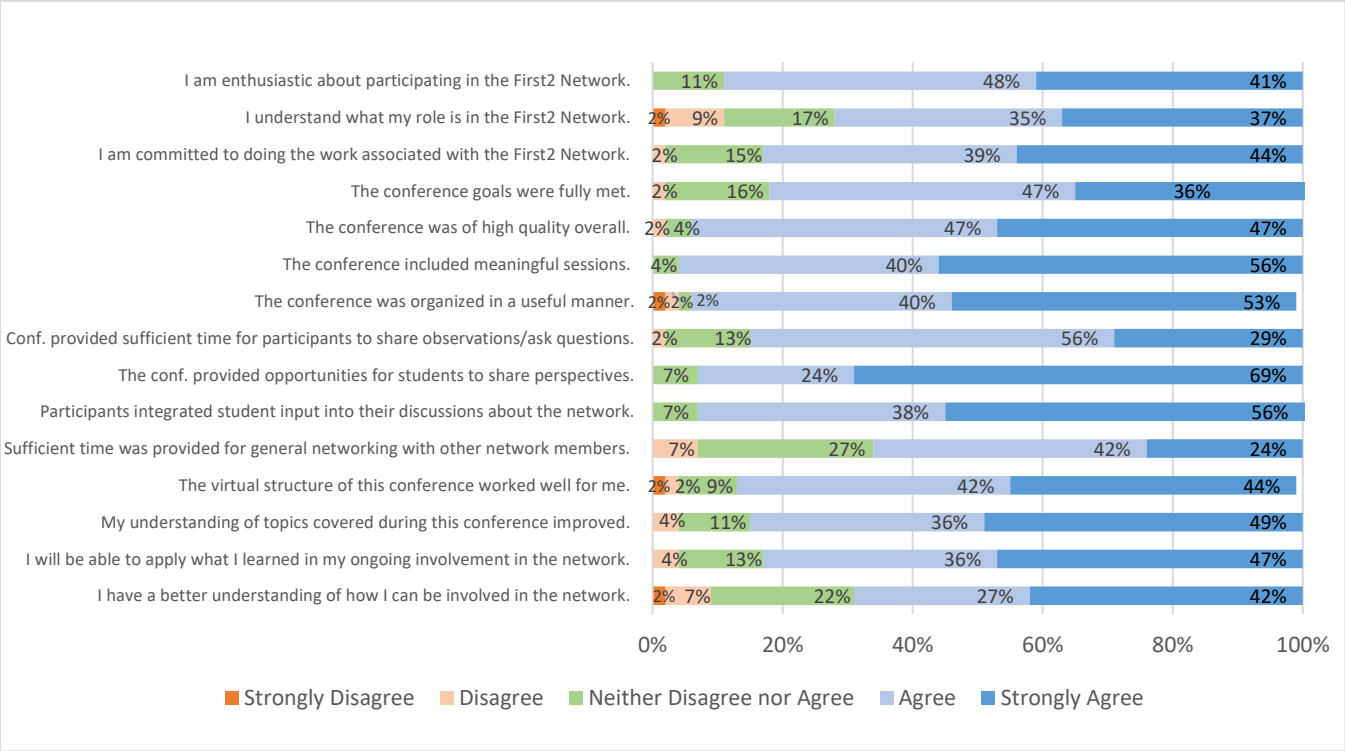


Figure 17. October 2021 Conference Evaluation Survey Item Means

2.7.2 January 2022 Virtual "Plan Do, Study, Act (PDSA)" Workshop: Deep Dive into the Study Phase

The First2 Network held a virtual PDSA workshop on January 6, 2022. A total of 41 respondents completed the online survey as of January 14, 2022. Nearly all respondents (98%) were already members of the First2 Network. The majority have been a member for more than 2 years (42%); 20% have been network members for 2 years, 10% for 1 year, and 27% for less than a year. Almost half (44%) were students, 29% were educators, 17% were from industry/nonprofit/ government/other, and 10% were staff/administrators.

Participants were asked to rate 14 items about the PDSA workshop on a 5-point scale of Strongly Disagree (1) to Strongly Agree (5). Responses were positive, with mean scores ranging from 3.51 to 4.32; nine items had mean scores at or above 4.00. Highest-rated was their improved understanding of topics covered at 4.32; lowest-rated was what they want to accomplish in a PDSA cycle and how to accomplish it at 3.51. Figure 18 below shows the item response percentages (organized as on the feedback form) and Figure 19 shows the item mean scores (organized by mean value).

Respondents were also provided an opportunity to make comments about the workshop. Nineteen individuals responded, with about half providing positive comments, followed by suggestions for improvement. A few illustrative comments follow:

> *Due to other commitments, I was only able to attend some portions of the workshop, but it was high quality and helpful for generating new ideas for study in the classroom and for retention of STEM majors. Thank you for all your hard work.*
>
> *I thought Jared's session was SO valuable and needs to be revisited with MORE time and more mixing up. This is the "doing work together" that will really help us all grow our understanding. I also find the study session of PDSA to be maybe the most meaningful way that students and non-students can collaborate.*
>
> *Awesome workshop! Kudos to the facilitators and tech team working behind the scenes!*
>
> *The breakout rooms are never long enough. Take the initial amount of time considered for a breakout room, and add 5 minutes.*
>
> *It would have been useful for a good description of what PDSA is for new students. I think a lot of information was assumed to be known.*

Figure 18. January 2022 Workshop Evaluation Survey Item Response Percentages

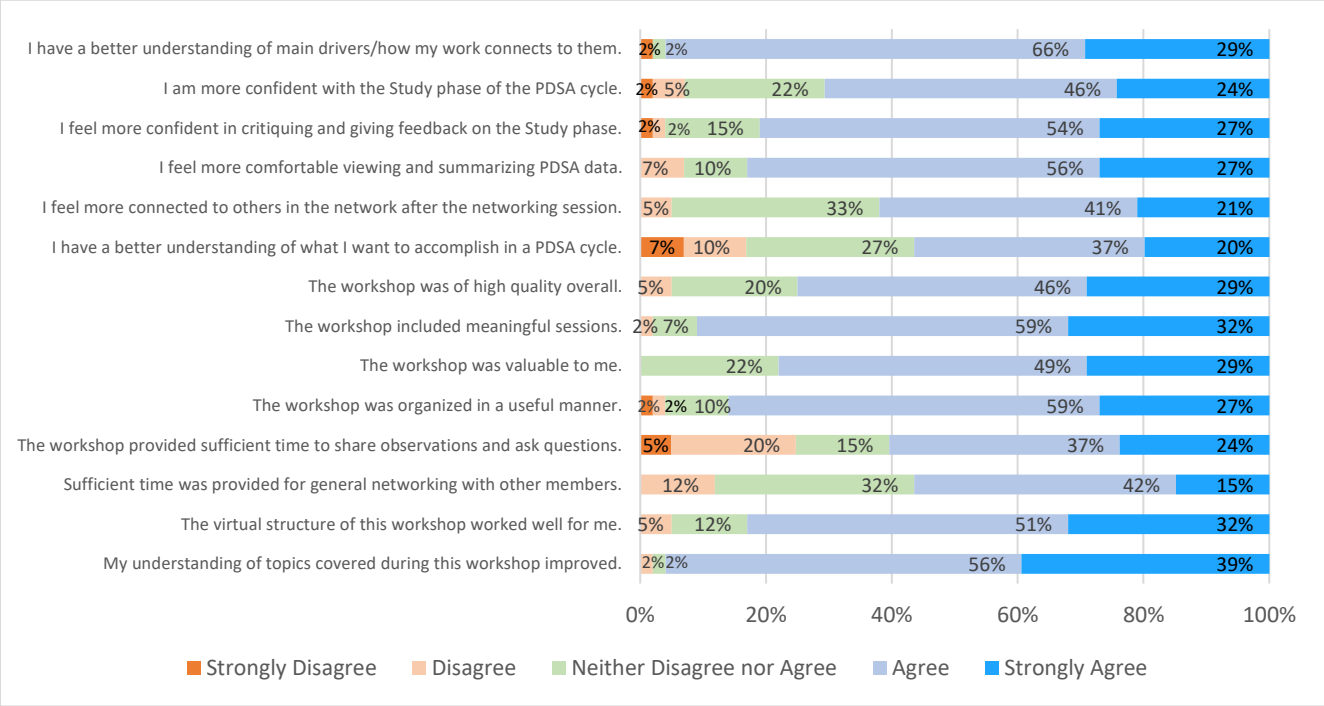
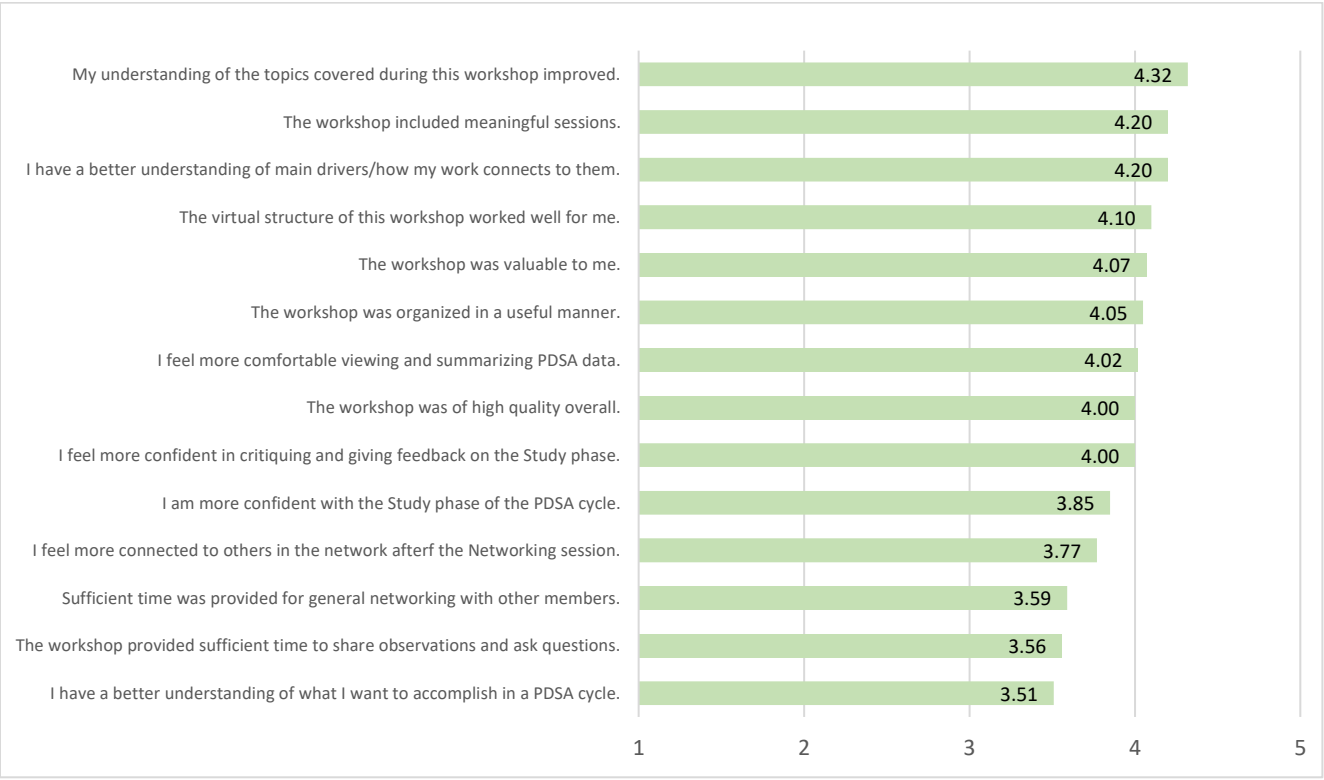


Figure 19. January 2022 Workshop Evaluation Survey Item Means



2.7.3 May 2022 Virtual Conference: Recognizing, Measuring, and Sustaining Success

The First2 Network held another virtual conference on May 16, 2022. A total of 28 respondents completed the online survey but two surveys were excluded since no items were rated and no open-ended comments were provided. Forty-two percent were members of at least one working group within the First2 Network and 27% serve in a leadership position in the network. An additional 19% indicated they were members but not involved in any working groups, and 12% indicated they were aware of but not involved with the First2 Network. Students were the largest role group present at the virtual conference (39%), followed by staff/administrators (31%), educators (15%), and industry/nonprofit/government/other (15%).

Participants were asked to rate three items about the First2 Network and then an additional 12 items about the virtual conference. Responses related to the network items were very positive, with mean scores ranging from 4.00 to 4.32 on a 5-point scale of Strongly Disagree (1) to Strongly Agree (5): they are enthusiastic about participating in the First2 Network (4.32), they are committed to doing the work associated with the network (4.21), and they understand their role in the network (4.00). Of the 12 conference items, 11 had mean scores above 4.25. The highest-rated items were that the conference was organized in a useful manner (4.64) and that participants had the opportunity to meaningfully engage with other members of the First2 Network from different campuses (4.60). The lowest-rated item was that the conference goals were fully met (4.12). Figure 20 below shows the item response percentages (organized as on the feedback form) and Figure 21 shows the item mean scores (organized by mean value). The three network items are depicted with green bars on the second figure to differentiate them from the 12 conference items.

In the final section of the feedback form, respondents were asked to provide comments for 5 open-ended prompts. When asked to identify the high point of the conference, 19 individuals responded, with about 25% each referring to the breakout rooms or having discussions across institutions. A few illustrative quotes include:

> *I actually loved the mixed breakout rooms (I never say that) but they were really well balanced, and I really thought they were really friendly and valuable.*
>
> *The breakout groups for the consulting session. I loved getting to hear from students and instructors/professors from other institutions that face similar issues and what their methods are for tackling them. Even though I am a new member, I felt that I understood a majority of the subjects presented and discussed. I felt that all issues addressed were those that I could personally take home with me.*

When asked to identify what did not work as well, 15 individuals responded. About 25% indicated that everything had worked well; several others suggested that more breaks would have helped given the "dense" nature of the sessions.

When asked what additional information was needed related to their work within the Network, 15 individuals responded, with about half noting no additional information was needed. Similarly, 14 individuals provided responses when asked what support was needed from the network for them to become more involved. Half noted no additional support was needed or they were unsure.

The last prompt provided an opportunity for final comments about the conference. Fourteen individuals responded, with nearly 80% providing positive comments. Illustrative quotes include:

> *Overall, this has been the most organized and most true-to-schedule First2 conference I've ever attended.*
>
> *Lots of work went into it; well worth the effort!*

Figure 20. May 2022 Virtual Conference Evaluation Survey Item Response Percentages

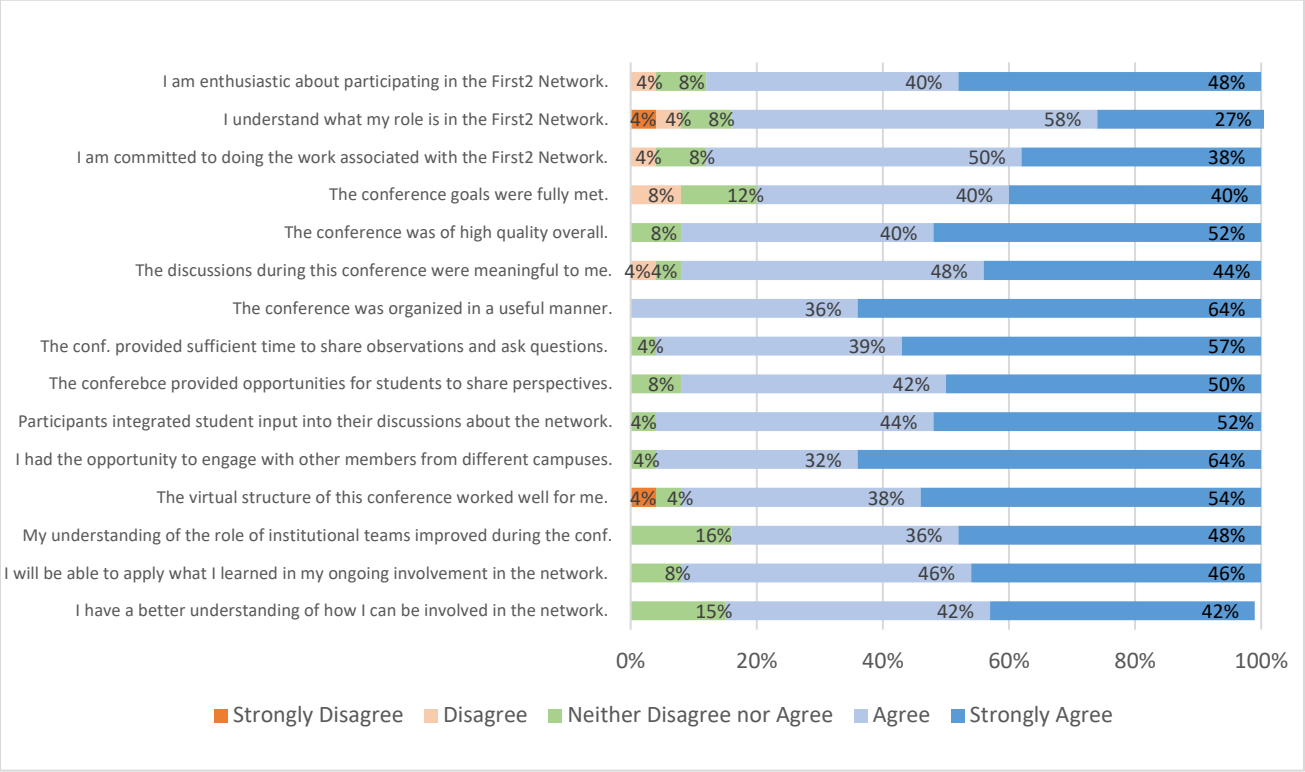


Figure 21. May 2022 Virtual Conference Evaluation Survey Item Means

2.7.4 May 2022 In-Person Conference: Recognizing, Measuring, and Sustaining Success

The First2 Network held an in-person conference May 23–24, 2022. A total of 28 respondents completed the online survey. Results are summarized below.

Nearly all respondents (89%) were already members of the First2 Network. Fifty percent reported they were a member of at least one working group and 39% reported serving in a leadership position in the network; 11% indicated they were new to the network. Nearly half (43%) described their role as student, followed by educator (29%), industry/nonprofit/government/other (21%), and staff/administrator (7%).

Respondents were asked to indicate all the conference sessions they attended. Results are shown below in Table 6 and reflect high participation rates across all sessions except the final two (career workshop and closing).

Table 6. May 2022 In-Person Conference Participation Rates

Day	Session	Participation Rate
Monday	Opening Session	89%
	Lunch & Networking	86%
	Diversity, Equity, & Inclusion Presentation: Privilege for Sale	82%
	Breakout by Institutional Teams	86%
	Understanding the College Persistence of Rural and First-Generation College Students*	54%
	Rurality and Student Success*	54%
	Rural FGC [First-Generation College] STEM Persistence (Dissertation Overview)*	46%
	Promising Practices from the External Literature*	39%
	Systems Change and Growth of the Network*	50%
	PDSA Synthesis & Driver Diagram	82%
	Industry Expo	89%
Tuesday	Welcome	96%
	Keynote: First Gen in West Virginia	96%
	Sustaining Success: Sustainability Planning	89%
	Breakouts to Discuss Sustainability	89%
	Report Outs	86%
	Industry Panel	96%
	Lunch & Learn	93%
	Learning and Scaling Student Success at Your Institution	79%
	Next Steps for Institutional Teams	71%
	Career Workshop	54%
	Closing	54%

*Concurrent sessions

Participants were asked to rate three items about the First2 Network and then an additional 12 items about the conference. Responses related to the network were very positive, with mean scores ranging from 4.26 to 4.30 on a 5-point scale of Strongly Disagree (1) to Strongly Agree (5): they are enthusiastic about participating in the First2 Network (4.30), they are committed to doing the work associated with the network (4.26), and they understand their role in the network (4.26).

Of the 12 conference items, 11 had mean scores at or above 4.00. The highest-rated item at 4.56 was that the in-person structure of the conference worked well. The lowest-rated item at 4.00 was that sufficient time was provided for general networking with other First2 Network members.

See the figures below for more detail. Figure 22 shows the item response percentages (organized as on the feedback form) and Figure 23 shows the item mean scores (organized by mean value). The three network items are depicted with green bars on the second figure to differentiate them from the conference items.

Figure 22. May 2022 In-Person Conference Evaluation Survey Response Percentages

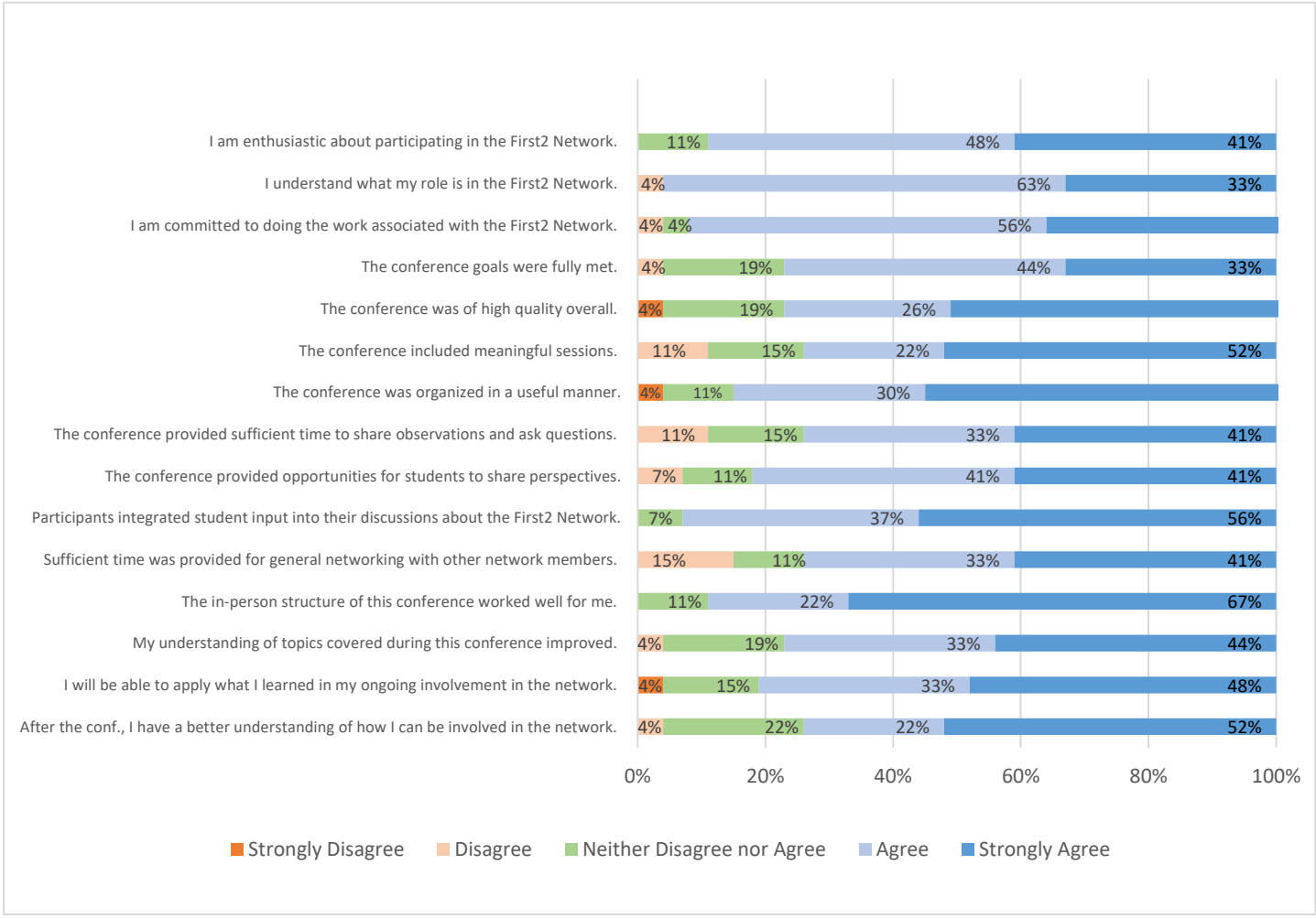
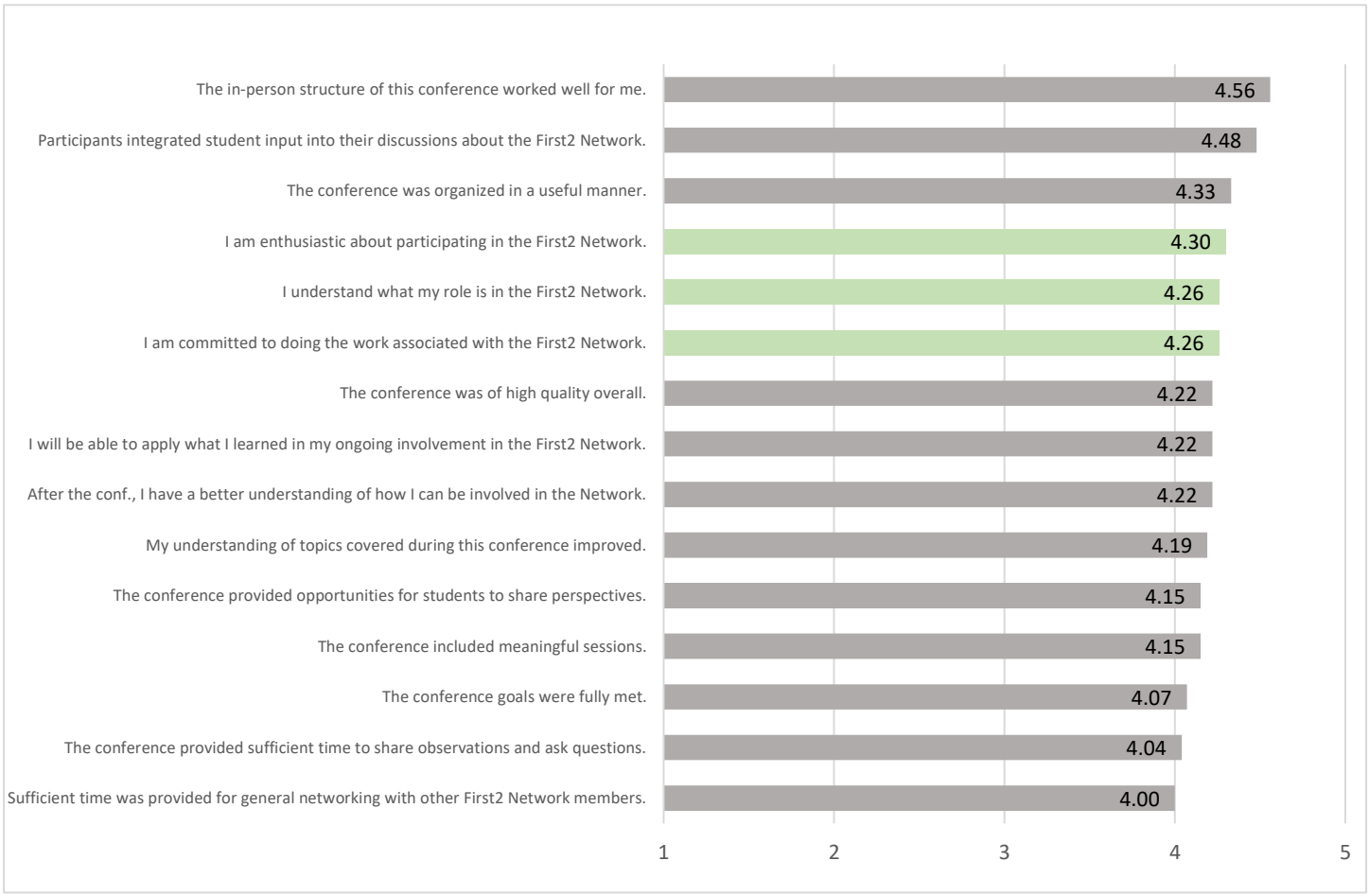


Figure 23. May 2022 In-Person Conference Evaluation Survey Item Means



In the final section of the feedback form, respondents were asked to provide comments for 5 open-ended prompts. When asked to identify the high point of the conference, 21 individuals responded, with three common themes: the institutional team sessions, the industry panel, and networking in general. A few illustrative quotes include:

> *The high point of this conference was the institutional teams breakout [for] identifying barriers to STEM persistence.*
>
> *Industry panel was really helpful and encouraging.*
>
> *Definitely the networking.*

When asked to identify what did not work as well, 15 individuals responded. The two most common themes were timing/organization or the need for other topical sessions running concurrently with the institutional team sessions for those participants who were not affiliated with the institutional teams. A few illustrative quotes include:

> *It would have been ideal if more concurrent sessions would have been planned for attendees that were not part of a specific institutional team. In addition, the pace was a bit frantic with little fun time for socializing/networking*
>
> *More "down time" to network casually with other members would be helpful.*
>
> *Maybe one or two more breaks each day simply because my brain stopped being productive at certain points.*

When asked what additional information was needed related to work within the First2 Network, 14 individuals responded, with more than half noting no additional information was needed. Similarly, 13 individuals provided responses when asked what support was needed from the network in order for them to become more involved, with nearly half noting no additional support was needed.

The final prompt provided respondents an opportunity to make any other comments about the conference. Fourteen individuals returned responses, most of which were positive. A few illustrative quotes include:

> *It felt wonderful to be in-person again! I applaud the folks who managed all the behind-the-scenes work for pulling off both this and a virtual session so close together.*
>
> *Great job integrating the virtual with the f2f. Thank you for organizing this conference—I felt re-energized and inspired. This conference was professional self-care. :-) Bravo!*
>
> *I really enjoyed this conference. I think it was the best it has ever been. I am looking forward to the next conference!!!*

In addition to the feedback survey used for each conference, conference participants were asked to provide their feedback to six prompts that were depicted on flipchart sheets in the meeting room. A brief synthesis is provided below.

Q1: Why did you first join the First2 Network, and why have you remained involved (what connects you)? Thirteen participants provided feedback; the most-frequently mentioned reasons were that participants were either first-generation students themselves or wanted to better serve such students. A few illustrative quotes include:

> *I first joined F2 because I heard it presents great opportunities for first-gen STEM students! I have continued with the network due to that.*
>
> *I first joined because I was a first-gen student. I remember all too well thinking to myself that I couldn't be a STEM major because "my parents didn't attend college" and "we weren't rich." I wanted to be able to address those concerns in students!*
>
> *Desire to find ways to help first-gen students persist. Remain because of the great work that is happening and continuous learning that is occurring.*

Q2: What is happening at your institution related to the First2 Network (things like data collection, data sharing, changes in policies or practices)? Nine participants provided feedback; several suggested more concrete examples of what was happening at their institutions:

> *We secured outside funding to offer a summer immersion experience.*
>
> *We completed a PDSA on the effects of volunteering on student mental health.*
>
> *F2 club, immersion (summer), data collecting/sharing, discussion of increasing math support at institutional level based on what we have learned with F2N.*

Q3: What is the most important accomplishment of the First2 Network so far? Ten participants provided feedback; networking and helping students were mentioned most frequently. A few illustrative quotes include:

> *Partnerships, awareness, students succeeding, and connecting.*
>
> *Bringing together all of the amazing stakeholders.*
>
> *The actual creation of a statewide learning network.*

Q4: What is the First2 Network's biggest challenge right now, and how can it be addressed? Eleven participants provided feedback; nearly all the comments focused on

the need for sustainability for funding beyond the current grant. A few illustrative quotes include:

> *Sustainability need for staff to keep the network functioning; funding; grant writing.*
>
> *The biggest challenge is to find a way to continue the work with students after the grant monies go away.*
>
> *Articulating path forward for funding.*

Q5: Describe your involvement in helping the First2 Network identify and test strategies for better serving rural, first-generation students. Six participants provided comments; a few illustrative quotes include:

> *Improvement science coach.*
>
> *With the direct help of the club members, we have developed [a] study hall to provide math support.*
>
> *I helped work on WVU's PDSA and serve as a student director.*

Q6: Any other feedback you want to share about the First2 Network? Five participants provided comments. A few illustrative quotes include:

> *Big change work take[s] time and we are making progress!*
>
> *What works for First2 students would work for other marginalized groups.*
>
> *Need to simplify decision-making.*

2.7.5 Conference Feedback Summary

In sum, participants provided positive feedback about the four events, with most of the rated items near 4.00 or higher on a five-point scale. At both the October (virtual) and May (in person) conferences, the lowest-rated item was that sufficient time was provided for general networking with other network members.

3. Systems Targeted by the First2 Network

3.1 Document Review

Latham's[57] framework for evaluating change in human service delivery systems is a useful schema for understanding the ways in which the First2 Network influences West Virginia systems to improve the persistence of rural, first-generation STEM students. This framework conceptualizes systems as *pathways* (progression through school levels and STEM programs, in this case) and *structures* (such as state education policies, resource flows, relationships and connections, and power dynamics).[58] Ultimately, systems change "is about changing the structures that shape our ability to improve pathways" (p. 13).[59]

Positive systems change, in the case of the First2 Network, involves improvements to structures—such as establishing incentives for using STEM instructional practices that increase persistence—and to pathways—such as increasing coordination between state K–12 and higher education subsystems to ensure that rural, first-generation students have adequate math preparation to succeed in STEM majors.

In this framework for assessing systems change, Latham suggests the following types of pathway improvement:

- **Increased pathway capacity**

- Improved quality: The quality of programs, or the number of high-quality programs, increases through adherence to quality standards or the use of continuous improvement methods.
- Improved scale: Better outreach and recruitment, accessibility, and supply of services increases capacity.
- Improved comprehensiveness: Capacity improves by addressing service gaps and ensuring that the right programs are available to diverse target groups.

- **Increased pathway connections**
  - Improved linkage: Transitions between programs or steps along a pathway are made easier through enhanced coordination.
  - Improved alignment: Entities align their efforts to achieve shared goals.
  - Improved cross-system coordination: Through partnerships and leadership coalitions, complementary programs sustain coordination over time.

Analysis of First2 Network documents, such as working group reports and meeting minutes, indicate that working groups and members have sought to improve pathways in various ways in Years 2 through 4 (see Table 7 for examples).

Table 7: Evidence of First2 Network Pathway Improvement Efforts

Element of pathway improvement	Evidence of pathway improvement efforts
Improved quality	• Year 4: Through an S-STEM award in February of 2022, First2 Network PI organization FSU will implement "Bridging the STEM Gap in Appalachia: Engaging with students to iteratively improve faculty practices in support of student success." Based in part on First2 Network processes for using improvement science methods, the project will engage faculty from FSU's math, computer science, and engineering technology departments in continuous improvement of their instructional and program practices. • Years 2 & 3: Working group members conducted PDSAs to continuously improve practices within their institutions.
Improved scale	• Year 3: First2 Network members partnered with the WVU Physics Frontier Center and five community colleges to submit an NSF Improving Undergraduate STEM Education proposal to collaboratively engage more students in STEM research. • Year 2: College Readiness working group members provided proposal assistance to partners to implement new STEM projects, including proposals for funding from Small Business Innovation Research, National Institutes of Health Science Education Partnership Award, and Department of Defense programs.
Improved comprehensiveness	• Year 3: First2 Network members developed a West Virginia STEM assets map to document STEM pathways available to students and identify service gaps. • Years 2 & 3: Immersive Experiences working group offers early research experiences and peer, mentor, and faculty networking to familiarize first-generation students with STEM work and campuses. • Years 2 & 3: Student Leadership working group provides peer support and campus clubs to help first-generation students acclimate to STEM majors.
Improved linkage	• Year 4: The First2 Network assumed a new role as the backbone for the WV Jobs Network, which is building a workplace competencies curriculum and training program, as well as connecting job seekers with employers. As part of this work, First2 Network members mapped the First2 student skill set and shared it with

Element of pathway improvement	Evidence of pathway improvement efforts
	the WV Jobs Network to be incorporated into its workplace competencies curriculum. • Year 3: The First2 Network established an Industry Advisory Board to facilitate co-creation of clearer pathways from STEM education to STEM careers, among other responsibilities. In Year 3, the board asked the network to conduct a literature review on related issues to inform next steps. • Year 2: College Readiness working group developed opportunities to improve student knowledge about the range of STEM careers so they can envision possibilities and plan more effectively for transition to college STEM majors (e.g., NASA Educator Resource Center to add STEM majors and careers information to student workshops).
Improved alignment	• Year 3: The First2 Network Leadership Team began planning to establish "institutional implementation teams" which are conceptualized, according to the Year 3 annual report, as "structural group[s] made up of people from a particular college or university that include STEM students, STEM faculty, and representatives from student support services, first-gen offices, advising and administrators, who might be able to support STEM student retention better if working together than alone." The Leadership Team will launch a support team in Year 4 to help partner campuses create implementation teams. • Year 2: College Readiness working group members trained Health Sciences and Technology Academy (HSTA) teachers and 4-H extension agents to integrate activities that build STEM research skills into programming.
Improved cross-system coordination	• Year 4: The First2 Network established formal partnerships with additional state institutions, including its first community and technical college, Blue Ridge Community and Technical College. In addition, the First2 Network maintained existing formal partnerships with the NASA West Virginia Space Grant Consortium; the Education Alliance; and several industry partners including Chemours, Solvay, Matric, and Toyota. New industry partners include InspectionGo, Leidos, and Stockmeier Urethanes. • Year 3: The First2 Network continued to build integrative relationships with other state STEM collaboratives and industry including Solvay, WV-INBRE, and the Education Alliance to jointly plan and coordinate STEM education efforts. • Year 2: The First2 Network established integrative relationships with other state STEM collaboratives and industry including HSTA, 4-H extension, West Virginia Space Grant Consortium, West Virginia Academy of Sciences, and West Virginia Science Teachers Association.

Latham's framework for evaluating systems change also offers a schema for understanding structural improvement, as follows, framed in terms of the First2 Network aim.

- **Reduction in barriers:** Identification and removal or mitigation of incentives, disincentives, or constraints that jeopardize STEM persistence
- **Development of enablers:** Establishment and implementation, or enhancement, of incentives and opportunities that promote STEM persistence

Some of the ways in which the First2 Network has sought structural improvement are presented in Table 8.

Table 8: Evidence of First2 Network Structural Improvement Efforts

Element of structural improvement	Evidence of structural improvement efforts
Reduction in barriers	• Year 4: Members of the First2 Network contributed to the development of, and then advocated for the passage of, West Virginia SB 228, which provides 1 year of tuition waiver for every year of AmeriCorps service a student completes. Lack of money for tuition is one of the key reasons first-generation college students drop out of college; this legislation removes a financial barrier to persistence. • Year 3: The Faculty and Student Engagement working group is facilitating a Rock Your STEM Major math bootcamp to help incoming STEM students improve their math knowledge and skills and enhance their study skills. This was intended to address a barrier to STEM persistence that the network has observed for many rural, first-generation students—insufficient math preparation due to lack of access to higher-level math courses or lack of teachers certified in math during high school. • Year 2: The Student Leadership working group and High Rocks assisted students to obtain computers and internet access via campus and other resources so they could participate in online instruction during the COVID-19 pandemic, removing the structural barriers imposed by lack of access to hardware and broadband. • Year 2: The Student Leadership working group and High Rocks sought to change power dynamics that discourage students from communicating needs to authority figures by providing entrée to legislators and state education leaders, and structuring opportunities for students to present challenges to all network members (e.g., at network conferences, via the Pandemic Poem shared on the First2 Network website).
Development of enablers	• Year 4: The First2 Network is listed as a key partner in the WV HEPC's Science and Technology Plan, which establishes a 5-year vision for state investment and action in scientific research, innovation, and capacity building. The plan directs HEPC and its partners to collaborate with the First2 Network to prepare and retain students in STEM programs of study as part of the state's efforts to strengthen its STEM talent pipeline. • Year 3: A First2 Network PI submitted what became SB 610, which proposed that any student completing a year of service in West Virginia as a participant in an AmeriCorps State, National, VISTA, or Senior Corps program would receive a tuition waiver for 1 year of tuition at a state public college. This bill would enable students who need to step of out college for any reason to secure funding for another academic year. SB 610 received a second reading in the state house but had not proceeded further by the end of the legislative session. • Year 2: the Student Leadership and Capacity Building working groups promoted network efforts to build policymaker awareness and support of efforts to improve STEM persistence. • Year 2: First2 Network member Kathryn Williamson launched a new West Virginia University Honors course, Ambassadors for Change, to learn about first-generation issues, serve as ambassadors to other current and potential first-generation STEM students, and develop communications about how to support such students. • Year 2: Through partner GlobalMindED, First2 Network offered funding to academic coaches to learn how to employ Lifebound coaching during June, July, and August 2020 trainings.

During Year 4, the First2 Network made at least two notable contributions to structural changes that could improve the STEM persistence of rural, first-generation students and other underrepresented STEM students. Members helped with developing and advocating for passage of West Virginia Senate Bill 228, which provides tuition waivers in exchange for AmeriCorps service—thereby addressing a significant barrier that first-generation students often face: lack of money for college. The second structural change is the inclusion of the First2 Network in HEPC's statewide STEM plan as a key partner and resource for supporting persistence, a change that could encourage institutions to seek consultation from, formal partnerships with, or other collaborative engagement with the network.

3.2 Case Studies of Systems Change

Two case studies based on interviews and document review feature two efforts to change systems influencing STEM persistence. The first case study highlights a campus-based project with students and an administrator to understand and address first-generation students' information needs about preparing for, applying to, and beginning college. The second case study focuses on the development, advocacy for, and passage of a new West Virginia law providing for tuition assistance in exchange for public service.

3.2.1 Case Study 1: First2 Students Focus on College Transition Challenges

For many first-generation students, college is a mystery that causes anxiety and concern even before they set foot in a classroom. Members of the First2 Network are trying to address this through an effort called "What I Wish I Knew" that has sought input from diverse parties, from current college students to high school youth and even college administrators.

The project at Marshall University is also part of First2's approach to empower college students to take initiative and design services not only for themselves but also for the students who come after them. As one student leader noted, "All of the Marshall people got together to discuss ideas that we are passionate about. One was the struggles of freshmen and first-generation college students. We'd like them to be more informed than we were when we started."

The result was a three-part initiative to provide more answers to the questions students wanted to know about college:

- In the first phase, First2 Network members at Marshall designed short surveys for college freshman before the start of their first year and then later in their first semester to examine questions they still had about college and challenges they face.
- In the second phase, First2 Network student leaders and the dean of the College of Science convened a group of about 30 Marshall freshmen to explore these issues in more detail, face to face.
- In the third phase, after processing surveys and feedback, student leaders returned to their graduating high schools to talk with current high schoolers about college, answer their questions, and provide helpful information.

In designing this initiative, student leaders utilized the PDSA model to research, design, study, produce findings, and then act on the topic of college transition. This step-by-step process is a core ingredient of the First2 Network, through which members can study and learn about strategies that might help first-generation students. In this case, the "change idea" of students was to identify and answer key questions that rising freshmen have about college.

After collecting data on students' questions, they published answers not only for college students but also for high schoolers planning for postsecondary study. Student leaders went back to their high schools to talk with students, part of the First2 approach through which scholars are to reach back to their hometown high school to help effect change.

For many students, this issue hit home based on their own experience. "I had to hunt down answers and I wouldn't have struggled as much as I did if I'd had this information," one noted.

Phase 1: Responses Show Student Concerns. Responses to the college student survey found first-generation students with many questions about college applications, financial aid, college classes, and study skills. Some also indicated they had limited confidence to address these issues. These open-ended responses typified the findings:

> *As a first-generation college student, I had to navigate the entire application process independently. It can be difficult at times. Moreover, I have found it to be common that individuals tend to underestimate me because of such.*
>
> *I didn't know how to apply for financial aid. I don't know how to buy my books. I had issues filling out any paperwork. I'm worried I missed things.*
>
> *I had no framework to guide me in the application, financial aid, or housing process.*

This was a familiar refrain to one First2 Network student leader, who started college with a long-range goal but little knowledge of how to adjust academically and personally. "Most students don't know everything about financial aid and how to study, how to prepare for college," the student said. This was reflected in the survey results, as about half of students' questions focused on academics and the other half on financial aid.

Moreover, students in the survey found it challenging to adjust to a college environment with more independence. These comments reinforced that point:

> *I wasn't taught how to genuinely study.*
>
> *I think it will be difficult for me to get connected because I'm a commuter, due to financial reasons.*

Phase 2: Getting Administrator Involvement. In addition to the surveys, First2 student leaders at Marshall gathered a group of freshmen to talk about these issues informally. Marshall's dean of sciences was instrumental in setting up this gathering, which was designed to generate discussion about challenges and possible solutions. One student leader said the dean's involvement was crucial to its success. As this student explained,

> *I found the dean's close involvement pretty significant. It was a bit of a culture shock since I was not used to working with administrators. But by having administrators, students, and faculty collaborate on projects such as this, I think that helps with changing that power dynamic on campus.*

The dean—himself a former first-generation college student—had some prior involvement in the First2 Network, and quickly volunteered to participate in the effort. "There were a lot of things that I didn't know when I went to college," he said. But it was also a different time when college cost considerably less. As he explained, "When I was a student, it was relatively inexpensive. A student could kind of wander through college a little bit and take time to find their way and still make it. But it's so expensive now and it's much less tenable for a student to take some time to get on their feet." Nowadays, he said, it is important for students to find their pathway more quickly and for colleges to support them in this process.

Through the survey and student meeting, the dean said he also learned more about students' concerns. He was struck by comments about keeping up with college coursework and wondering if other students will be more prepared for the experience.

"I think a lot of folks have a feeling of imposter syndrome, like they're not worthy of college," he said. "I see students putting on a brave face most of the time. But what I was a little surprised at is they were willing to say, 'I'm not really all that confident though I'm trying to look like I am.' "

Phase 3: Acting on the Research. With the college student findings, First2 student leaders returned to their high schools, either virtually or in person, to discuss college transition issues with high school students. One student returning to her high school found an attentive audience that appeared to agree with the findings. But students asked her few questions. Instead, many followed up with emails or messages later.

This student leader said that the process was indicative of how many first-generation students approach the mysteries of college. "I think they didn't want to ask questions while I was there, and I understood how they felt," she said. "Sometimes I didn't know what to ask or whether I was asking a dumb question." For this reason, she provided her contact information so that students could easily follow up after the event.

To help students already at college, First2 student leaders have designed a "Frequently Asked Questions" document and are preparing a brochure to highlight key resources for first-year students. The FAQ provides information on staying motivated, dealing with stress, building relationships with professors, finding or changing a major, and tips for effective studying.

Overall, First2 Network administrators have said this pilot program has revealed major information gaps as first-generation students exhibited limited knowledge of financial aid, college expectations, and strategies to help them succeed in higher education. However, current and future students now have more information about college transition issues, and administrators—in this case, those at Marshall University—have important information they can use to help onboard new students. First2 Network students also hope that other institutions can learn from this initiative. As one administrator noted, "It just shows you the brilliance of students and how they're more connected to this issue than we are. I was a first-generation student, but that's a long time ago. It's a different world now."

3.2.2 Case Study 2: New Law Offers "Win-Win" to Promote College Success

West Virginia faces a variety of educational and economic challenges, as many students struggle to pay for college and those that do succeed often move out of state. But legislation just passed in the state—designed in part by First2 Network leaders—aims to address both concerns at virtually no cost.

Approved last March, Senate Bill 228 would grant tuition waivers for young adults who participate in an AmeriCorps state, national, VISTA, or Senior Corps program in West Virginia. For every 1,200 hours of service, a student would earn a 1-year tuition waiver good for use at any public higher education institution, from community colleges to graduate programs. "Give West Virginia a year of service, and we'll give you a year of school," a flyer for the bill states.

The idea for the bill came from First2 Network leaders who have both worked with STEM students and successfully guided young adults through AmeriCorps assignments where they work with high-need youth and adults.

"West Virginia is losing population at an alarming rate. There's really not a sustainable future or a sustainable economy if we can't reverse that trend," one First2 Network leader said. But while lack of hope may be a "dominant" narrative for young people in the state, "That's not actually

true. We have employers who are trying to drive the economy that can't find the quality talent that they need."

For example, studies show that 60% of the state's workforce needs a college degree to meet labor market needs. However, the current rate is only 31%.

"For us to fill our projected workforce needs, we need more STEM graduates and we need more STEM graduates going on to have successful, lucrative, happy, and healthy careers right here in West Virginia," she said. "The barriers can absolutely be overcome. It just takes a little more support."

AmeriCorps' Appeal. A First2 Network leader outlined a common scenario: Students start college but struggle to pay for the rest of their education, or they experience academic challenges and either lose scholarships or just need a break. For such individuals—as well as for recent high school graduates unsure about pursuing a college education—AmeriCorps provides an option to gain work experience and make a difference.

AmeriCorps participants typically receive assignments at agencies that help address poverty, educational challenges, and environmental concerns. They generally earn a modest living allowance and some money toward education expenses. The new legislation offers West Virginia participants a 1-year tuition waiver for every year of AmeriCorps service.

"We have a lot of young people in West Virginia that aren't graduating from college, and they're dropping out part of the way through. They ran out of money or they got bad grades for one semester. Then they're getting stuck in the service industry when they really want to be on a professional pathway." But through AmeriCorps, they have a viable way to return to a professional pathway. "It's a way for them to reset and get back on the pathway to higher education and to a professional job," this First2 Network leader said.

Even college graduates can benefit from AmeriCorps, she said. As a nonprofit executive, she has seen recent graduates without a strong skill set struggle to become successful employees. But daily work through AmeriCorps is a way to build those skills, including soft skills, collaboration, and public speaking.

AmeriCorps also helps reach students who are looking for a new adventure. "They're saying, 'I want to explore. I want to try something new.' " Students may serve just for the summer, though many continue for an entire year. "Then if you can keep them for 2 years or 4 years, guess what? They're probably staying in West Virginia."

The Road to Passage. The bill had strong support from the West Virginia State Senate in 2021, but it bogged down in the state house due to fiscal concerns as well as a perceived lack of bipartisan support beyond its Democratic Party sponsors. Advocates switched tactics and instead used a Republican sponsor in 2022, Sen. Patricia Rucker.

"I told them the honest truth: Let's try it with a different sponsor," the Republican said. "Sometimes politics interferes. I'm practical and I want to have good things get through."

Internally, Rucker set up meetings with the chair of the West Virginia House Finance Committee, where the bill had failed previously. With this communication, "He would know and understand that this was not a partisan bill. It was just a good bill."

The issue had particular resonance with Rucker, who grew up in Venezuela where young people are required to perform 2 years of national service after high school.

"Most young adults can become more mature through service. Most can use extra time to become more mature for college. Not only do you increase your involvement and feeling of belonging, you also wake up to differences that you might not know if you go straight from K–12 to higher education. There are students who never see poverty and there are students who

don't know the struggle that others have in their lives. That exposure will make you a more well-rounded human being."

She described the bill as "a win-win," with participants gaining job experience and educational benefits while nonprofits who employ AmeriCorps members receiving enthusiastic support staff. Some AmeriCorps participants also may come to West Virginia from out of state, she said, so it provides an avenue to recruit more people to the state and its postsecondary institutions.

AmeriCorps Alums Get Involved. The legislation hit home with many AmeriCorps participants and alumni, who banded together to advocate for the bill. "AmeriCorps found me when I wasn't sure where to go," one alumnus said. AmeriCorps service led her directly to a full-time job seeking to better the lives of children and adults. Now in graduate school, she expressed hope of reaping a direct benefit from the new legislation and its implementation.

"We have a lot of socioeconomic problems in West Virginia, a lot of poverty, a lot of families who can't afford to send their students to school. So having that opportunity for them to be able to serve the community and receive something back would be a good thing."

AmeriCorps members may serve right out of high school or take a break in their college studies because they want more work experience and career exploration. With this legislation, she said, "They could serve with AmeriCorps and then go to college, and they might have a little bit of a better idea what they want to do."

Working in social service programs alongside recent high school graduates, she said she has seen many individuals who talk about taking a year off from college, in part to "take a breather after the stress that COVID brought on so many of them." She noted that after a few semesters in college, many "feel they need a break from school," and AmeriCorps may represent a valuable learning and career opportunity.

"For a state as impoverished as ours, I think we have to be very savvy and smart and strategic about how we go about things if we choose to go to college, go to a trade school, you know, pursue something outside of a high school education."

Another former AmeriCorps participant in West Virginia made phone calls, wrote letters, and created social media posts to build support and enthusiasm. "It came down to the wire," she said, with lawmakers only agreeing to the proposal in the final days of their legislative session. Yet the long-term impact may be significant for individuals and for the state. "People will use this law and then tell others, and in the process more people will learn about its advantages."

These advocates wrote letters, made phone calls, and posted messages on social media to generate enthusiasm for the bill. Others also visited the state legislature to plead their case.

Ready for Implementation. Slated to begin in the fall 2022 semester, the program is open to students as long as they first complete their Free Application for Federal Student Aid and accept all offers of state and federal financial assistance for which they are eligible. As a result, this program is "last-dollar funding," applicable only after accepting all other government grants. Students can earn a waiver of one semester's tuition for every 600 hours of service, up to a maximum of 4 years, or eight semesters of enrollment. AmeriCorps service must be completed in West Virginia to qualify.

Public colleges and universities already have options to grant tuition waivers for students, so the legislation will not cost any money. However, institutions do have the flexibility to limit the number of waivers granted if there is high demand. Proponents expect about 200 individuals a year to seek assistance. "We had to figure out how to do something to move the idea forward without asking for money," one First2 Network leader said.

A critical element of implementation will be accessing and presenting the letters of service that detail AmeriCorps' members time in the program. Students will log into the portal at https://my.americorps.gov/mp/login.do to access and print the letters to send to their college or university. Volunteer West Virginia has published a list of frequently asked questions about the waiver initiative at https://volunteer.wv.gov/AmeriCorps/Pages/Resources-for-AmeriCorps-Members-.aspx, and West Virginia University has posted its guide at https://financialaid.wvu.edu/waivers/americorps.

Aside from the interest within West Virginia, the new legislation is drawing interest throughout the United States. "This is a nationally ground-breaking model," the First2 Network leader said. "Other states are really excited about how we pulled this off and what comes next."

3.3 Backbone and Mentor Backbone Interviews

During June 2022, the ICF evaluation team conducted individual online interviews with three staff members from the Division of Science and Research at the WV HEPC DSR) and two staff members from SRI International, all of whom have been involved with the First2 Network project for at least part of the past year (July 2021–June 2022). The purpose of these conversations was to help evaluate the progress made toward achievement of the First2 Network goal of building capacity of the HEPC DSR to serve as a sustainable hub or backbone for the network, with SRI serving as a mentor backbone and providing capacity-building support.

Interview prompts were organized into four categories: capacity-building activities carried out over the past year, extent to which capacity was built and any remaining needs, backbone tasks carried out and facilitating/impeding factors, and a wrap up. Responses are organized by question within these categories.

3.3.1 Capacity-Building Activities

Describe the types of backbone capacity-building activities you have participated in, or the capacity-building supports that have been provided related to the First2 Network over the past year. According to interviewees, SRI has provided less direct instruction this year and instead has served in a mentorship or coaching role for HEPC DSR staff. SRI staff are still involved, but no longer focused on teaching about collaborative infrastructure or networked improvement communities. Further, this year has seen SRI become more involved with both HEPC DSR, the Improvement Science work group, and then network membership in general in providing more targeted support on improvement science (PDSA cycles).

Weekly backbone meetings have continued throughout the year, including staff from SRI, HEPC DSR, and FSU (where one of the First2 leaders is employed). Focal points of these backbone meetings this year have included conference planning (for a virtual conference in October 2021, an online PDSA workshop in January 2022, and both virtual and in-person conferences in May 2022); how to onboard institutional teams across the First2 Network; development of PDSA resources for the institutional teams; preparation for the NSF reverse site visit; and how to support the Industry Advisory Board.

HEPC DSR and SRI staff also participated in weekly First2 Leadership Team meetings over the past year and are now beginning to engage in a newly-formed group focused on sustainability (which came about both as a "natural" evolution of nearing the end of the grant and as a result of the 2022 NSF reverse site visit) that will include HEPC DSR staff, as well as First2 leadership from High Rocks, GBO, and FSU. This group will be responsible for crafting a network sustainability plan in the coming year.

HEPC DSR staff also reported capacity-building efforts focused on making more connections within the larger HEPC entity, beyond the DSR. One individual described how the network involved the assistant director of the DSR as the facilitator/mediator of a discussion involving First2 leadership and students. Another described how the network is "partnering more with the Division of Student Affairs" and provided an example of having Elizabeth Manuel (senior director of student services) give the keynote speech at the First2 in-person conference in May 2022. Yet another example was that HEPC is taking the lead in trying to get statewide consistent tracking across public higher education institutions of first-generation status of students, due in part to First2 creating "a buzz about the first-generation population in the state." One interviewee commented, "That would be really invaluable data for the network to figure that out because it would help us target where to put the efforts in how to go forward … which places have the most first-generation students."

SRI support for the HEPC DSR staff this year also included biweekly meetings to discuss change ideas from the institutional teams where members "workshop" the plans, i.e., "we talk about what's wrong, what's right, how to make it better, and we're planning to do more of that in the future," along with talking with the institutional teams about the change ideas being documented in their PDSAs. One of the SRI staff members is currently modeling one-on-one coaching of institutional teams for Improvement Science work group members so that in the future they can provide such coaching for institutional teams related to their PDSA efforts. This focus on improvement science activities grew out of an audit of the First2 PDSA data in NILS and finding a lack of linkage to the network driver diagram, inconsistencies in metrics, and a lack of reflective iterative inquiry by practitioners. This had created "almost unusable" findings that were not being shared across the network. "There was no central way for the network to learn from what members of the network were doing."

Further, after the January PDSA workshop, there was a recognition of the need to begin with helping members change their mental models (first level of systems change) before institutional changes in communication and relationships could take place, which could then lead to policy and programming changes. Hence the efforts last year and continuing into Year 5 of helping foster those understandings of what will change the system. By working individually with institutional teams, the goal is to document and harvest those promising practices at the micro level and begin scaling and measuring those practices across institutions.

It should be noted that one SRI interviewee perceived the implementation science support as separate from yet related to capacity-building support (although this view seems contrary to how other interviewees were interpreting the improvement science support). This individual commented, "I don't think of myself as building HEPC capacity at all and … I think my experience of HEPC's engagement has been less than what I would have anticipated from a backbone." This individual noted that the fact that the PDSA audit was completed by SRI staff was an example of how SRI may be moving beyond the backbone support role by doing the work for the network: "We can provide feedback and support, but fundamentally, we shouldn't be doing this for them."

Other examples of this perspective were provided; e.g., SRI being viewed over time as the "technical expert" to being "sidelined" to "the savior" for particular crises, such as how to set up a backbone, preparation for the NSF reverse site visit, and improvement science. This interviewee advocated for more of a push to make it "okay to fail" in order for HEPC DSR to be given "the expectation of full backbone leadership," which includes opportunities to fail and learn from those experiences. "The expectation and the possibility for failure, I think, is like a precondition to really owning the backbone work."

Finally, one HEPC DSR staff member and one SRI staff member also reported participating in a collective impact conference and the Carnegie Foundation Summit.

Which of the activities or supports were most valuable in building capacity, and why? One HEPC DSR interviewee noted, "Absolutely, the SRI support," especially for improvement science. "When I first moved into this role, … I didn't understand how big the improvement science piece was to the backbone organization" and that perhaps across the network "I don't think it was accounted for the fact that this division would be responsible for holding the improvement science part of the network. And so [SRI] has really brought a lot of expertise and coaching to help build our capacity in that way."

One of the SRI interviewees reflected,

> *I think that the decision to develop the improvement science team that's going to handle the coaching around these PDSA cycles probably feels to me like the most effective. Just because we need to get people's minds around this. We need them doing it and thinking about it. And we have to have a structure for having that conversation.*

3.3.2 Extent to Which Capacity was Built and Remaining Needs

To what extent did the activities or supports meet the Division's needs for capacity building to serve as a successful backbone for the First2 Network? One HEPC DSR staff member noted that "SRI has been successful in identifying how they need to change, what their support is like," and described how SRI support has covered multiple topics over the years, such as backbone roles and responsibilities, systemic change, driver diagrams, improvement science, and the NILS PDSA system.

One HEPC DSR interviewee said,

> *I think we've learned this year that we really need at least two more full-time positions that are dedicated to the network. Because we've identified some, I don't want to call them weaknesses, but they really are. They're just these vulnerable positions that First2 is in in some areas.*

Those areas were identified as communications (securing information from each institution and sharing it across the network) and data (tracking improvement science across the state). Another HEPC DSR staff member suggested the need for a grant writer as well.

A third HEPC DSR staff member commented:

> *Over the whole course of the INCLUDES grant, … the things that always stood out were in the past how difficult it was to kind of filter through everyone's opinions or comments or needs and seeing what was very specific and what was most urgent. That was very difficult from a communication side. And then more recently, in the … middle to latter end of this grant, it's been much easier … hiring a program coordinator for our backbone was the best idea.*

According to one SRI interviewee, HEPC DSR capacity has shown most progress around the area of conference planning and communication, and in HEPC's ongoing efforts to begin consistent measuring of first-generation status of students across state institutions of higher education.

What remaining capacity-building needs does the Division have to be able to serve as an effective backbone for the First2 Network? While responding to this prompt, one HEPC DSR interviewee reflected:

> *The way that the network was set up [was] with five grants and five PIs, and forming a very large leadership team as a result of that was not very effective for*

> *making leadership decisions and made the role of the backbone really difficult. … Everyone is on equal footing and there's no hierarchy, which makes decision-making slow and painful. And it's also a group of people who are not good at delegating, so I feel like we were really bogged down and at least now I think we realize that that's the case. In some ways I think it really kept the backbone from doing what backbones are supposed to do, because every single thing that was done was questioned and many times reorganized. So I think it's going to be really good for us in this sustainability plan to identify … who's actually going to get the money if we apply for more money and who will manage it, which will create a new leadership structure that will hopefully be much simpler and easier for people to deal with. … So I think if we can get to that point in the sustainability planning where that's clear who will receive the money, how will it be overseen to run the programs, then I think that'll be a big plus and the backbone can become much more effective. But we aren't there yet.*

Similarly, an SRI interviewee noted the network structure and its effect on sustainability: "Is it sometimes inefficient? Is it too many cooks in the kitchen? Yes, but that's the system change story, right? To me, that's the system."

Another need mentioned by several of the HEPC DSR interviewees was the need to apply for and secure funding to cover the First2 program coordinator role, which is 100% of a DSR staff member's time, after the current NSF grant funding concludes. One commented, "I'm worried that because it has taken us so long to get to this point [having a sustainability plan] … that we needed to maybe go through this process earlier, but you know it's a complicated network."

One SRI staff member noted ongoing need for improvement on communications, especially related to synthesizing and sharing stories from PDSA efforts across the network. Similarly, another SRI interviewee acknowledged the need for continued coaching for those individuals who will later provide PDSA coaching support for institutional teams, noting "we need strong PDSA coaches to support teams and strong PDSA work. … There needs to be accountability." This individual described a "Measurement Must Menu" that can be used to provide more consistency, continuity, and accountability across network institutional teams in carrying out their PDSA efforts. That menu includes required process and outcome measures (shared metrics) "that are consistent across change ideas and across institutions and measure leading indicators that are likely to lead to success."

Both HEPC DSR and SRI interviewees noted the need for additional staffing to more fully carry out the backbone responsibilities for the network. Specifically noted were the need for an executive director position and a data analyst position, as well as more time for communications and grant writing.

Another focal point emerged from HEPC DSR and SRI feedback—not necessarily a weakness per se, but an example of the diversity of viewpoints among First2 Network leadership and its members that may be causing some conflict. Two HEPC DSR staff noted an emerging perception among some First2 leaders this year of another type of backbone for the network—student leadership. One interviewee said at least indirect connections are needed for this role, so that the leadership team is more fully aware of student engagement and requirements. Another interviewee held a different view, perceiving that the role was not similar to a backbone. An SRI staff member also acknowledged the emergence of this student backbone idea, noting:

> *I think it's a healthy thing that that got surfaced. Is it resolved? No. I think it might get somehow resolved through this sustainability discussion. But I just think there's a lot that has to be worked on there in terms of relationship and trust*

building and people really understanding what it's going to take to sustain this thing. … That conversation is still not resolved, it's a work in progress.

3.3.3 Backbone Tasks Carried Out and Facilitating/Impeding Factors

Describe the tasks that the Division carried out this year to fulfill its backbone role. Interviewees provided a rich description of the activities undertaken by HEPC DSR staff in carrying out the backbone responsibilities over the past year. Some activities were those identified in previous years, such as holding the weekly backbone meetings, participating in leadership team meetings, securing institutional partners and obtaining signed memos of understanding, fundraising, carrying out the strategic plan, organizing and hosting Network conferences, communications (including a monthly newsletter, the network website, and social media), building relationships and partnerships, and general overall coordination of the network. One HEPC DSR staff member noted connecting with staff from Stockmeier Urethanes, Leidos, Toyota, and Big Brothers and Sisters of the Tri-State (serving specific counties in Kentucky, Ohio, and West Virginia) to discuss partnership possibilities.

In addition, new activities over the past year included providing improvement science support and resources for the institutional teams; forming the sustainability work group that will create a sustainability plan for the network; and presenting at several meetings, including the West Virginia Council meeting (for 2-year higher education institutions) and the West Virginia Student Success Summit.

What factors seem to be helping the Division's efforts to serve as a backbone organization? Several facilitative factors were identified and most of these factors differed from those identified last year. Factors this year included SRI providing support; having strong HEPC leadership support; the commitment, flexibility, patience, and attitudes of the HEPC DSR staff; having conversations about sustainability; and (similar to last year), having a full-time First2 program coordinator.

In discussing how sustainability conversations served as a facilitative factor, one HEPC DSR interviewee reflected how the conversations helped to uncover and clarify "a lot of misconceptions" about DSR and its relationship within HEPC, as well as with what roles are needed in the network. For example, seeing a need for someone to provide improvement science support that is separate from (or at least in addition to) backbone responsibilities—"being a backbone and an improvement science person resource for the Network is just like, that's got to be separate, it's way too much." Another HEPC DSR interviewee noted the autonomy within her role "to do what I feel is best" and that the leadership support and relationships are "empowering to me."

What factors seem to be impeding the Division's efforts to serve as a backbone organization? Impeding factors were similar to those identified last year and included insufficient staffing levels for fully carrying out backbone responsibilities and ongoing communication issues.

Regarding staffing, HEPC DSR interviewees pointed out the impossibility ("the biggest hindrance") of current First2 funding (at approximately 1.2 full-time employees [FTE]) to fully carry out expectations currently embedded as "backbone" responsibilities—improvement science, conference planning, grant writing, fundraising, data, communications, sustainability, and program coordination.

Regarding communications, with the current network structure, "there wasn't a plan and a consensus on how communication works … it was not defined how the" various teams (leadership team, working groups, backbone, advisory committee, industry advisory board) "communicate with each other." One individual noted, "I think that also needs to be a big part of

a sustainability plan, to define the way that they communicate and the key avenues that information is going to go back and form with them." Another reflected a need to pinpoint more specifically what the network needs communicated, and when.

3.3.4 Wrap Up

What other comments would you like to share about your experience contributing to the backbone team for the First2 Network? Interviewees provided several diverse comments about their experience with the First2 Network.

One HEPC DSR interviewee reflected:

> *The sustainability plan should be the highest priority thing that we're doing right now and it's not. And I also think that we could be exploring more corporate support and that that could solve a lot of problems. But you know, we have to come up with a united picture of what we want in order to get it, so I don't think the situation is maybe as dire because we don't necessarily have to get the funding from the NSF. But people don't have time to work on and explore like, "What are the possibilities for funding from corporations or other foundations that might be in the area?"*

This individual added that perhaps deeper partnerships could be fostered eventually with corporations or other foundations, "but we can't get there yet because we can't articulate what it is we want."

Another interviewee commented,

> *Well, I think it's been a really interesting experience to be part of the Network because everybody is so dedicated and so passionate, but also so dedicated to the network Improvement Community model that it's really amazing, although it's sometimes hampering but it is really amazing. Another thing that's really helped over the past couple years is the network has realized we can't do everything that they started out to do and that's really important because there was a lot of … it was just way too unwieldy and so now it's a lot more focused down and I think that's good.*

An HEPC DSR and an SRI staff member both noted how the network has tightened its focus to home in on core areas for achieving desired outcomes. Both described how earlier the network included ambassador work at the high schools, which had to do with being ready for college. One commented,

> *What have we really done and do we have any bandwidth on that? And we really don't, let's be honest. That was an aspiration maybe at one point, but that's changed.*
>
> *We've got these students in college right now, and so we have what we have to work with. We're not, we can't, we can do very little for what happens to them before that. We have so little control in West Virginia over that arena that really the key thing is to figure out what happens once they get to college or are about to go to college.*

One SRI interviewee reiterated the need for more efficient operations within the network, noting, "they're making a little progress in this department, but it's still not where it needs to be." And went on to suggest the leadership team employ a "stand-up" meeting tactic where it is more about brief reporting by a single backbone member, rather than a "PTA meeting" type structure, which calls for a more interactive discussion of what

needs done and by whom. This individual added that members need empowered to do the work in their respective lanes. Another SRI staff member reflected "I think SRI has been expected [to] and wanted to do too much this year. … We have done too much for First2 rather than with First2."

3.3.5 Backbone Interview Summary

In sum, most HEPC DSR and SRI respondents perceived that considerable progress had been made during the year, both in continuing to build HEPC DSR capacity to serve as the First2 backbone and in HEPC DSR carrying out those backbone responsibilities. Similar to last year, the most frequently mentioned area of need is for additional staffing and new for this year is the need to move forward immediately with sustainability planning.

3.4 Network Value Survey

The Network Value Survey, administered annually in June, asks members to use a 4-point scale to rate the value of aspects of the network across 23 items divided into five value lifecycles: (1) Immediate value, (2) Potential value, (3) Applied value, (4) Realized value, and (5) Impact value. This survey is based on research suggesting that what people value about the networks in which they are engaged evolves in a roughly developmental manner.[60]

Figure 24. Network Value Lifecycle

According to this research, Figure 24 depicts how networks generate five progressive levels of value to their members over time, each of which is aligned with the five survey sections:

1. **Network and Community Building (Immediate value/activity):** Activities and interactions (e.g., network events, new relationships)
2. **Gaining New Knowledge (Potential value/output):** Knowledge capital (e.g., acquisition of information and skills that can be applied later)
3. **Applied Learning and Practices (Applied value/application):** Changes in practice (e.g., employment of new knowledge and skills)
4. **Performance Improvement (Realized value/outcome):** Performance improvement (e.g., achievement of network goals, such as improved STEM program persistence rates in this case)
5. **Influence and Redefining Success (Reframing value/impact):** Redefining success (e.g., development of new, more ambitious network goals)

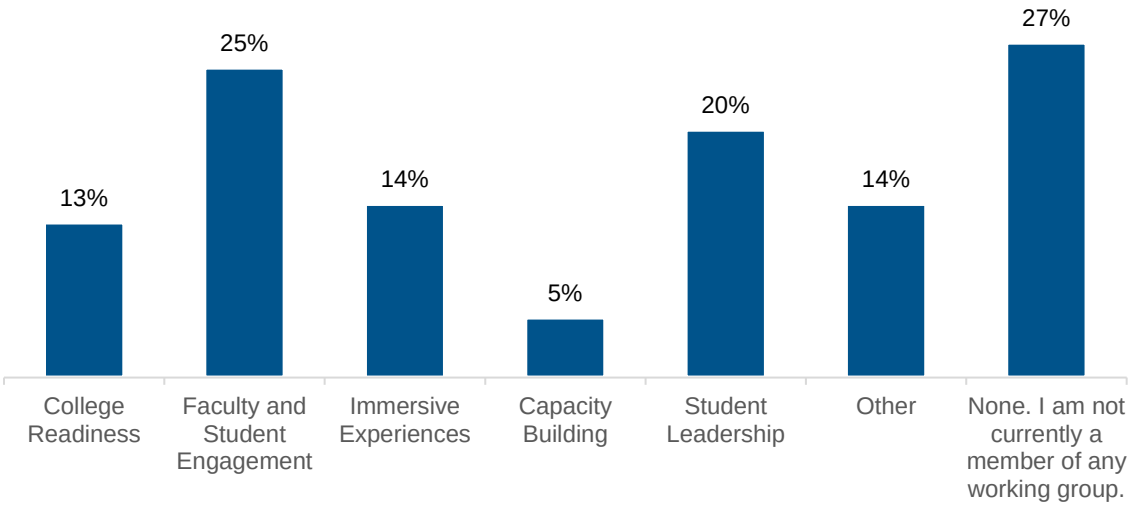
The first set of five items on the Network Value Survey assesses the extent to which members value the networking and community-building generated by network participation (Activity). The next four items ask respondents to rate the extent to which they value gaining new knowledge from network participation (Output). The next set of five items asks members to rate the value of opportunities for applied learning and practice that the network offers (Application), whereas the next four items ask members to rate the value of possibilities for performance improvement generated through network participation (Outcome). The final five items invite members to rate the extent to which they value the network for its contribution to

their ability to refocus and redefine success (Impact). In addition, open-ended questions ask members to share examples of how the value acquired through network participation manifested in their own work.

The evaluation team examined the extent to which members' value beliefs about the network change over time. A total of 58 responses were included in Year 4, 46 responses were included in the analysis of Year 3 member respondents, 49 in Year 2, and 39 in Year 1. Survey respondents indicated their level of agreement to 23 statements related to their experience with First2 membership. The items used a 4-point scale: 1 = *Strongly Disagree,* 2 = *Disagree,* 3 = *Agree,* and 4 = *Strongly Agree*. Results for all analysis reported in this section are based on those who responded to the item. All effect sizes are small unless otherwise noted.

Surveys also included questions prompting respondents to report on member status and working group participation. Of the total Year 4 respondents, most were faculty members (43% of 56), followed by student members (27% of 56). The percent of community member respondents remained the same between 2021 and 2022 (N=5), while Year 4 data showed slightly higher numbers of respondents who indicated "other" in Year 4 (N=12) compared to Year 3 (N=8). When asked to elaborate, respondents reported being staff, partner, or employer and two respondents who did not indicate a member type. Finally, Figure 25 details working group affiliation. Most respondents were from the Faculty and Student Engagement working group (25%), followed by the Student Leadership working group (20%). Over one-quarter of the respondents reported no affiliation with a working group and another 14% reported "other" affiliation. When referring to "other" in the working group affiliation, respondents noted measurement and industry.

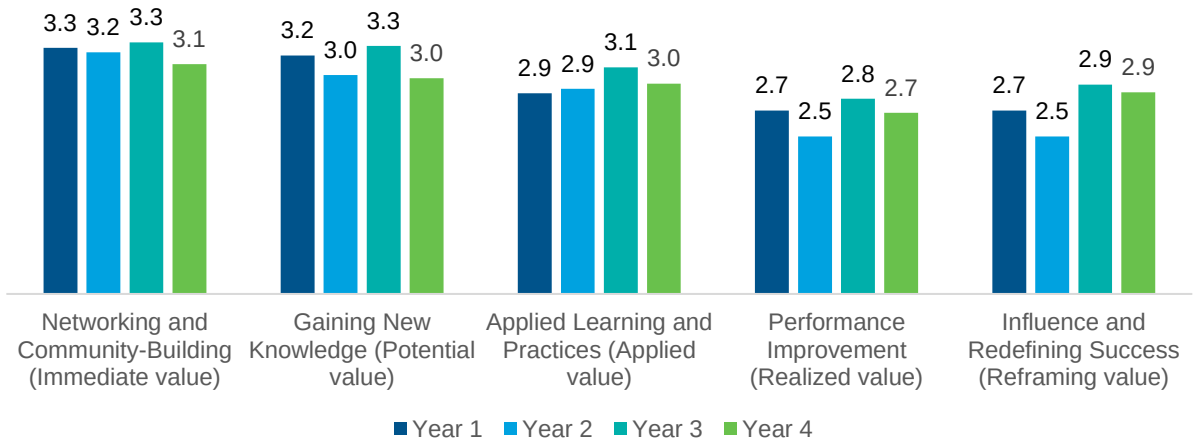
Figure 25. Working Group Affiliation of Respondents



Lifecycle mean responses ranged from 2.7 to 3.1, and the highest mean ratings among Year 4 members was in Immediate value manifested as Networking and Community Building (Mean=3.1) and the lowest mean was in Realized value reflected as Performance Improvement (Mean=2.7). Mean ratings for Reframing value as in Influence and Redefining Success was the only lifecycle phase to show an increase over the past year (Difference=+0.1). Expectedly, members find the greatest value in the initial activity phase, Networking and Building Community, found early in the network's lifecycle, when members focus on Immediate value—that is, on the creation of new relationships and shared network experiences. This is followed by the next two phases:

Potential value as in gaining new knowledge from network participation and Applied value as in opportunities for applied learning and practice that the network offers (Mean=3.0 each). In Year 4, network members also reported value in the last phase, Reframing value. This aspect is measured by five items that rate the extent to which they value the network for its contribution in their ability to refocus and redefine success (Impact). Figure 26 below provides an overview of these ratings by year.

Figure 26. Overall Mean Scores by Lifecycle and Year



Overall mean scores from 2019, 2020, 2021, and 2022 are presented in Table 9 below, as well as mean scores for items associated within each lifecycle. While there were no gains from Year 3 to Year 4 ratings, the largest overall mean rating was associated with the Immediate value lifecycle, which indicates that members continue to recognize value in the ways in which the network supports networking and community-building activities, with mean component ratings of 3.28 in 2019, 3.24 in 2020, 3.33 in 2021, and 3.13 in 2022, respectively.

The highest-rated item at 3.33 was that members participated in network activities that were meaningful. The least-rated item—observed data indicating that my organization's performance improved—within the least-rated lifecycle, performance improvement (Realized value/outcome), was the lowest-rated across all cycles (2.46), and across all 4 years. This indicates that members are not seeing the evidence of improvement in their own organization or through achievement of network goals, such as improved STEM program persistence rates. Overall, Year 3 to Year 4 ratings show several declines ranging from -.04 to -.38, and while some slight declines should not be concerning, larger declines may reflect a need for leadership to dig deeper into understanding any changes in the network's structure or communication that have changed between Year 3 and Year 4.

Table 9. Network Value Survey Item and Subscale Mean Scores

Cycle	Response Option	Year 1	Year 2	Year 3	Year 4	Difference Yr 4 – Yr 3
		(*n*=42)	(*n*=49)	(*n*=46)	(n=58)	
Networking and	Participated in network activities that were meaningful	3.31	3.21	3.39	3.33	-0.06

Cycle	Response Option	Year 1	Year 2	Year 3	Year 4	Difference Yr 4 – Yr 3
***Community Building* (Activity)**	Made connections with colleagues around shared goals	3.38	3.38	3.41	3.24	-0.17
	Gained access to professional relationships that change my perspective or understanding	3.29	3.10	3.33	2.98	-0.35
	Engaged regularly with the network*	3.14	3.26	3.09	3.09	No Change
	Interacted with students as contributing members of the network	N/A	3.26	3.41	3.03	-0.38
	Activity Mean	3.28	3.24	3.33	3.13	-0.20
		(*n*=37)	(*n*=48)	(*n*=46)	(*n*=58)	
Building New Knowledge (Output)	Saw opportunities for learning that I did not see before	3.33	3.02	3.38	3.02	-0.36
	Gained access to new tools, information, or processes I would not otherwise have access to	3.18	2.98	3.22	2.97	-0.25
	Gained insight about a person or group I can turn to for information or support	3.28	3.17	3.41	3.09	-0.32
	Acquired a new skill or new knowledge	3.05	2.94	3.20	2.91	-0.29
	Output Mean	3.21	3.03	3.30	3.00	-0.30
		(*n*=39)	(*n*=48)	(*n*=46)	(*n*=58)	
Applied Learning and Practices (Application)	Applied skills or practices learned through the network to accomplish a goal or connect to student groups	2.92	2.83	3.05	2.93	-0.12
	Used knowledge or skills obtained through the network to contribute to understanding of problems or issues	N/A	3.10	3.33	3.02	-0.31
	Made changes in my organization based on network work	2.64	2.63	2.89	2.76	-0.13
	Used a document produced or made accessible by the network	2.95	3.00	3.14	2.98	-0.16

Cycle	Response Option	Year 1	Year 2	Year 3	Year 4	Difference Yr 4 – Yr 3
Performance Improvement (Outcome)	Leveraged a network connection to accomplish a task	2.92	2.92	3.11	3.07	-0.04
	Application Mean	2.86	2.90	3.10	2.95	-0.15
		(*n*=37)	(*n*=49)	(*n*=46)	(*n*=58)	
	Observed practice/policy improvements at my organization resulting from network work	2.54	2.48	2.70	2.64	-0.06
	Encountered evidence that the network has advanced its reputation	3.03	2.67	3.18	2.82	-0.36
	Observed evidence of improvement in the key student outcomes we are pursuing	2.76	2.54	2.82	2.75	-0.07
	Observed data indicating that my organization's performance improved	2.46	2.17	2.52	2.48	-0.04
	Outcome Mean	2.70	2.46	2.81	2.67	-0.14
		(*n*=36)	(*n*=49)	(*n*=46)	(*n*=57)	
Influence and Redefining Success	Engaged previously uninvolved stakeholders in network efforts	2.94	2.70	2.83	2.79	-0.04
	Contributed to a new framework or system for achieving network aims as a result of new understandings	2.89	2.79	2.80	2.93	-0.07
	Used what I learned from network work to develop a new strategic direction at my institution	2.50	2.46	2.66	2.70	0.04
	Reflected anew on what it takes to achieve success	3.19	3.02	3.33	2.95	-0.38
	Demonstrated an understanding of the complexity of elements important to rural students' pursuit of STEM careers	N/A	3.00	3.12	3.11	-0.01
	Impact Mean	2.88	2.79	2.95	2.89	-0.06

N/A: Members were asked three additional survey items this year; as a result, no data for these items are available from Year 1. Appendix B contains a reproduction of the Network Value Survey.

3.4.1 Immediate Value: Networking and Community-Building (Activity)

Among the respondents on the 4-point response scale, most agreed that they found value from the networking and community building available as a participant in the First2 Network community. The mean average 3.13 decreased from the previous year by .20, and Figure 27 and 28 below detail how input from community and other members may have contributed to that overall decline. Specifically, student members rated four out of the five items higher this year than the faculty or community and other members, with an overall mean rating of 3.43 compared to 3.29 among faculty and 2.70 among community and other members. Faculty and community and other members agreed most with the item *Made connections with colleagues around shared goals* (Mean = 3.50 and 3.06) and students agreed most *with Interacted with students or student groups as contributing members of the network* (Mean = 3.53). In fact, 80% of all member respondents found strong value within the network to make connections with colleagues around shared goals. Additionally, nearly 3 out of 4 community or other member respondents believed in the value of the network to help them gain access to professional relationships that change their perspective or understanding.

Figure 27: Immediate Value: Year 4 Mean Ratings by Member Type

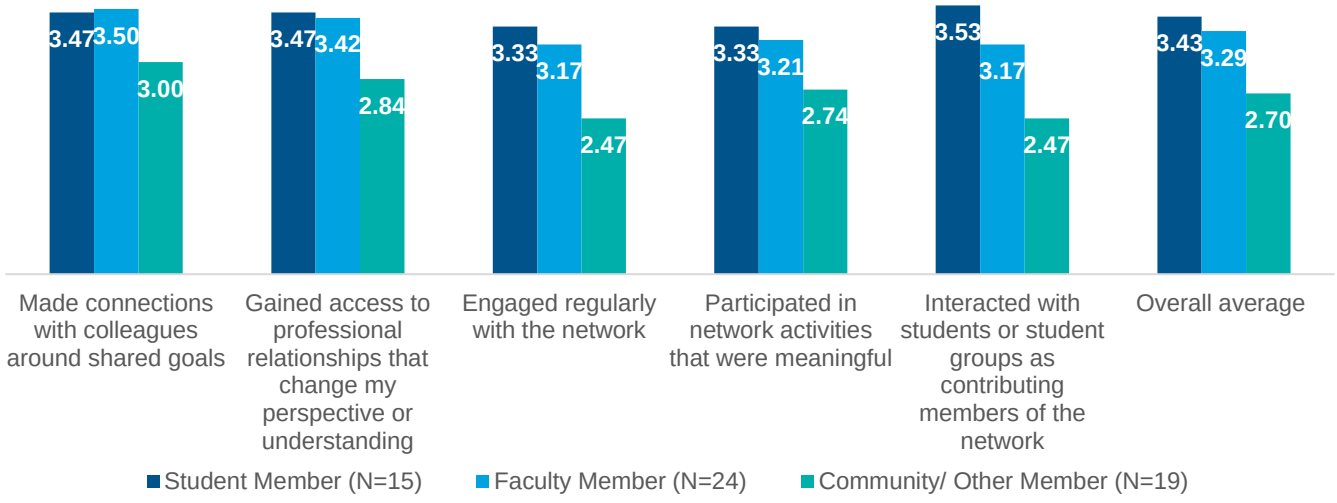
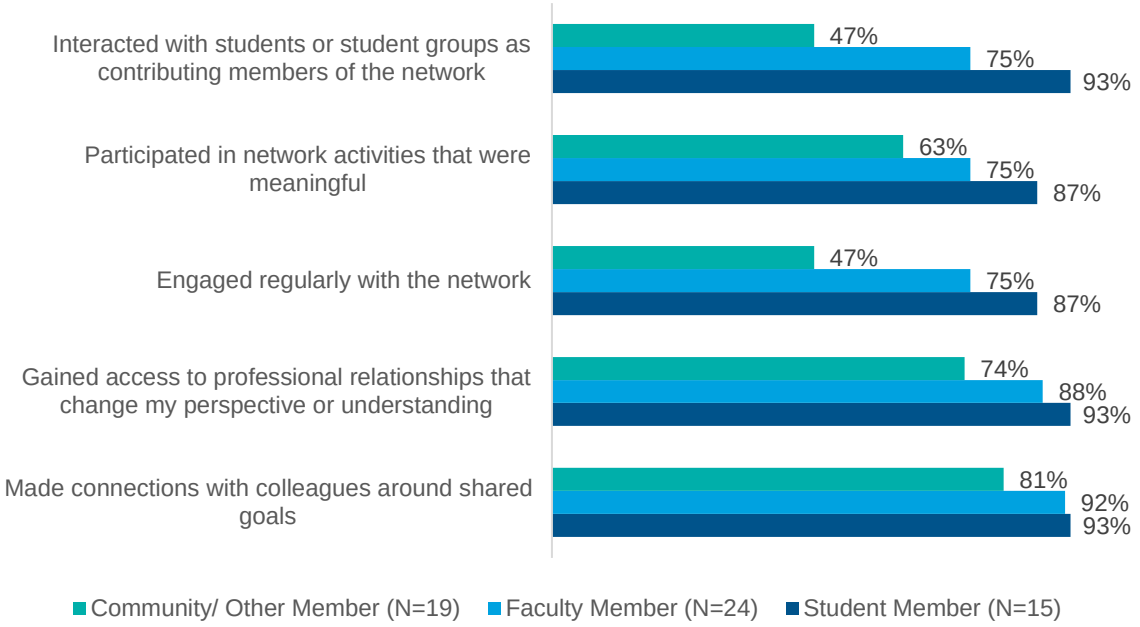
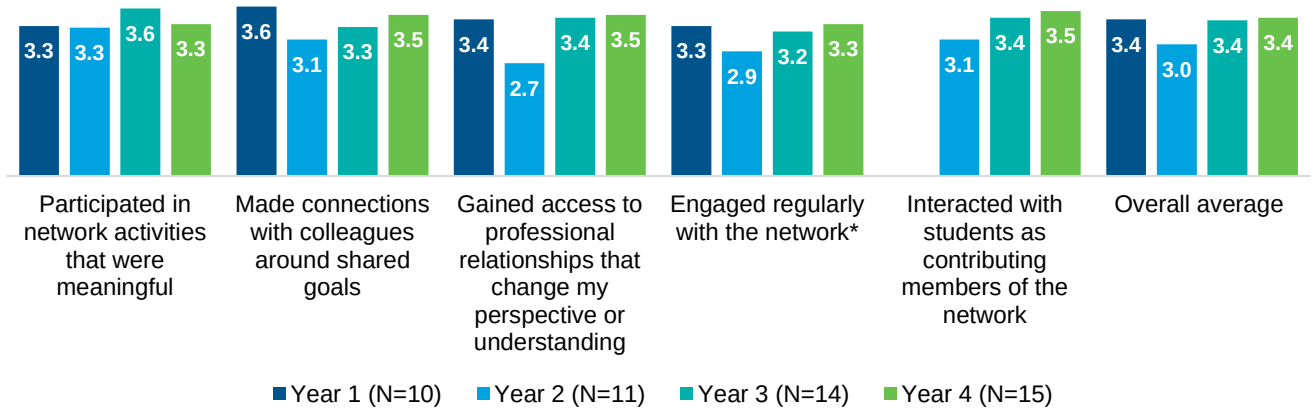


Figure 28: Immediate Value: Year 4 Agreement Percentages by Member Type



As shown in Figure 29 below, student respondents showed kept a similar overall agreement rating from Year 3 to Year 4. Across the previous year, student members reported the greatest gains in immediate value from *Made connections with colleagues around shared goals* (difference = +0.20 points) followed by *Interacted with students as contributing members of the network* (difference=+.10). This may be attributed to First2's Student Leadership working group efforts, summer internships, and faculty mentorship—a consistent level of student participation within and across institutions, as discussed in the Social Network Analysis section of this report. The lowest mean rating—indicating that the item was not as highly rated as the previous year—was for *Participated in network activities that were meaningful* (difference = -0.30).

Figure 29: Immediate Value: Mean Ratings for Student Members by Year



The survey subsection included an open-ended item asking respondents to describe a meaningful activity or connection you experienced (e.g., a conversation, a working session, a project) through the network. Of the 30 respondents to this question, most believed they had participated in activities or events and accessed resources and opportunities that supported a common goal of student success amongst first-generation students. Some students noted the connection to the campus club. One student shared, "My campus club had a lot of meaningful group activities that contributed to the retaining of most of our members." Others identified conference sessions, online summits, or research projects as where they connected with professionals, important benefits to the First2 Network membership. "Attending the spring conference in person provided an excellent opportunity to connect with industry partners and institutional team members from around the state," noted one. For several members, they "made many connections during the in-person conference" and shared how it was among the most useful opportunities to gain new perspectives about their work. One respondent noted, "I have had many meaningful experiences within this network. I think the most impactful were related to the DEI programs."

3.4.2 Potential Value: Gaining New Knowledge (Output)

Using the 4-point response scale, respondents most agreed that they found value from gaining new knowledge as a participant in the First2 Network community. However, the mean average for all members decreased from the previous year by 0.30 points (Mean=3.0). On average, there was some variation in the Potential value of the network by member type. Figure 30 shows faculty valued the new knowledge acquired via network participation more highly than did students or community and other members (Mean = 3.22, Mean = 3.10, and Mean=2.69).

Regarding individual subscale items, all members were most likely to agree with the statement, *Gained insight about a person or group I can turn to for information or support* (Mean = 3.20, Mean = 3.29, and Mean = 2.74). Students and faculty agreed on the Potential value of their experience in the network, while community and other members had less agreement across all items, as evidenced by mean ratings. Specifically, less than half of community and other member respondents (47% of 19) agreed they had *Gained access to new tools, information, or processes I would not otherwise have access to*, compared to 73% of student respondents and 79% of faculty respondents. This difference may be attributed to community or other members having less involvement in working groups, where others have gained PDSA knowledge and resources to conduct improved science activities.

Figure 30: Potential Value: Year 4 Mean Ratings by Member Type

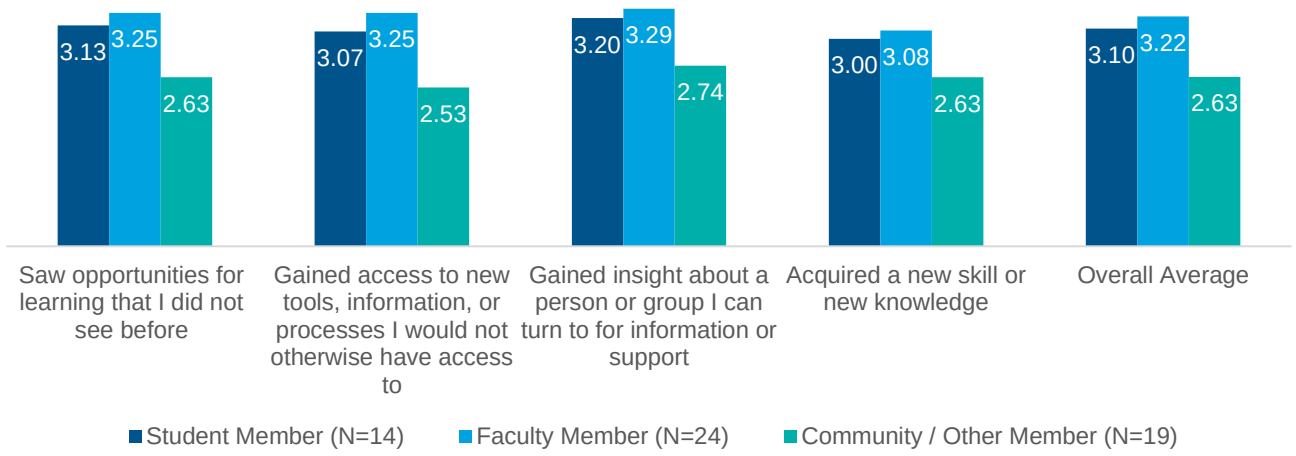
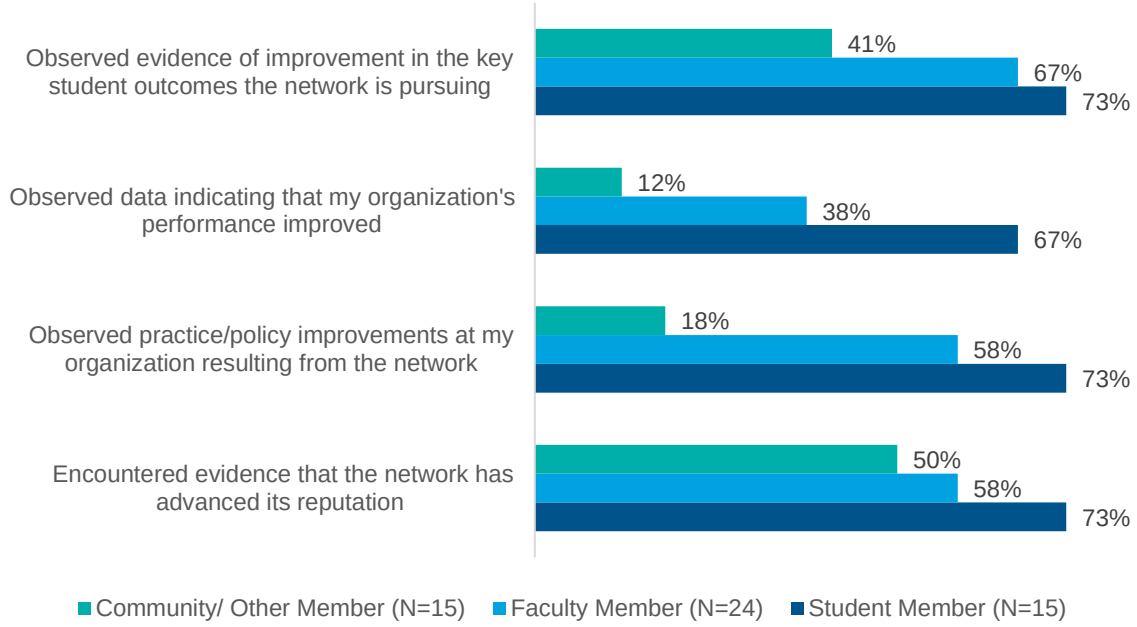
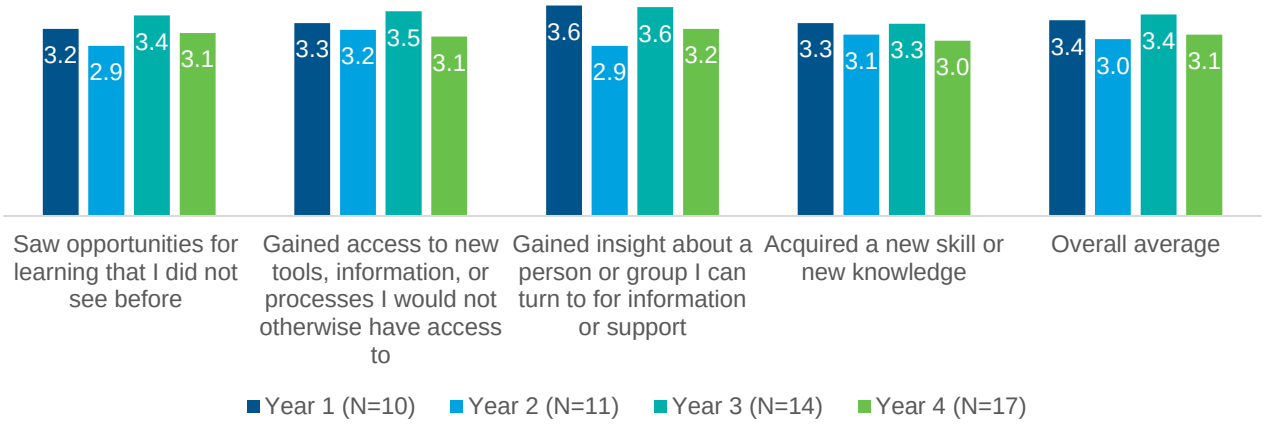


Figure 31: Potential Value: Year 4 Agreement Percentages by Member Type



Among student respondents, overall mean ratings decreased by 0.3 points from Year 3 (Mean = 3.4) to Year 4 (Mean = 3.1) as shown in Figure 32. All 4 years show students reported less agreement about gains in all Gaining New Knowledge subscale items from Year 3 to Year 4. The highest rated item is *Gained insight about a person or group I can turn to for information or support* (Mean = 3.2), and the lowest rated item is *Acquired a new skill or new knowledge* (Mean = 3.0).

Figure 32: Potential Value: Student Member Mean Ratings by Year



When asked to **describe a specific network-developed resource** and why they thought it might be useful, many members elaborated on their work with PDSA development and shared understanding of the network goal. One person stated, "Our renewed focus on data, including guidance and encouragement from SRI to collect more institutional data, is starting to open up my understanding of what is possible to collect and what we might be able to learn from it." Other members also expressed their appreciation about the PDSA cycle activities. One member shared, "The resources regarding PDSA work have been helpful." One member shared a positive sentiment that they "learned about PDSA research on change." Some noted the challenges associated with PDSA data collection and tracking.

> *The PDSA templates and planning documents for institutional teams that were presented at the conference could be useful if they are implemented and the network supports the efforts of these teams.*
>
> *Whenever we think of new ideas/etc., there are roadblocks when talking about initiating or trying these new ideas. There are too many hoops to jump through to start these small ideas (PDSA, PDSA class/workshop, creating things to track/record). They try to create quantitative data for a qualitative project. It's a bit frustrating so I no longer try.*

Several other members shared how they value the sharing of resources and knowledge. One member reported a desire to learn even more. "I am interested in resources such as literature, funding opportunities to seek professional development and implementing changes in my/our classrooms regarding underrepresented students," they noted.

Other respondents expressed an appreciation of the network for providing opportunities to learn from one another and gain new perspectives on student learning and experiences, specifically amongst first-generation populations. "By talking with a first-gen student in my lab, I got a perspective of their daily lives and their interactions with family members" one said.

3.4.3 Applied Value: Applied Learning and Practices (Application)

All members valued the applied learning and practices afforded them by the network (Mean = 2.95), but students had a slightly less overall average than faculty members (Mean=3.09 and Mean=3.20) on the 4-point agreement scale. Figure 33 details the individual items and their mean ratings by member type. Overall, students and faculty members have similarly high ratings (above 3.0) for three of the five items, including *Used a document produced or made accessible by the network* and *Leveraged a network connection to accomplish a task*.

Community and other members had less reported Applied value as members of the network, with an overall mean rating of 2.53. This variance may be attributable to the steady active participation of faculty and student leading working groups, as compared to community and other members who may not have been as involved in the network work in Year 4.

The highest-rated item for student members was *Applied skills or practices learned through the Network to accomplish a goal or connect to student groups* with a mean rating of 3.27. The highest-rated item for faculty member type was *Used knowledge or skills obtained through the network to contribute to understanding of problems or issues* with a mean rating of 3.29. The highest-rated item for community and other member types was *Leveraged a network connection to accomplish a task,* with a mean rating of 2.74. The lowest-rated item across all three member types was *Made changes in my organization based on network work.* Two of the five Applied value items had ratings of at least 50% agreement for all member types (combined ratings of Agree and Strongly Agree). See Figures 33 and 34 below for more detail.

Figure 33: Applied Value: Year 4 Mean Ratings by Member Type

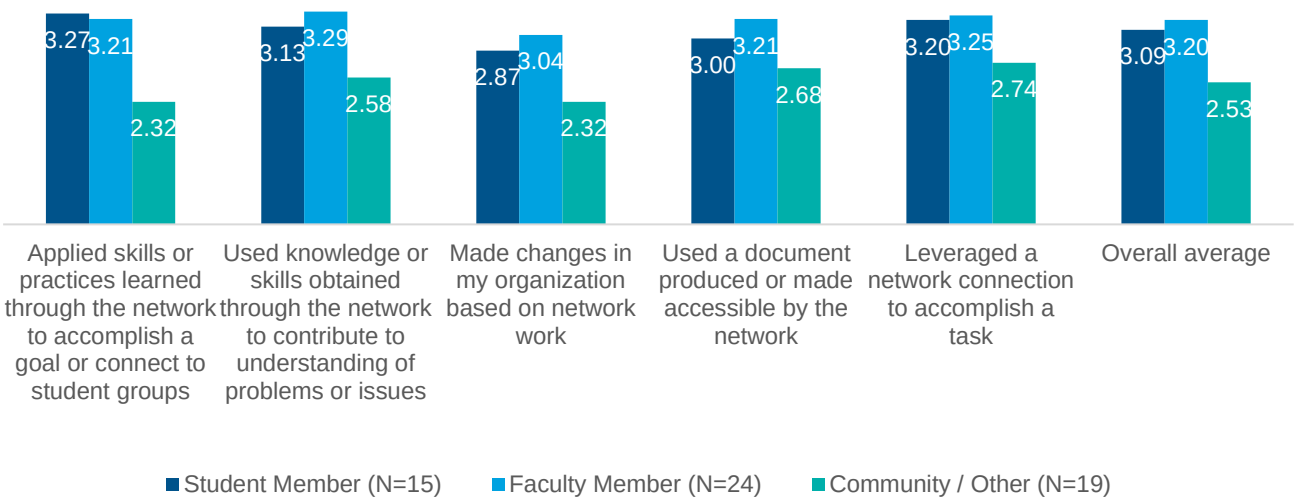


Figure 34: Applied Value: Year 4 Student Member Agreement Response Percentages

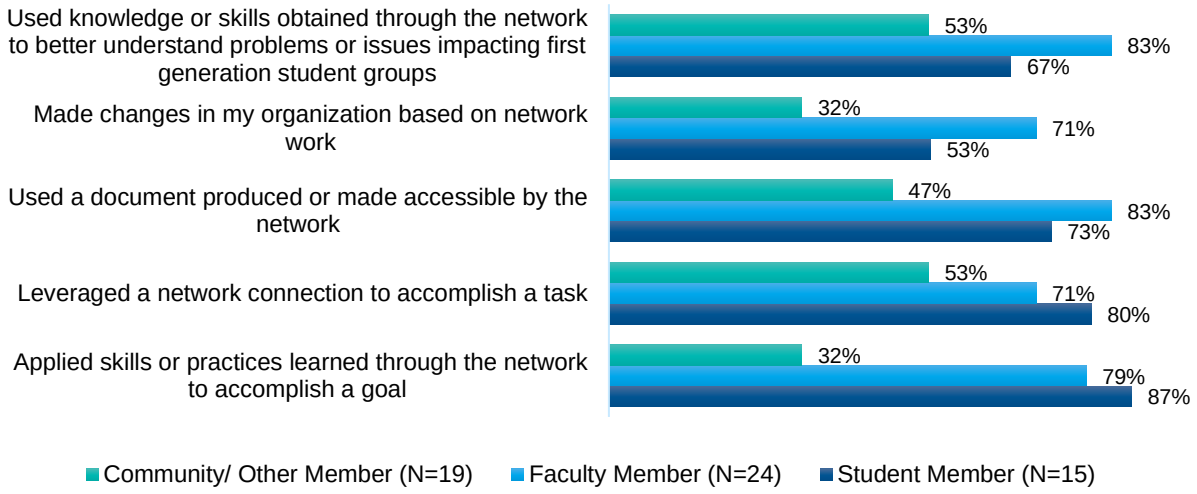
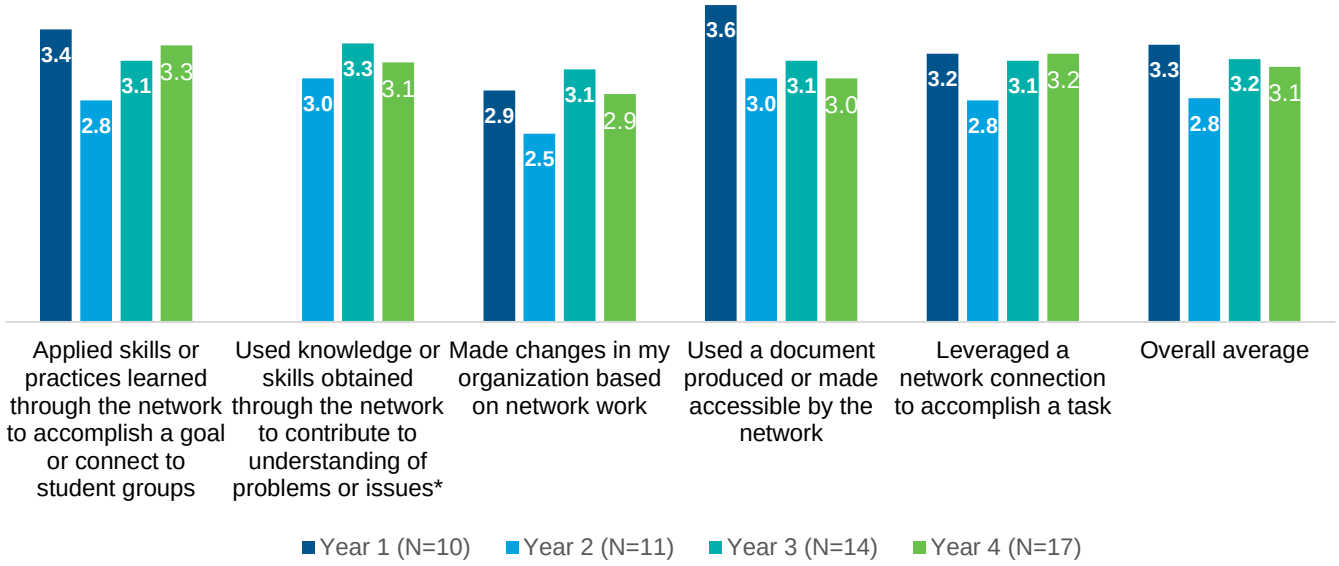


Figure 35 shows student respondents felt consistently stronger about the value of the application of tools and resources from the network to their lives. Student respondents mean ratings increased in two categories, *Applied skills or practices learned through the network to accomplish a goal or connect to student groups* and *Leveraged a network connection to accomplish a task* from Year 3 to Year 4 (0.2 and 0.1, respectively). Students in Year 4 were least likely to agree they *Made changes in my organization based on network work*.

Figure 35: Applied Value: Student Member Mean Ratings by Year



Approximately one-fifth of total respondents (12 out of the 58), provided comments when asked an open-ended question about how they applied something they learned through the network to their practice and what it enabled that might not have happened otherwise. Several respondents shared that they had really interacted with students as partners, and one of those noted learning more about "student empowerment in organizations." And while students were

the central theme, most respondents reported applying principles to their personal life and professional lives.

> *I apply principles to my own personal life. I tend to find that the knowledge I socially acquire through the network allows me to enhance the quality of interactions (inadvertently leading to an increase in quality of life) with those around me.*

Others discussed how their involvement in the network encouraged them to incorporate student voices. "Student voices affected how I work with first-generation students," one noted, and another reported how they "increasingly sought student input in decision-making." Other respondents cited examples of increased "ideas to address student retention" and consideration of applying various means of engagement of student partners in network activities. "Thinking more in everyday applications how to better serve first-gen students, it is now part of my job," one said.

3.4.4 Realized Value: Performance Improvement (Outcome)

Student and faculty members rated the value of performance improvement similarly (2.9 and 2.8, respectively). Figure 36 shows student and faculty members rated these areas of observation much higher than community/other members, as this group ranked 0.6 points higher than community/other members (Mean = 2.9 and 2.8 compared to Mean = 2.3).

For faculty members, mean ratings fell below 2.8 for only one item, *Observed data indicating that my organization's performance improved*, indicating there were some faculty members who disagreed with the statement (Figure 36). The highest-rated item for faculty members and community and other members concerned encountering evidence that the network has advanced its reputation, with mean ratings of 3.0 and 2.6, respectively. Regarding individual subscale items, the highest-rated item for student members was *Observed practice/policy improvements at their organization resulting from the network*. Over half of all members, including community and other member respondents, agreed they had encountered evidence that the network has advanced its reputation (combined ratings of Agree and Strongly Agree). Nearly two-thirds of student members agree that they see the value of the network through *Observed data indicating that my organization's performance has improved*, as compared to only 13% of community and other members and 38% of faculty members. See Figures 36 and 37 below for more detail.

Figure 36: Realized Value: Year 4 Mean Ratings by Member Type

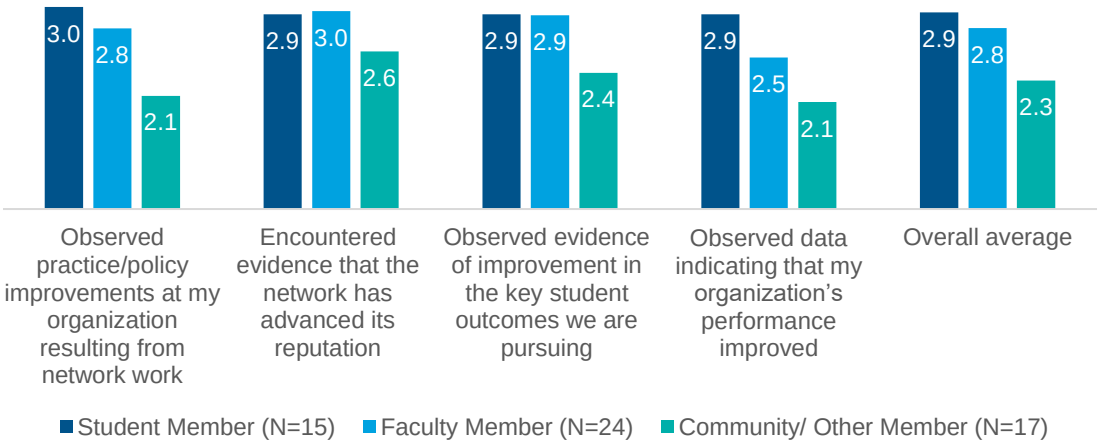
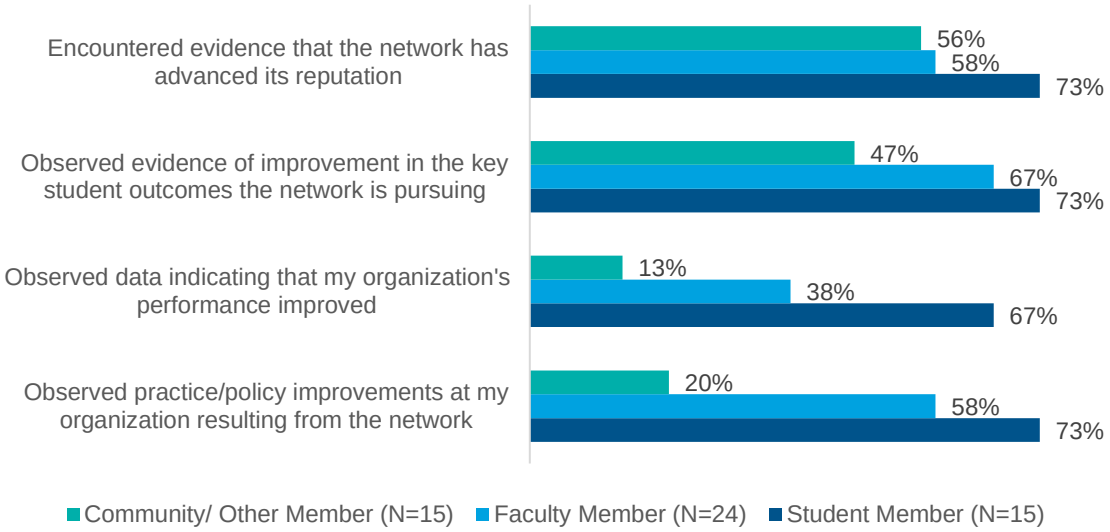
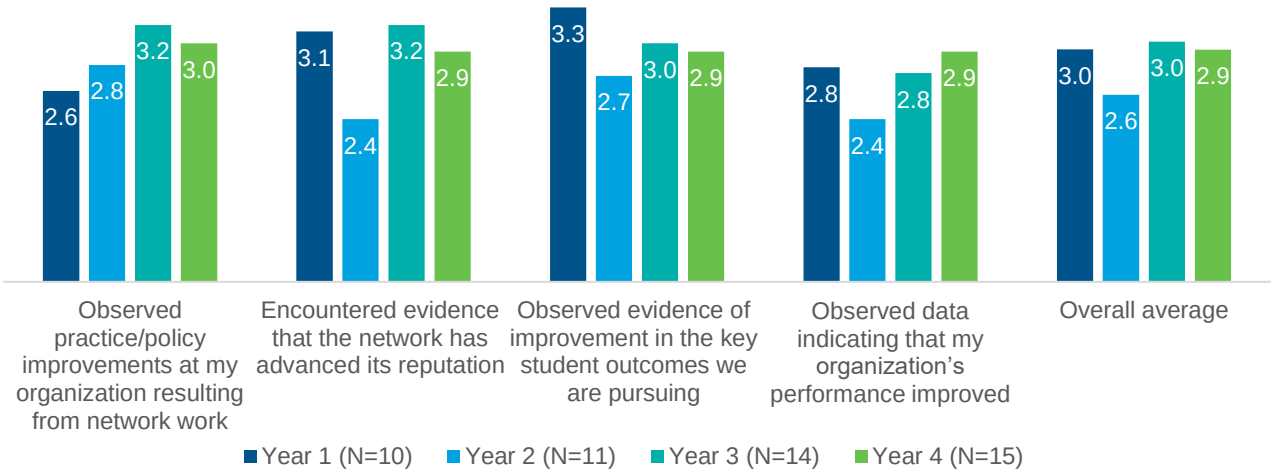


Figure 37: Realized Value: Year 4 Agreement Percentages by Member Type



Student respondents felt consistently stronger about the effects of the network's performance improvement aspects on their lives. Overall mean ratings increased by 0.1 points from Year 3 to Year 4 on one item, *Observed data indicating that my organization's performance improved*. Students were the most likely to agree on all four subscales associated with Realized value (Figure 38). This means most students agreed they observed outcomes related to their direct involvement in First2, the highest-rated item, *Observed practice/policy improvements at my organization resulting from network work*.

Figure 38: Realized Value: Student Member Mean Ratings by Year



When asked to **expand upon how participation in the network affected your success** (personally, professionally, or organizationally) some respondents shared struggles while others talked about successes. Specifically, one respondent expressed their ability to foster relationships to support first-generation students, saying, "Our college set up its own first-generation student program and we contacted several alumni who have offered internships for first-generation students."

In addition to exposure, several respondents expressed positive sentiments about an increased sense of belonging and support amongst their cohort and/or colleagues. As one faculty member noted, they stayed "connected with others professionally." In terms of student value, respondents were appreciative and reported network benefits of connection with faculty, staff, and employers. A few shared how participation increased their "network in school," and in their personal lives helped them "get into research early on" and "continue[d] to help [them] progress in [their] academic degree," as one respondent shared.

While most comments shared highlighted the connections within the network, a few comments noted the struggles. One respondent said, "It's been difficult to get my college involved in F2N, so most of the gains have been personal." Two respondents shared a great deal about their struggle with understanding the value of time and money to the overall vision:

> *I am part of this network for the students. The students asked me to stay involved and not leave. Network participation creates more work with no benefits to you or the students … Our organization is not going to make changes once the funding is depleted, we simply cannot afford it. Forcing meetings and increasing workload for staff/faculty also doesn't help, it creates resentment and frustration. We have created unnecessary time burdens, which is why many students leave and some institutions have decreased their involvement.*
>
> *The network seems to lack a cohesive vision and consistent strategies. I have not heard how well the network is advancing STEM persistence in this state, which is the main goal of the network. I appreciate the connections with other passionate people that participating in the network provides; however, I would like to see how the students that*

have participated in First2 initiatives have fared in their STEM majors. In order to convince industry and other partners to invest in the network, there needs to be documented evidence that the current practices are working well.

Overall, many respondents indicated better personal and professional attributes, gained through lessons learned or connections made because of their network participation. One respondent noted, "Personally: allowed me to be a better person overall. I am more considerate, reasonable, and empathetic. Professionally/Organizationally: allowed me to foster a productive, healthy work environment for myself, my colleagues, and my superiors."

3.4.5 Reframing Value: Influence and Redefining Success (Impact)

Faculty rated the Reframing value component slightly higher than student members, meaning most faculty agreed about the influence of redefining success brought on by their participation as First2 Network members. With all items, community and other members had lower ratings; the least-highly rated item for them, *Used what I learned from network work to develop a new strategic direction at my institution*. Half of student members agreed they *Engaged previously-uninvolved stakeholders in network efforts,* as compared to 73% of faculty. The highest-rated item for all three member groups: *Demonstrated an understanding of complexity of elements important to rural students' pursuit of STEM careers*.

Figure 39: Reframing Value: Year 4 Mean Ratings by Member Type

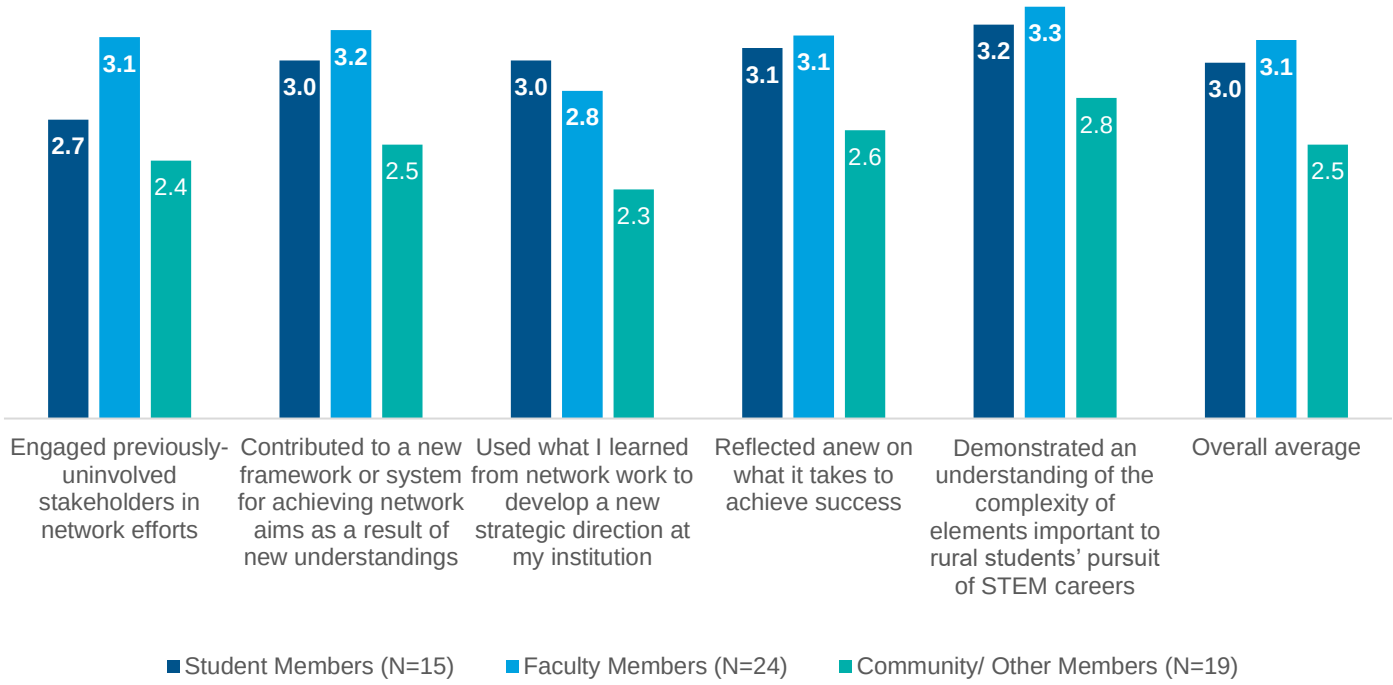
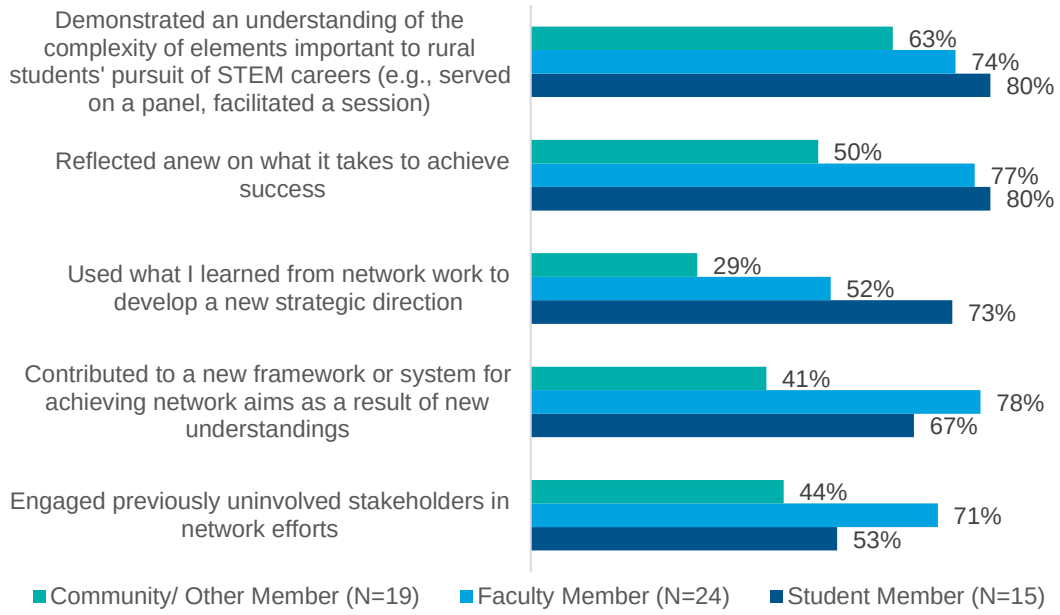
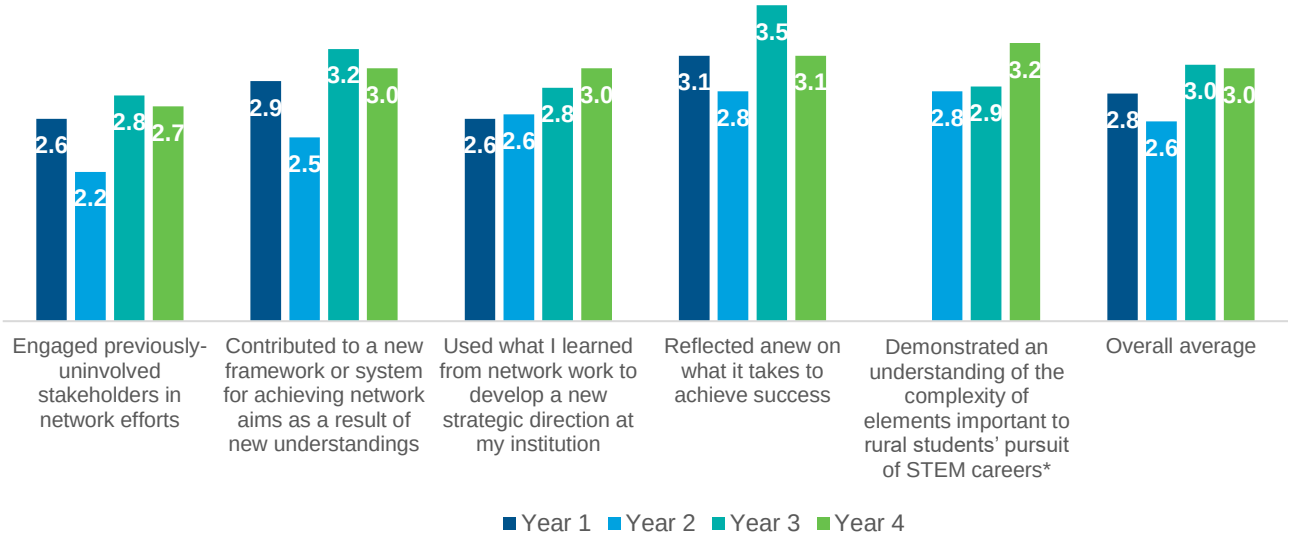


Figure 40: Reframing Value: Response Percentage Ratings by Member Type



Overall, student member ratings were similar in Year 4 to Year 3. Year 4 students valued the impact First2 Network is having on their personal and professional lives and on campus. The highest-rated item, *Demonstrated an understanding of the complexity of elements important to rural students' pursuit of STEM careers,* with a mean rating of 3.2, was followed by *Reflected anew on what it takes to achieve success* (3.1). Two items showed a pattern of increase from Year 1 to Year 4, these items were: *Used what I learned from network work to develop a new strategic direction at my institution* (3.0) and *Demonstrated an understanding of the complexity of elements important to rural students' pursuit of STEM careers* (3.2); the lowest-rated item at 2.7 was *Engaged previously-uninvolved stakeholders in network efforts*.

Figure 41: Reframing Value: Student Member Mean Ratings by Year



Twelve respondents commented on the open-ended question regarding any changes in their perspective, direction, strategy, or understanding of what success is as a result of First2 collaborative efforts. Most respondents did not mention a change in their beliefs about success, but rather a reflection in understanding what it takes to achieve success or consider other perspectives of success as a network member, with two responding:

> *[To achieve success] I had to step back and rethink how I could creatively involve myself in the network.*
>
> *Success is success. My time in the network has taught me that although it takes hard work and determination to achieve success, it also takes planning and open-mindedness.*

Other members expressed feelings of dissatisfaction that the network has not met its expectations of success related to its initial goals of student success through retention. Specifically, two comments below express how the network did not commit resources in a way that consistently empowers first generation students.

> *My participation in this collaborative network has not necessarily made me feel more optimistic about how "the system" views success. Specifically, I worry that the network perpetuates a "rescuer" mentality, particularly for rural, first-generation students. Students should feel empowered and optimistic as a result of their participation in First2 activities. From what I have witnessed anecdotally, that does not seem to be occurring.*
>
> *I am a rural, first-generation, underrepresented person in STEM—but activities I know increase student interest in research and retention are not allowed to be implemented because it "does not help the network." No, it helps the students, which was the original purpose of this grant.*

Another member expressed the challenge of understanding the direction of leadership, explaining how it is confusing for membership. "I find this group extremely disorganized and difficult to accomplish anything as there are constant miscommunications and a lack of leadership. Too many changed directions," one member wrote.

3.4.6 Network Value Survey Summary

Overall, average ratings of all five components on the Network Value Survey declined somewhat between Years 3 and 4, but gains were realized for some students and faculty. Students indicated appreciation for the connections, colleagues, and collaboration provided them through the work in the network. Some students also alluded to an increased sense of STEM identity, with a better sense of understanding and confidence related to their STEM experience and career. These students cite high levels of involvement in First2 student clubs, internships, and working group PDSA activities. Faculty members indicated a positive impact in understanding PDSA and its tools and resources provided through the network to support better teaching and course structure. Additionally, members expressed an increased understanding of student needs and voices, specifically students from rural, first-generation backgrounds. While members in 2019, the baseline year, valued benefits of Networking and Community Building—indicated by high ratings—the evaluation team has documented student gains related to item level participant ratings, in the Immediate, Applied, Realized, and Reframed value afforded through network involvement.

4. Impact of the First2 Network

4.1 Social Network Analysis

Social network analysis (SNA) permits the analysis of network size and the number and strength of connections among network members. Sixty-five network members completed the annual social network survey in December 2021 (compared to 44, 32, and 25 respondents, respectively, in the previous 3 years) based on their network activity over the past year. The composition of network members' organizations is provided below in Table 10.

Table 10. SNA Survey Respondent Organizational Affiliation

	Organization Name	Number of Respondents	Percent of Respondents
Lead First2 Network organizations	West Virginia University	24	37%
	Fairmont State University	10	15%
	Green Bank Observatory	3	5%
	Higher Education Policy Commission	2	3%
	High Rocks	0	0%
Other organizations	Marshall University	5	8%
	University of Charleston	5	8%
	WVU Institute of Technology	5	8%
	West Virginia State University	4	6%
	SRI	2	3%
	Davis & Elkins College	1	2%
	Pocahontas County Schools	1	2%
	Randolph County Schools	1	2%
	Glenville State College	1	2%
	West Virginia Department of Education	1	2%
Total		**65**	**100%**

Note: Percentages may not equal 100% due to rounding.

Of the 65 respondents, 79% were female, 43% had completed some college (and 26% had achieved a doctoral degree), and 59% were between 18–24 years of age (followed by 22% between 55–64). About a fourth (28%) were at their organization 3–5 years; another 23% had served at their organization for 6 months or less and 22% for 1–2 years. In addition, more than half (55%) were undergraduate students and 20% had a primary role of faculty member/lecturer/teacher.

Respondents identified up to 10 members of the First2 Network with whom they communicated on issues relevant to their tasks in the network. For each individual identified, respondents assigned a code describing the level of engagement with each individual (1 for *less strong relationships* up to 5 for *strong collaborative ties*). The five levels[61] include:

1. **Networking:** Aware of organization, loosely defined roles, little communication, independent decision-making
2. **Cooperation:** Shared information, formal communication, somewhat defined roles, independent decision-making
3. **Coordination:** Shared information frequently, defined roles, some shared decision-making
4. **Coalition:** Frequent communication, shared resources, shared decision-making
5. **Collaboration:** Frequent communication, shared resources, mutual trust, coordination on most or all decision-making

The number of individuals identified, along with the average collaborative scores, are shown in Table 11 and Figure 42. Sixty-three respondents identified at least one individual with whom they collaborated; one responded with "emails from listserv" but did not identify any names and one responded with "N/A New Member." Seventeen respondents collaborated with 10 individuals, and eight collaborated with one individual; all other respondents collaborated with between two and nine individuals.

As anticipated, the collaboration score is higher for the first individual identified by the network respondents, and collaboration scores generally decrease throughout the remaining individuals identified, although there are some slight fluctuations. The overall score is 3.75, which falls closest to the Coalition level. This year's results indicate a slightly higher level of engagement, moving from the overall score of 3.56 for Year 3, 3.34 for Year 2, and 3.11 for Year 1, which were closer to the Coordination level.

Table 11. Network Members Identified as Collaborators in the First2 Network

Individuals Identified	Number Identified	Average Collaboration Score
1 member	63	4.19, Coalition
2 members	55	3.80, Coalition
3 members	48	3.60, Coalition
4 members	40	3.66, Coalition
5 members	36	3.68, Coalition
6 members	31	4.07, Coalition
7 members	25	3.70, Coalition
8 members	24	3.86, Coalition
9 members	20	3.47, Coordination
10 members	17	3.47, Coordination
Overall score		3.75, Coalition

Figure 42. Levels of Collaboration by Individuals Identified

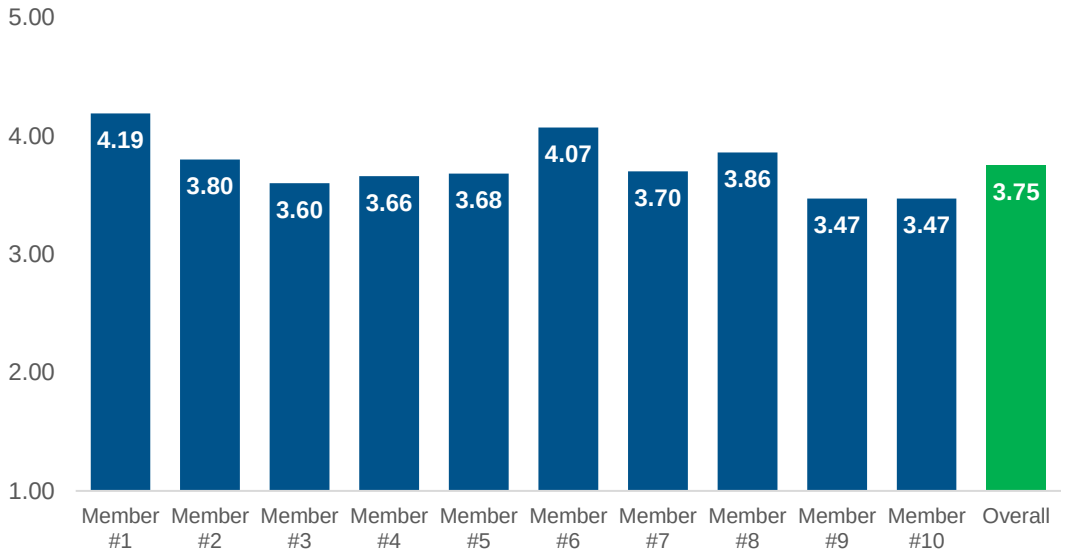
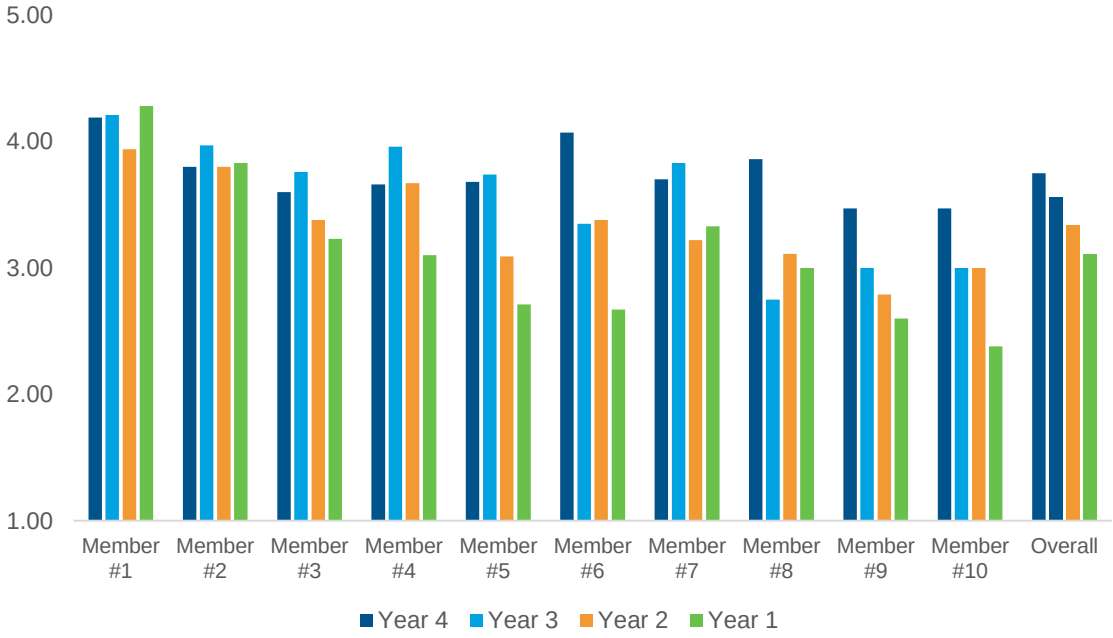


Figure 43 depicts the overall strengthening of the engagements from Year 1 to Year 4, in general, for the members identified as collaborators.

Figure 43. Levels of Collaboration by Individuals Identified by Year



The survey asked respondents to select one person out of those individuals identified whom they considered to be of exceptional importance (in terms of resources, information, or guidance provided) to their role in the First2 Network. As anticipated, the first few individuals identified were most frequently identified as the key contact (especially the first person identified, at 71%). Respondents were also asked to identify whether the individuals they identified were prior acquaintances, with whom they were in contact prior to their network

involvement. Again, as might be expected, the first few individuals identified were most often prior acquaintances. For example, for the first member identified, 38% were prior acquaintances; for the second member identified, 29% were prior acquaintances.

Based on the 65 respondents, the graphs shown in Figure 44 depict the connections among those individuals identified as collaborators within the network for Year 4 as well as for the previous 3 years. Each circle (or node) depicts an individual, and the size of the node corresponds to the number of times a person was mentioned (the larger the circle, the more often the person was identified as a collaborator). The line width (edges) corresponds to the strength or level of collaboration (the thicker the line, the higher the level of collaboration). The organizations of individuals most frequently identified are denoted with different colors.

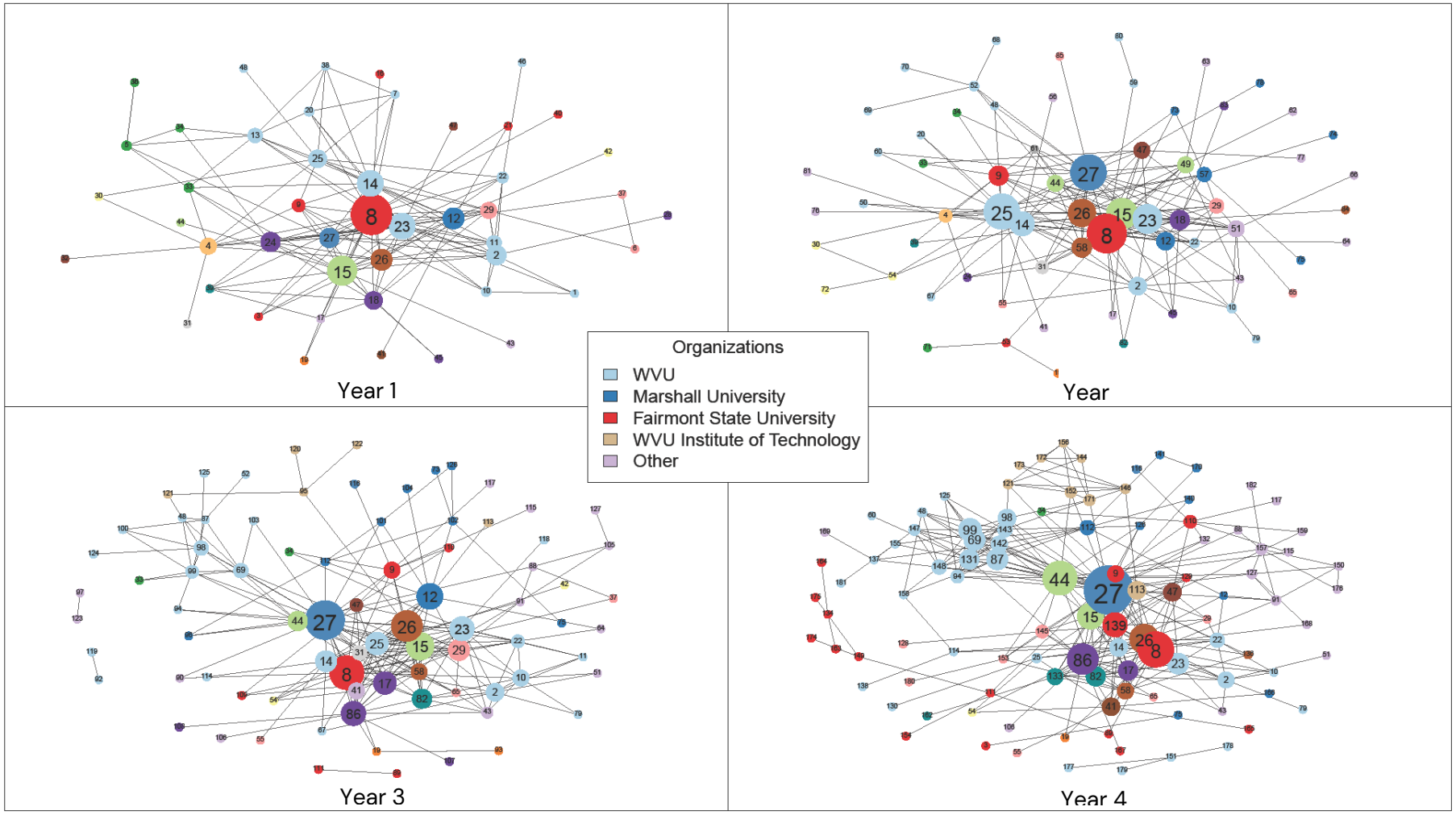
These four graphs show the growth of the network over time, illustrating not only an increase in identified collaborators, but also in the number of connections these collaborators have, as well as the strength of those connections. Across all four graphs, those individuals most central (most connected, strongest connections) are from FSU, Marshall University, and WVU.

The number of nodes (individuals) increased annually from Year 1 to Year 4 (from 48 in Year 1 to 182 in Year 4), as did the number of edges (connections) (from 146 in Year 1 to 304 in Year 4). The graph density decreased from 0.13 in Year 1 to 0.06 in Year 4, indicating that approximately 6% of all possible ties or connections are present in the Year 4 results. The social conductivity score (measuring conductivity from direct paths) increased slightly from 2.78 in Year 1 to 3.03 in Year 4, indicating the average strength of the connections between individuals remained fairly constant (around coordination) even though the network has more than doubled in size. The robustness score (measuring conductivity from indirect paths) also increased slightly from 2.55 in Year 1 to 2.89 in Year 4, indicating that even with the increased number of individuals, the removal of direct ties between individuals should not disrupt the flow of knowledge throughout the network.

4.1.1 SNA Summary

In sum, the trend across years continues as the First2 Network has become more collaborative this year with an increase in the number of ties between members and higher levels of collaborative engagement among members. Despite overall growth in the size of the network, relationships among members remained durable.

Figure 44. SNA Map of Connections in the First2 Network by Year



4.2 Intern Survey

The intern survey is administered to student participants in the network's immersive research experiences before and after their participation to assess changes in their STEM efficacy, identity, and education and career plans; sense of school belonging; and knowledge of, attitudes about, and skills to conduct research. Eight sites offered 2-week research internship experiences in summer 2022, as listed below.[iii]

- Blue Ridge Community and Technical Center (July 18–29): Students worked on an applied research project with ROCKWOOL regarding process efficiency.
- Fairmont State University (July 10–23): Students conducted research in one of three areas: atomic absorption spectroscopy, stream health, or accuracy and precision of 3D scanners when digitizing human skeletal remains.
- Green Bank Observatory (August 1–14): Students worked on a cutting-edge receiver for the Green Bank Telescope by characterizing radio frequency interference for future machine learning algorithms.
- HSTA Happen for Rising College Freshmen (HCOP) at WVU (July 5–22): Students took either Chem 110 or College Algebra 124 in small classes with a mentor; they also learned study skills, time management, and how to navigate a college system and access resources.
- Marshall University (July 17–29): Students conducted research in one of three areas: nanotechnology applications of DNA, neuroscience, or physics and water purification.
- University of Charleston (August 17–26): Students researched the effects of long-term acid mine drainage input in riparian areas on biological indicators.
- West Virginia University (July 17–29): Students conducted research in one of four areas: determining the modulation transfer function of smartphone cameras, fish in a dish, mapping Appalachia, or measuring the speed of light.
- West Virginia University Institute of Technology (July 24–August 5): Students conducted research in one of two areas: cybersecurity or investigating the effects of tilt angle and shading on solar panels.

Students who were 18 years or older were invited to complete an online survey at the beginning and end of the internship. Thirty-seven students completed a pretest survey and 36 completed a posttest survey (34 of the same students who completed a pretest, plus two students who had not completed a pretest survey). Results were aggregated across all eight sites.[iv]

More than half of the respondents identified as female (57%); the remainder selected male (30%), nonbinary (8%), gender queer (3%), or preferred to self-describe (3%). Seventy-two percent described themselves as white, 21% as Black or African American, 8% as Hispanic/Latinx, and 3% as Asian/Asian American.

About half (51%) qualified for a federal Pell Grant, 24% did not qualify, and 24% did not know if they qualified. Fifty-seven percent considered themselves as first-generation college students;

[iii] At the time this report was prepared, the University of Charleston site had not yet completed the summer internship and thus survey data for that site are not included in this summary analysis. Further, Green Bank Observatory did not have any First2 Network students participating in their summer internship.

[iv] The demographic descriptive summary is based on the 37 students who completed a pretest survey and thus is missing responses from the two students who completed only a posttest survey.

18% reported their parents/guardians attended some college, 13% reported their siblings attended or completed college, 8% reported at least one of their grandparents attended or completed college, 15% reported at least one of their aunts/uncles/cousins attended or completed college, and 18% reported no one in their immediate/extended family attended or completed college. Nearly half (49%) described the place where they grew up as rural (24% selected town, 19% suburb, and 8% city) and 74% graduated from high schools within the state.

Students identified a variety of majors or intended majors, as shown in Table 12. Twenty-seven percent selected engineering, followed by biology at 19%.

Table 12. 2022 Intern College Majors

Major	Number	Percent
Biochemistry	1	3%
Biology	7	19%
Chemistry	1	3%
Computer/Information Science	7	19%
Education	1	3%
Education and Biology	1	3%
Engineering	10	27%
Environmental Geoscience	1	3%
Exercise Physiology	1	3%
Forensics	4	11%
Nursing	1	3%
Physics	1	3%
Software Development Engineering	1	3%

Note: Percentages may not equal 100% due to rounding.

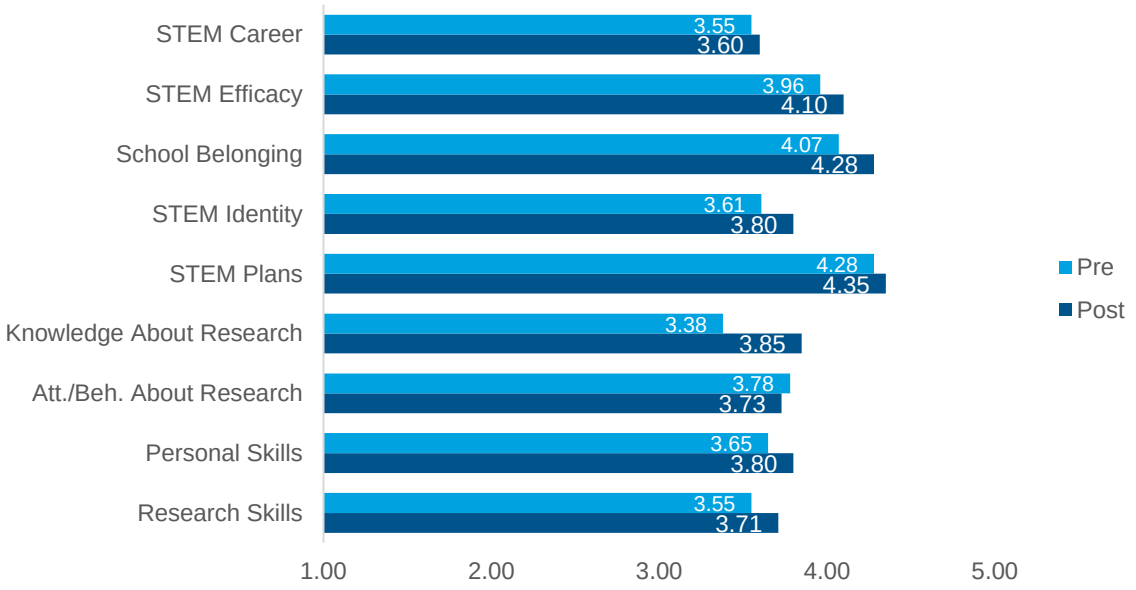
Table 13 shows results for the five subscales of STEM Career, STEM Efficacy, School Belonging, STEM Identity, and STEM Plans (on a 5-point scale of *Strongly Disagree* to *Strongly Agree*), as well as the four subscales of Knowledge About Research, Attitudes and Behaviors About Research, Personal Skills, and Research Skills (on a 5-point scale of *None* to *A Great Deal*).[v] At pretest, the highest-rated subscale was for STEM Plans at 4.28 (SD 0.85); the lowest-rated subscale was Knowledge About Research at 3.38 (SD 0.68). At posttest, STEM Plans was again the highest-rated subscale at 4.35 (SD 0.89) and STEM Career was lowest at 3.60 (SD 0.75). The Knowledge About Research subscale showed the greatest amount of change from pre to post (0.47) and Attitudes and Behaviors About Research showed a slight decline from pre to post (-0.05). Figure 45 depicts the pre/post mean scores for all nine subscales.

[v] The survey contained 27 items grouped into STEM Career, STEM Efficacy, School Belonging, STEM Identity, and STEM Plans; and 37 items grouped into Knowledge About Research, Attitudes and Behaviors About Research, Personal Gains Related to Research, and Skill Gains Related to Research. Cronbach's alpha reliability estimates were computed for each subscale and for the overall set of rated items. At pretest, subscale correlation coefficient values ranged from 0.73 (for STEM Career) to 0.96 (STEM Identity), with an overall value of 0.94. At posttest, subscale values ranged from 0.82 (STEM Career) to 0.97 (STEM Identity), with an overall value of 0.98.

Table 13. 2020 Intern Pre/Post Survey Results

Subscales	Pretest Results			Posttest Results			Mean Difference (post – pre)
	Number	Mean	Std. Dev.	Number	Mean	Std. Dev.	
STEM Career	37	3.55	0.63	36	3.60	0.75	0.05
STEM Efficacy	37	3.96	0.49	36	4.10	0.40	0.14
School Belonging	37	4.07	0.54	36	4.28	0.58	0.21
STEM Identity	37	3.61	1.15	36	3.80	1.12	0.19
STEM Plans	37	4.28	0.85	36	4.35	0.89	0.07
Knowledge About Research	37	3.38	0.68	36	3.85	0.82	0.47
Attitudes/ Beh. About Research	37	3.78	0.91	36	3.73	1.04	-0.05
Personal Skills	37	3.65	0.88	36	3.80	0.88	0.15
Research Skills	37	3.55	0.89	36	3.71	0.78	0.16

Figure 45. Pre/Post Mean Subscales Scores for 2022 Internship Survey



To investigate whether any of the pre/post changes were statistically significant, a matched pairs *t* test was conducted for each of the nine subscales. A total of 34 matched pairs (linking each individual's pre/post scores) was identified for the subscales. This analysis revealed statistically significant results for three subscales, as shown in Table 14, in which students' posttest scores were significantly higher than their pretest scores for School Belonging, Knowledge About Research, and Personal Skills (STEM Identity and Research Skills were approaching statistical significance).

Table 14. 2022 Intern Pre/Post Matched Pairs Survey Results

Subscales	N	Post Mean	Pre Mean	Mean Diff. (post – pre)	*t*	df	Sig.
STEM Career	34	3.62	3.54	0.08	-0.59	33	0.56
STEM Efficacy	34	4.11	3.99	0.12	-1.50	33	0.14
School Belonging	34	4.29	4.09	0.20	-2.26	33	0.03**
STEM Identity	34	3.82	3.64	0.18	-1.99	33	0.06
STEM Plans	34	4.41	4.26	0.15	-1.20	33	0.24
Knowledge About Research	34	3.89	3.37	0.52	-4.28	33	0.00*
Attitudes/ Beh. About Research	34	3.76	3.73	0.03	-0.16	33	0.87
Personal Skills	34	3.86	3.61	0.25	-2.62	33	0.01**
Research Skills	34	3.72	3.51	0.21	-1.90	33	0.07

*Statistically significant at .001; **statistically significant at .01 (using only matched pairs for the analysis).

When asked what they told family or friends about the internship, students at pretest most frequently described the internship as an opportunity to help prepare them for college and career, noted they would be conducting research, or noted they would be participating in an internship. Several students seem to have misinterpreted the prompt and instead shared what their family or friends said to them. A sampling of illustrative quotes is provided below.

> *I say it's an opportunity for me to get a taste of what my future college experience will be like.*
>
> *I say that I will have the opportunity to help with lab research and learn more about scientific procedures in the process.*
>
> *I say it's an internship for the students who are going to college and are either first-generation or a minority and going into a STEM field.*
>
> *My mother said, "WOW! Make sure you do well, and be focused."*

At posttest, responses were heavily focused on the positive experiences the internships provided to students and on the opportunity to do research. A sample of illustrative quotes is provided below.

> *I tell my family and friends that I was able to learn about college research before the school year started and become better prepared for my courses as well as getting to meet peers and mentors.*
>
> *It was amazing. Everything about the experience was great and I wasn't ready for it to end.*
>
> *I will tell them that it was an amazing experience. It gave me the tools I needed to be successful.*
>
> *I learned how to properly research and made connections with others.*

That it is something I will always remember because of all the different things I have been able to do.

Students were also asked at pretest and posttest what job or career they expected to have in 10 years. As shown in Table 15, careers in the medical or engineering fields were the highest at both time points.

Table 15. 2022 Intern Job/Career Expectations in Ten Years

Career	Pretest (n=37)		Posttest (n=33)	
	Number	Percent	Number	Percent
Biology	3	8%	3	9%
Computer Science	6	16%	4	12%
Engineering	7	19%	6	18%
Forensics	4	11%	4	12%
Medical	9	24%	5	15%
Miscellaneous	3	8%	4	12%
Not Sure/Don't Know	3	8%	2	6%
Pilot	1	3%	2	6%
Science/Research	1	3%	3	9%

Note: Percentages may not equal 100% due to rounding.

The posttest survey also included a set of 16 items about the internship components rated on a 5-point scale of *Strongly Disagree* (1) to *Strongly Agree* (5), seven items about the usefulness of the internship components rated on a 5-point scale of *Not at all Useful* (1) to *Very Useful* (5), and three items about the usefulness of their favorite or assigned research project rated on the same 5-point usefulness scale. Table 16 depicts the results of those rated items.

Overall, respondents rated the internship experiences favorably, with all 16 mean scores above 4.00 on the 5-point scale. All agreed or strongly agreed they would recommend the immersion experience to others (mean 4.56, SD 0.50) and the experience positively influenced how they feel about their chosen college (mean 4.44, SD 0.50). The lowest-rated item (80% agreement) was they were more likely to pursue a career in research as a result of the experience (mean 4.14, SD 0.88).

When looking at the items focusing on the specific research internship components, all seven items were rated very favorably with mean scores above 4.00. Respondents rated meeting/conversing with faculty members and research oversight/training provided by faculty members the highest, with mean ratings of 4.47 (SDs 0.65 and 0.90, respectively). Team-building activities and community-building activities were rated the lowest, with mean ratings of 4.19 (SDs of 0.98 and 0.92, respectively).

Table 16. Response Option Frequencies and Descriptive Statistics for Rated Items: 2022 Intern Posttest Survey

Items	Response Frequency Percentages					Descriptive Statistics	
	(1) Strongly Disagree	(2) Disagree	(3) Neither Agree nor Disagree	(4) Agree	(5) Strongly Agree	Mean	Std. Dev.
The immersion experience met my expectations. (n=36)	0%	3%	8%	42%	47%	4.33	0.76
This experience helped to improve my research skills. (n=36)	3%	0%	8%	39%	50%	4.33	0.86
This experience helped me to increase my knowledge of research within a STEM field. (n=36)	0%	0%	8%	36%	56%	4.47	0.65
This experience helped me to increase my general scientific knowledge. (n=36)	0%	6%	6%	36%	53%	4.36	0.83
This experience helped me learn how STEM research is conducted. (n=36)	3%	0%	8%	39%	50%	4.33	0.86
This experience helped me see myself as someone who can do STEM. (n=35)	0%	3%	11%	34%	51%	4.34	0.80
I am more likely to pursue a career in research as a result of this experience. (n=35)	0%	6%	14%	40%	40%	4.14	0.88
The things I learned during this experience will help me stay in my STEM major when my coursework is challenging. (n=35)	0%	6%	9%	34%	51%	4.31	0.87
I am more likely to pursue a STEM degree as a result of this experience. (n=36)	0%	6%	11%	36%	47%	4.25	0.87
This experience will help me succeed in college. (n=36)	0%	0%	6%	44%	50%	4.44	0.61
I would recommend this immersion experience to others. (n=36)	0%	0%	0%	44%	56%	4.56	0.50
The recruitment process made it easy for me to apply to this experience. (n=36)	0%	0%	8%	42%	50%	4.42	0.65
The recruitment information adequately prepared me for what to expect for this experience. (n=36)	0%	0%	8%	58%	33%	4.25	0.60
The format of the immersion experience worked well for me. (n=36)	0%	0%	6%	56%	39%	4.33	0.59
This experience positively influenced how I feel about my chosen college. (n=36)	0%	0%	0%	56%	44%	4.44	0.50
I am more certain my STEM major is the right choice for me as a result of this experience. (n=36)	0%	0%	14%	33%	53%	4.39	0.73

	(1) Not at all Useful	(2) A Little Useful	(3) Neutral	(4) Useful	(5) Very Useful	Mean	Std. Dev.
Research mentoring provided by undergraduate mentors (n=36)	0%	0%	6%	44%	50%	4.44	0.61
Community-building mentoring provided by undergraduate mentors (n=36)	0%	3%	6%	36%	56%	4.44	0.74
Meeting/conversing with faculty members (n=36)	0%	0%	8%	36%	56%	4.47	0.65
Research oversight/training provided by faculty members (n=34)	3%	0%	9%	24%	65%	4.47	0.90
Team-building activities (at your internship site) (n=36)	3%	3%	14%	33%	47%	4.19	0.98
College readiness activities (n=36)	0%	3%	11%	31%	56%	4.39	0.80
Community-building activities (across the First2 Network) (n=36)	0%	3%	25%	22%	50%	4.19	0.92
For your favorite/assigned research project worked on during the internship:							
The activities you carried out for that project (n=36)	0%	3%	3%	47%	47%	4.39	0.69
The data analysis required for that project (n=36)	3%	3%	8%	42%	44%	4.22	0.93
The presentation of your project findings (n=36)	0%	0%	3%	44%	53%	4.50	0.56

Notes: Percentages may not equal 100% due to rounding.
The number of individuals who responded to each item is indicated by the (n=) notation in each row.

Each of the sites carried out various research projects. When asked to identify their favorite project, respondents identified the following:

- Blue Ridge Community and Technical College: ROCKWOOL efficiency project
- Fairmont State University: All three projects (atomic absorption of lead in paint, water quality, and 3D scanning of human bones)
- HSTA HCOP at WVU: Students either did not respond or indicated N/A
- Marshall University: DNA nanotechnology and dye filtration projects
- West Virginia University: All four projects (biometrics, fish in a dish, mapping Appalachia, and measuring speed of light)
- WVU Institute of Technology: the cybersecurity with Python programming project

After identifying their favorite/assigned research project, respondents were asked to rate three items based on that particular project. Respondents rated presentation of project findings the highest, with a mean of 4.50 (SD 0.56); followed by project activities carried out (mean 4.39, SD 0.60); and data analysis (mean 4.22, SD 0.93).

When asked which research project was least enjoyable, nearly a third of the 28 respondents (32%) indicated they enjoyed all the projects and several indicated they participated in only one project or that they weren't sure. No particular project was mentioned more than once or twice. There were a handful of comments related to data and analysis; an illustrative sampling follows.

> *Compiling data, because I don't know what people want to know.*
>
> *Statistic[al] analysis. I have trouble doing it because I don't understand how to put data into the tests and why. I have not been taught and the internet is confusing.*

Of the 37 respondents, 31 provided comments when asked what they found most enjoyable about doing research. The most common aspects included carrying out the research, learning new things, the hands-on lab work, and networking and collaborating with others. Similarly, 46 respondents provided comments on what they found challenging or intimidating about doing research. A few illustrative quotes about carrying out the research follow.

> *What I found most enjoyable about doing research is contributing to work that could potentially help others.*
>
> *The "Yes" moment when something finally worked.*
>
> *I enjoyed solving the answers to my research questions.*

The most common challenges included having self-doubt or the fear of "messing up," limited background/content knowledge, and presenting findings. A sample of illustrative quotes follow.

> *What I found most intimidating was the fear of making mistakes while in the lab.*
>
> *Afraid to make mistakes or ruin the data by accident.*
>
> *Not knowing what certain words meant or the difference between [them].*
>
> *It was material I had never covered before.*
>
> *Doing something you have no experience doing is very intimidating.*
>
> *The presentation at the end.*
>
> *I was scared to present but the time period allowed me to get prepared.*

The posttest survey also included four other open-ended prompts to garner feedback about the research internship experience. All but two of the 47 respondents provided comments about what they liked best about the internship program. The most common themes were the networking aspect—getting to meet their peers, mentors, faculty members, and like-minded people—and the research experiences. A few students also noted college preparation and the recreational activities. Illustrative quotes for the networking and research aspects follow.

> *Personal connections with college faculty.*
>
> *Meeting new people and learning more about the campus.*
>
> *I really enjoyed the fact that I feel like we actually made a difference with our research and it will be useful to them.*
>
> *I liked the research experience before going into major research.*
>
> *What I liked best about the internship program was the opportunity to learn and work in a lab and to see what undergraduate research and lab courses could be like.*

Thirty-one respondents provided comments about how the internship program should be improved. The most common theme focused on a variety of suggestions for modifying the schedule and improving organization, followed by nothing needed improvement or that more fun activities were needed. Less frequently mentioned themes included having more communication sooner and having better food options. Illustrative comments related to schedule modifications and additional activities are provided below.

> *The amount of time spent listening to speakers was a little long. I wish I had more time in between speakers.*
>
> *I think we should have more days to analyze our data.*
>
> *I really enjoyed my experience with the program, but some things that maybe could be changed/improved are making it slightly longer and allowing students to work in multiple labs.*

Maybe a less packed schedule, a little bit more lenience would like be amazing.

More organization in schedules or just more breaks throughout the day.

More activities on and off campus for students to interact with each other and learn things about the school.

I think there needs to be more fun activities.

There should be more fun activities where students have to work together to get something done.

When asked how they learned about the First2 Network program, 31 respondents provided a response. The two most common methods were by emails from faculty, advisors, or others and from interaction with a variety of individuals, such as faculty, advisors, teachers, and parents.

Twenty-eight respondents provided feedback about what worked best and what didn't work for First2 Network recruitment. On what worked well, respondents most frequently noted email messaging, the online application, and talking with network faculty members. On what did not work so well, respondents noted items such as limited details in communications and insufficient advertisement of the internship opportunity.

4.2.1 Intern Survey Summary

In sum, 2022 summer research interns viewed their internships as very successful. Thirty-seven students provided pretest survey responses and 36 provided posttest survey responses; of those, 34 provided both pretest and posttest responses. About half were female, from rural locales, were first-generation college students, and qualified for a federal Pell Grant; about three-fourths were white and graduated from high schools within West Virginia.

Three subscales showed statistically significant increases in mean scores from pre to post, including School Belonging, Knowledge About Research, and Personal Skills. Knowledge About Research had the largest increase and STEM Plans was rated highest at both pre and post.

Participants rated the internship experience favorably, with high ratings (above 4.00) for all items. All respondents agreed they would recommend the immersion experience to others and the experience positively influenced how they feel about their chosen college. Specific internship components were also rated highly, especially meeting/conversing with faculty members and the research oversight/training provided by faculty members.

Respondents identified networking and the research as the best parts of the internship; the most common suggestion for improvement was for schedule adjustments. Email was the most common way of learning about the network and the most successful recruitment strategy.

4.3 Student Focus Groups

During the week of March 20–26, 2022, the evaluation team conducted five virtual group interview sessions with college students who had either participated in one of the eight summer 2021 research internships or who were involved in some other capacity with the First2 Network (i.e., campus clubs, student leadership, scholars, mentors, and so forth). A total of 25 students participated in the virtual interviews; in addition, four students who were unable to participate in one of the group sessions also provided their responses via email. Those responses are included in the following summary.

As an icebreaker activity, students were asked to provide a one-word description of their First2 Network experience. Figure 46 below depicts their responses; not all students responded but of

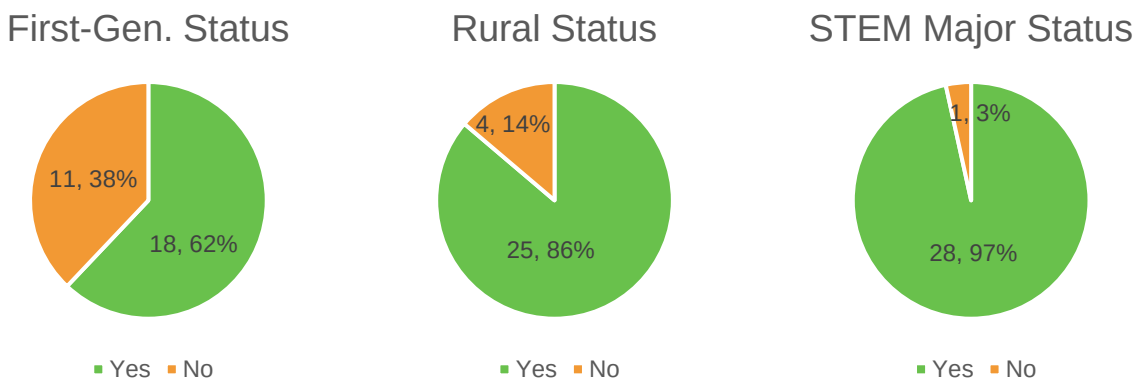
those who did provide a description, three used the same term of "supportive," two used "helpful," and the remaining descriptions were all unique and mostly positive.

Figure 46. One-Word Description of First2 Network Experience

Students were also asked three descriptive questions to identify whether they were first-generation college-goers, whether they came from a rural background, and whether they had a STEM major. As shown in Figure 47, 97% had a STEM major, 86% were rural, and 62% were first-generation college-goers.

The remaining questions were organized into four categories: students' early experience with the First2 Network, their experiences during the summer research internships (for those who participated), their involvement in First2 Network more broadly, and a wrap up. Responses are organized by question within these categories.

Figure 47. One-Word Description of First2 Network Experience



4.3.1 Early Experience with the First2 Network

How did you learn about the First2 Network? The most frequent ways of learning about the First2 Network were through friends who either knew about the network or were already in the network, or from faculty members. Other methods included university communications (emails or newsletters), high school staff, and family members. A few students also mentioned unique methods such as NSF staff, a network lead, an internet search, a network flyer, and an Organization Day activity.

What was the main reason you wanted to become a member of the network? The most frequently mentioned reason to become part of the network was the opportunity to get involved in research early in their college experience. Another common reason was for the networking opportunities—to meet other students and faculty as well as meet individuals statewide with an interest in STEM. Also mentioned was the need to secure scholarships, grants, or funding; to have something to do during the summer between high school and college; for career exploration; and to work as a tutor. Illustrative quotes follow.

Initially it was simply for the money and flexible work schedule, but I soon realized the impact First2 can have on a student population who is at such a high risk of dropping out, and I wanted to be a part of that. – Student member

I wanted to make connections throughout the state, and I also wanted to meet other people who were also interested in STEM majors.

I didn't know how I should contact professors, or who I should be looking for. And so I thought the First2 Network would give me good advice on how to do that.

The main reason I wanted to become a member was to meet and network, hopefully with other non-traditional students maybe that were also first-gen college students.

I like the idea of being in a science-related organization.

For me, all of my friends are in the First2 group here on campus, so I joined in too.

I wanted to go to medical school, so you have to do a lot of different things to get into that. And so I was excited to be able to use the First2 Network to branch out and do the tutoring and do the research and those kinds of things.

I wanted another source of income that focused on improving my academic career.

What suggestions do you have for sharing this network opportunity with other students?

There was a consensus among many participants that more awareness of and outreach by the First2 Network was needed for students entering college as freshmen or for students already in college. Several illustrative quotes follow.

On college campus itself, maybe during freshman orientation, also reach out. Because I'm a senior, but this is actually my sixth year on campus. And I did not hear about or learn about First2 until last summer when working a science camp. – Student member

Definitely have faculty at colleges reach out to incoming freshman students.

Make more opportunities for students to learn about it through college business days or college days at the high schools where the colleges can come.

> *I was going to talk about freshman orientation as well because I didn't hear about it until my junior year. So if we can especially teach the freshmen about it, that would probably be really helpful.*
>
> *I think more of the welcome week activities on campus or getting them once they actually go to the school [college] and getting them connected with the club is a better way of getting them interested because they already know that they meet the criteria.*

Some students also advocated for more outreach at the high school level, as noted by the quotes below.

> *We need to get more rural high school[s] involved in any way we can. I do not think ambassador visits are enough as most students go back to their school of origin and a lot of the southern schools are not getting the same information or opportunities.*
>
> *I think starting at the high school level and getting interest down there would be really important because then they'll already have that connection once they get to college. Because I know it's hard for people to branch out sometimes in college.*

A few other suggestions included more advertising in general ("Just keep talking about it and the word will spread"), more advertising via social media (Facebook for parents and Instagram for students), and more outreach to Health Sciences and Technology Academy students, who would be "great candidates for this."

What suggestions do you have for making the application process better for future applicants? Some participants believed that first-generation status was a requisite for being accepted into the First2 Network but others perceived that it was optional. (It could be that some students were thinking of eligibility to be selected as an intern, versus others thinking of participation in First2 more broadly, such as campus clubs, etc.).

> *I believe that a lot of people still get confused that they have to be first generation to be part of First2 Network. Well, it's not really true. I'm personally not a first-generation student so I was working with high school students and a lot of them were shocked that they don't have to be the first generation. So … clarify in our applications that they don't really have to be first generation and they just need to qualify [for] some of the requirements, that would make more sense.*
>
> *I do remember thinking that I wasn't going to be accepted due to me not being first generation. So I also think clarifying that would help those like me.*
>
> *One of the issues I had during the application is understanding … the definition of rural.*
>
> *I'm pretty sure I remember on the application it asking for who your mentor would be. And luckily I knew that it was going to be asking that and I got involved with a mentor before I filled out the application, so I was able to put something in. But I think for people who haven't found a mentor yet, or haven't really figured out how to get into research yet, and that's why they're joining, [they] might be a little confused by the application.*

Other students thought the application process was "pretty straightforward" and that nothing "stuck out as negative or overly difficult." A few students noted that some of the requirements may be "scary" to younger students, such as a cover letter and resume. One participant suggested that the application include a section "that discusses difficulties the applicant has experienced in college." Another suggested, "A personal connection … or First2 leader who could connect with and guide you into the network at first" after being accepted.

4.3.2 Summer Research Internship Experience

To what extent did the research internship meet your expectations? Not all of the students who engaged in these group interview sessions had actually participated in one of the First2 Network summer research internships; therefore, this set of results is based on a subset of respondents. For those students who participated in one of the summer 2021 research internships, four noted that the research component did not meet their expectations, with several suggesting it felt more like "summer camp" or that they were expected to be "camp counselors." Illustrative quotes follow.

I love the experience and I love the friends that I made there, but it felt a lot like a summer camp instead of a research opportunity, which bothered me because we were busy all the time and we didn't have very much downtime and having to do things, we had to go hiking and stuff like that. And overall it just, especially in the Morgantown campus, there's a lot of walking, so there wasn't much downtime and not a lot of time to relax. – Student member

> *Honestly, it was not at all what I expected when I signed up. The email that they sent in partnership with WVU that I originally got had a tagline of something along the lines of like, "Do you want to get paid to do summer research?" So I applied, I was super excited to go. I knew going into it that High Rocks was an outdoor site and that we'd be doing environmental research, which I was really excited about since that's my major, but it was not really research-based I found. We only got to do maybe 2 hours a day of research max and the rest of it they kind of expected us to be camp counselors to the High Rocks summer camp program that was there. And that was not communicated in the advertisement that they wanted us to take on these mentor roles, I guess. I think we all went into it thinking we were going to be mentored. And so, yes, I feel like I got a lot of connections out of it and the professors that led the program ended up being professors from WVU and all the girls that went ended up also going to WVU. So it was nice that I got to meet people and I feel like the networking was really there, but I feel like the research time was very, very limited compared to how it was advertised. And I felt like it leaned more towards a summer camp than it did an internship.*
>
> *Research-wise, I just feel like it kind of fell short of what we were told it was going to be. We showed up and it was more of a summer camp than anything else because it was shared with an actual summer camp of high school freshmen and some 8th-graders. And so that kind of threw us off as incoming college freshmen. And a lot of our time during the day we only got about 2 to 3 hours of doing actual research-related activities. And the rest of the day we had to do activities with, like, the younger kids and do what the summer camp was doing instead of getting to do our own research.*

However, one student had a very positive perception of the research that was carried out, noting:

> *I did not have any expectations going in. I was quite unsure of what we were going to do actually. But I think that the research that we did, … primarily for computer science or information systems majors, that's the kind of research that they were doing. That's my major as well. I think that it very, very much helped me adjust to what I'm going to be learning during the computer science year or the fall semester.*

Other students who had participated in a 2021 summer internship also had positive perceptions of their experiences. Illustrative quotes follow.

> *It met my expectations of what a summer program should look like in a 2-week internship.*
>
> *It was everything I expected.*
>
> *My experience was a lot better than I expected. At first, I was like, "Oh, I'm going to be at college during the summer," and I wasn't expecting it to be very fun. And then I got there and I had a ton of fun and the friends I met there are still my closest friends at college.*

Several students provided feedback related to their participation in a 2020 summer research internship. Even with the virtual nature of those internships, feedback was positive.

> *It met my expectation and it went really well for it being fully online. We did a lot of new activit[ies] that I had never done, so I was really glad I did that internship.*
>
> *It was, I think, about as good as it could have been. I didn't really have a whole lot of expectations going in because of that. I thought it was an okay experience. But we were all trying to get used to that whole new setting. So not much expectation there.*

Finally, several students provided feedback from their vantage of serving as a mentor for one of the First2 2021 summer research internships. Both expressed some disconnect between what they had expected their role to be compared to what they actually did as mentors.

> *I feel like, especially on the online setting, they just had us there to just sit there. Because last time, the past summer I was there, we were supposed to be attending different conferences and listening to all the professors and stuff like that. But then as soon as we got in there, they're like, "Oh, well you only need to be here for an hour and 30 minutes." So we just—that's all we did. So I kind of wish I would've been able to get an idea of what they were doing. Because when I looked at the finished projects for everybody when they were presenting their research, it made me feel bad for not understanding what they were supposed to be gathering. … And it just made me feel like we should have had a better understanding of what we were getting into.*
>
> *When I got there we just kind of sat around. I remember having to email the main person of the immersion site and asked them for materials to see what we were doing with the students. I wanted the materials to see what exactly I'm supposed to be trying to teach them. But the whole entire time we kind of just, like, were just there. We never were usually really needed unless it was like, they didn't have anything else planned. I know that I tried to interact with some of the other staff that we had, and then it was kind of like they were busy. And it definitely was nowhere near the expectation I had. Meeting faculty and professors … and making connections with them—that didn't happen at all.*

What provided the most value to your college experience? Most of the students who had participated in a research internship identified the networking aspect as the most valuable aspect to their college experience. Illustrative quotes follow.

It's just having the network of people, meeting the people that are going to be going to your college in the future and, so, having that when you go on campus already. – Student member

> *For me, I established some of my relationships with my STEM professors that I have now, and it reconfirmed where I wanted to go to college at, for me.*
>
> *Yeah. I mean, it was a good introduction to networking, both with people that are higher up in the organization, faculty at my college, and as well as with my peers.*

The networking with not only the other people at the internship site, but also the professors was really useful. And those professors actually did get me my research position that I have during the year. It was great from that standpoint.

There was one night where the mentors sat us down and told us, here is a place where you can look for current faculty who are seeking out undergraduates to do research for them. And they showed us how we should write emails so that way we could schedule a meeting with the professors, and see if we would be a good fit for their lab. And from that experience, I actually was able to find the lab placement that I'm currently in. So it did help me get started in doing research during the semester.

Several other students identified other features that were most valuable to them. Two specifically mentioned the research experience—that it confirmed "that's it something that I will enjoy" and that it provided "some prior experience" before getting "into a lab in college." Another student most valued the "presentations and talks about resources on campus and highlighting differences between high school and college."

How, if at all, did participating in the research internship affect your decision to declare or not declare a STEM major? Students seemed ambivalent about whether the research internship affected their decision about a STEM major, since only a few responded to this particular prompt. Three noted no effect on their decision about a STEM major; one student said, "If anything, the summer internship confirmed my decision to study a STEM major." Another described how the internship experience led to a change from a B.A. to a B.S. major.

I switched from environmental geoscience to geology, and that was all because of my research mentor who I wouldn't have worked with if I hadn't gotten into research through First2. So in a roundabout way, they kind of affected the field that I'm in now. – Student member

How, if at all, did participating in the research internship influence your confidence in your ability to do STEM coursework? All of the students who responded to this prompt perceived that the internship experience had positively influenced their confidence in their ability to do STEM coursework. Illustrative quotes follow.

I do think those connections and getting the, I guess, personal side of relationship with a professor, really did make me feel more confident that they're normal people too. You can work with them, you can go ask them questions, you can have a relationship with them. – Student member

Made me more comfortable with the campus and hearing from professors.

The internship added help from faculty, which essentially improved my focus on coursework.

I would say it boosted my confidence because going into college, I was scared that I wouldn't be able to handle my course load. I wouldn't be able to work in a lab because I didn't have that much experience in high school. And then when I came during the internship and I was like, "Oh, I love the lab and I'm doing great." I was like, "Okay, college is going to be fine."

I would say that the internship in 2021, it definitely showed me what I was going to be doing in STEM and how much more, or how different it was from high school because STEM classes are definitely a lot different than high school classes. So I would say it

definitely influenced, it definitely boosted my confidence knowing that I have a little bit of background in this before I go into the fall semester.

For me personally, definitely. Because whenever we actually got to do something research-related, it was a lot of the same stuff that I'm doing in my labs now. Especially like the microscopy stuff. We do a lot of that in some of my classes so it definitely simulated what college was going to be like.

I would say yes because it was a good exposure to a lot of STEM-related topics. But honestly, college was such a different thing than I was used to so it's kind of hard to say.

How, if at all, did participating in the research internship influence your sense of yourself as a future scientist or mathematician? Several students provided feedback for this prompt, and all four perceived the research internship had positively influenced their sense of themselves as a future scientist or mathematician. Illustrative quotes follow.

Made me realize that maybe basic sciences research, especially chemistry, is not the route I would want to do. Made me further feel more inclined to go to medical school so I can do clinical research and practice as a physician. – Student member

It's always great to be around students with similar interests in math and science.

Yeah, I think the internship helped. I think it helped me and other interns feel more comfortable around other people in our major field. So, it helped a little with imposter syndrome, I would say.

While it was only 2 weeks and it was all online, it was still a good exposure, I guess, to the different things you can do with [a] STEM degree and with STEM knowledge. So, yeah, I think it was a good insight into potential future opportunities.

How, if at all, did participating in the research internship continue to influence your progress through your STEM major? Several students perceived that the First2 Network had positively influenced their progress through their STEM majors. Illustrative quotes follow.

Gave me the network to be able to have people to talk to and learn from.

The overall immersion program helped me to continue my education with confidence that I can finish college.

I decided to take on more [teaching assistant] and research positions so I guess that kind of influenced it.

From First2, certainly. As far as the immersion, probably not, it was fairly limited. And I know that's not necessarily the fault of anyone. But it's kind of hard to say if the internship itself has continued to influence me.

And several other students focused specifically on how particular professors had positively influenced their progress.

I would 100% say that there is an influence and that's just the connection that I made with the professor who was the faculty advisor at the research camp. He was my computer science professor and because of the connection that I had made with him over the summer, I felt comfortable to talk to him and ask him more questions about the computer science class that I had.

I would say for me, it definitely influenced my progress and really got me focused in a specific area of environmental science. So, the professors I worked with both work for the college that I'm in and they actually got me connected with a professor that is now

my research supervisor. And, really, his research got me really focused in a specific area. And as a result of that, I'm now taking more classes that are very focused instead of very vague and general. So it definitely did help me focus in on my major and what exactly I wanted to do with it.

What changes should be made to improve future research internships? Several students provide suggestions for improving future research internships, and five of those focused on specific structural changes, including more time for and understanding about research, more tailored advertising, more mentor training, and extending the duration of the internship. Illustrative quotes follow.

More emphasis on how research at some times can be boring. Not everything is going to give you spectacular results. Things take time and research isn't all about finding one crazy discovery. – Student member

I personally think that we just wanted more research time. We felt like an hour or an hour-and-a-half a day of research just wasn't enough to really finish our projects. Nobody finished their project. And we often didn't get to finish the lessons or presentations that the professors had put together for us that day. So we felt like if we would've had a little bit more time, we would've gotten a lot more done and been able to do a lot more.

I think that some of the advertisement for specific internships could be more tailored to that particular internship and not just the internships in general, because I know each one is really different. And maybe having that explanation … reviewed by either mentors or interns who have been to that site could be beneficial. Because virtually none of the information we were given about the site was at all accurate.

I think they should definitely try to train the people that we're going to work with because I feel like they had a lot of problems [weren't respecting people's pronouns, had problems connecting with students, didn't help students gain understanding of what to do]. … So I feel like they should teach the mentors to help the students digest their information, and help them along for a little bit, and then let them go on their own, like my research professor is doing. She's teaching me one thing at a time, making sure that I get it right, and then moving on to the next one.

I would say maybe, if we can … make it more than 2 weeks. Because if you want kids to experience research experience, it's hard to do any research project within 2 weeks. So maybe extending it to a month-long experience would help.

One student who participated in a previous year's internship and then served as a mentor in 2021 noted it "was a much more enjoyable and engaging experience, … a vast improvement already."

4.3.3 Experience with the First2 Network

What role do students play in the First2 Network? Participants noted a variety of roles that students fill in the network, such as serving as campus club leads or liaisons, participating in campus clubs, serving as student directors, serving as scholars, serving as tutors, and serving as mentors (both formally as part of summer internships and informally in helping other students). However,

Students are the core working piece to the mission of the First2 Network. Without students there's no way to measure the success or failure of the mission. In fact, the underlying mindset is that this program does not work without the students. – Student Member

in addition to identifying specific roles, students also reflected a vision of how student-centric the network really was and how the student role was integral to inform and operationalize the network. Illustrative quotes follow.

> *We rally for change and describe difficulties in college that we had to overcome.*
>
> *Students give info about life in college and being a STEM major … about hardships.*
>
> *Students are really central to it. … All the time I feel like students are free to share their opinions. Like here, we're sharing our opinions and being listened to.*
>
> *Students in First2 are the base of it.*
>
> *I think they play an advocacy role just to get more people involved and comfortable and reaching out to more STEM students who might have not heard about this and just get them aware of it.*
>
> *I would explain it more like a give-and-take relationship where students get something. Like we get opportunities and stuff. Of course, we get to do research and we get to be student directors, lead the club. And giving to work, just that we help the network grow and improve and we help other students to be in the network. So, I would say that students play an important role. And within that, we are getting something and we are giving away something.*

Students also recognized the value they provide in supporting one another, and in the support provided by the network. Illustrative quotes follow.

> *Students supporting students. But I also feel like we have support from professors. We have support from other individuals in the network. And we have opportunities that the network can give us that students that are not in the network don't necessarily have available to them.*
>
> *I feel like we're supporting each other with different opportunities, whether it be tutoring or financial support or any other thing related to what you actually need to do to get through college. I feel like students play … a pretty decent role in that.*
>
> *I think one of the main and probably most important roles is the students supporting each other. And that's like a big help, especially in STEM fields where things can get overwhelming and labs are time-consuming and you get to the upper level and everything's hard. So just having a support role that you know you can go to. And that it's students that are experiencing the same things you are and the same troubles and everything. It makes it like really nice.*
>
> *I definitely feel like I'm being supported by everyone in the network for sure. And it's also really nice that you have the support. … Like, it is really nice to have that network.*

Other than participating in the summer research internship, in what ways are you involved in the First2 Network? In addition to participating in a summer internship, or serving as a mentor for subsequent internships, participants identified a number of ways in which they had individually been involved with the network. Students mentioned mentoring, serving as club president, participating in the campus clubs, organizing and hosting campus activities or events, serving as a tutor, serving as an ambassador chair, serving as a student director, serving as a scholar, conducting research, and participating in network meetings. One student noted,

> *I am the vice president of the campus club. I've presented at the statewide math teacher conference recently. Last semester I presented at the statewide science teacher conference. I've presented at the conference for admissions and recruitment for all colleges in the state. I have presented at Maroon and White Day, which is kind of*

> *like an introduction to incoming students for my campus; I've done that three times now. I've been very vocal about showing students what the First2 Network is. And we've kind of fought to get more opportunities for First2 to be at events on our campus. … I really enjoy being able to go and spread the word—what First2 is.*

Describe your involvement in helping the network identify and test strategies for better serving rural, first-generation students. Some students reported direct involvement in network PDSA activities. Topics focused on interactions with faculty, student leadership, mental health awareness, study cycles, study hall, scheduling, and office hours.

> *I have conducted two cycles of a PDSA focused on connectivity between STEM students and STEM professors. This occurred because I noticed a lot of students, freshmen particularly, would not get help in classes because they did not feel comfortable with professors. I conducted a similar PDSA cycle as described above within the network with students and leadership. I have helped with a massive PDSA last year concerning mental health awareness as a network-wide initiative.*
>
> *I know one of our PDSAs that I briefly helped on was we are doing a trivia night and the whole purpose of that is to try to show students that our STEM professors aren't scary, because they actually do the trivia night with us. So that's one thing that we're working on is bridging that gap between professors and students.*
>
> *We did a PDSA cycle. We wanted to test if … students outline what they're going to study, how long they're going to study, … because we help them plan a study cycle. A majority of the students, it has been helping them. So I think, I guess, from that cycle, hopefully next year, they are able to do it on their own, planning a study habit.*
>
> *At 5:00 p.m. on Wednesdays and Thursdays, we have our 1-hour study hall and either they can work on homework or use that time to rest or whatever. And then at the end, they fill out a survey that says, "Today I used time in study hall for …" and then there's options and you can describe what you did. I think at the end of the semester or the end of the year, they look at the answers and help with statistics somehow.*
>
> *I'm doing PDSA right now on office hours. So it's just like kind of testing how much office hours can improve your STEM studies.*

Other students were either not involved in PDSA activities or were involved in more general types of improvement activities.

How much of a voice do you have in the network? Students in general? Responses were mixed as to the degree of voice students had in the network. Some students had mostly positive perceptions about the degree of voice students have. Illustrative quotes follow.

I feel myself and all students have a very strong voice in the network. I feel we are always heard and considered, but I know sometimes it gets lost in translation where our concerns are going and/or what is being done about it. – Student member

> *I think our voices are heard equally. Mine, I'm just shy, but if I have something to say, I would say it. I would usually tell someone or ask someone a question and then they'll answer, or they'll say it out loud for me because I'm still a shy person.*
>
> *I feel like a lot of ideas or like anything I suggest definitely has consideration. I don't think I've done anything super major, like I've influenced anything really major in the network but I definitely feel like the ideas will be considered. … And then, overall students in*

general, I feel like they have a say because I feel like a lot of things [are] voted on and surveys are given all the time.

In my experience, any concerns that have been brought so far seem to have been heard and, like, handled quickly. And so I think that that is pretty positive when it comes to your voice being heard, at least in my experience so far.

I think that anybody on campus, if there's a question, we have multiple people that we can go to. It's not as easy to get in communication with others outside of our campus club but I know that our director does try to make sure that if we have any questions, they're in contact with someone higher up who can answer those.

Other students had more mixed perceptions of the degree of voice students have in the network, recognizing areas where student voices are minimized or unbalanced, but also describing efforts undertaken to address those inequities. For example, several students described the recent reduction in the number of required meetings to minimize the pressure that students were feeling in trying to attend those meetings (reducing the number of required club meetings from eight to five). Illustrative quotes follow.

Being a scholar … I know we don't have much decision-making power. We don't have a whole lot of voice in decision-making. But I know we're transitioning and working on that a little bit because we've recently undergone a change in requirements. … It's definitely been nice to see that our suggestions are taken into consideration. – Student member

I 100% understand how scholars feel that maybe their voice is not heard that much, because they only meet with leadership once a month versus [as] a director, we meet with them every week. … I get we're supposed to be the voice for the scholar, which sometimes can be hard because … it's hard to have one voice for 20 people. But one thing that a lot of the directors saw was the freshmen were struggling with the requirements that are supposed to be helping them. So that when we brought up to their attention of saying, "Hey, we know that it's supposed to be helping them, but it is really stressing them out about eight meetings," leadership took that and … over the past few months have been working with us.

So, for the overarching network, I would say I have pretty little to no voice. … I really don't feel like I have much of a say at all in the overarching network or anything that happens. And most of the time I honestly have no idea what's happening. … In terms of the campus club, I am really involved and we do have really good conversations about what's happening with our directors and as a whole club. And I feel like on the club level or student-to-student level, we're able to be pretty impactful. And I feel like they are trying to listen to students more and the student voice is increasing. … I would say the directors have been really instrumental in trying to move that forward for us. I feel like a lot of the directors, in having conversations with their own respective clubs, have realized that a lot of the requirements or a lot of the expectations and communication is really confusing and hasn't really been defined and is constantly changing. … Our directors all did a really good job getting together with each other and having conversations behind the scenes to help go to leadership and say, "This is a problem. We want this changed."

My voice is only, I mean, I barely have one. It's just for on campus in the student club meetings. But … I'd say that they [directors] have a big voice.

I feel like I don't have too much say in things since I am not a director. Sometimes I feel like students' voice gets distorted because at times we feel like we have to appeal to the people above us.

I definitely think I have more of a voice within the club on campus rather than like the whole network. I think it would be easier for me to actually be heard in the club because it's a much smaller number of people.

A lot of time we do get to, especially in weekly meetings, we do get to share our opinions on certain things, but our ideas and our concerns just stay within that meeting and they're never discussed anymore. Well, it's more like they will ask you about something certain, specific, and they'll be like, "Should it be this way or that way?" … But in the end, whatever they think is right will happen.

Students are given the opportunity to voice their opinions a lot, and quite often, but not as often are those concerns or suggestions actually taken into consideration.

How, if at all, has your involvement in the network Influenced your ability to progress in your STEM program or helped you persist with your STEM studies? These prompts are combined since most participants provided comments that addressed both strands. Two major themes emerged, with the first focused on the benefit of building a stronger network of connections among faculty and students. Illustrative quotes follow.

One of the greatest things about being involved in the network is I am able to network with people outside of my university. So being able to meet with professors … at Fairmont or WVU, who I probably never would've met without the network—I'm able to find more opportunities. I have a research opportunity for the summer with, sadly, not First2, but I found it through First2. – Student member

I have become more connected to professors and internship/graduate program opportunities.

For me, the people in my First2 groups on campus have helped me a lot progressing through my STEM major because biology majors, it's rough. … So, it's really helpful for me to be able to go up to other people that are doing the same thing as me and being like, "Hey, do you feel this way or am I just being overly dramatic?" And people being, "Okay, I understand you."

I would say that being in the network has just increased my confidence in reaching out and being willing to network with faculty at my school, in my STEM programs. And so, it got me in with research with a professor. And now I have a relationship there, relationship with other professors, because of that networking. So, yeah, I think that has helped me, like I said, gain confidence, gain connections. Good things like that.

The one thing that [the] network has provided is it gave me a broader group to communicate with, other STEM majors that aren't chemistry, because I don't get to leave my floor very often. And then, on top of that, just experience in communicating with people that are higher up, that aren't the same people I've been used to communicating with over the last few years of being here. So, it's opened up and given me like new people and new roles and everything to practice with, which I think will be more beneficial as I'm getting ready to enter the workforce.

The second theme identified by students focused on the benefit the network provided through the various research opportunities. Illustrative quotes follow.

I would say with respect to research, it has helped me progress in my STEM major, just because research is a really important thing to have, and something that you kind of need to graduate for what I major in. – Student member

> *It allowed me to get into a research lab, which obviously has helped progress my STEM career, but it's also given me connections with people, both in the network and out of the network. People in my research lab who have helped me figure out what I want to do, because I had a moment for a while where I was thinking about picking up a chemistry major. But the people in my research lab talked me out of it, just because with what I want to do, I don't have to have a chemistry major along with a biology major. It's nice to have people who have gone through the same route as you take you under their wing and give you advice.*
>
> *I think that it's influencing my ability to progress because it's not like a job that takes away from school and takes my time and takes my attention away from school because I'm still researching and still doing stuff. … The research we're doing is cybersecurity and so this isn't stuff that I would get into until junior, senior year. And so it's influencing my ability to progress because it's exposing me to stuff I'm going to see in 2 years, 3 years already. So, I have a little understanding of it.*
>
> *Getting in the research with my professor hasn't I would say influenced [me] right at this exact moment, but I do have to take classes in that area. They are typically junior, senior classes … so that is something I'm going to be facing next year. And I feel like having that has really given me the confidence that I can do it. I know what that is. That class will not be as difficult for me as it would if I didn't have this background and all this experience and this real-world application of everything.*
>
> *This is my senior year and so I just joined this year. In reality, it hasn't much influenced my ability to progress through it but it has given me the opportunity to do more research. … It's given me the opportunity to do more research and focus more on that rather than go out and have to get a job and also focus on research. So it allowed me more time to develop my research.*

Finally, several participants perceived their participation in the network had not influenced their ability to progress in their STEM programs or helped them persist with their STEM studies. Illustrative quotes follow.

> *Not really. Not really progressing [in] my STEM program. I think it's nice to have extracurricular activities, such as the service projects, a bit of a sense of like comradery with general college advice. But for the STEM program in general, like research, not really. I'd say my Research Apprenticeship Program kind of does that.*
>
> *I got involved in the network very late in my STEM career as I was a junior in college, so I don't think the network has helped me very much with this; however, it has put me in a position to mentor and guide students, which has fostered my love of teaching, which I want to do in my future career.*

4.3.4 Wrap Up

How can the First2 Network provide you with better support as you continue in your STEM program? Several themes emerged from students' suggestions for better support from the network. One was for improved communications, both in terms of streamlining and in clarity. Illustrative quotes follow.

> *I think we have a lot of communication issues within the network, especially with incoming students. I had no clue what the requirements were whenever I came into the network and so debriefing and explaining those would be really nice. I also think clear, more consistent communication about deadlines, activity dates, meetings, anything like that … just having a clear, concise answer that doesn't change would be nice.*
>
> *This is my first semester being a scholar and it is very hard to figure out when requirements are [due]. I'm having to ask my friend who is also a scholar and did it last semester, "What is happening?" … I just miss dates because I have no idea when things are due, because there's no reminder or concise system to say where it is.*
>
> *I think they need to get their forms of communication all in one website or one method of communication. I think it's confusing having to go between like at least two different platforms [First2 Network website and Slack] to get a grasp on what's going on. … I've got it more figured out now but it was definitely difficult in the beginning trying to figure out where to find what I needed.*
>
> *One thing that I've noticed is sometimes we are told things by like one set of leadership position people and then another set has no idea. So I think better communication at an upper level between those members. And … maybe one key way of communicating that down to the lower levels to help everyone always stay and be on the same page.*
>
> *I think the First 2 Network needs to be more clear with what its expectations of itself and students are.*

Another theme was to recognize that students were indeed students, with many competing demands for their time and attention, and to structure network requirements accordingly, i.e., more flexibility, more advance notice of and alternative schedules for meetings, and fewer obligations. Illustrative quotes follow.

> *Less requirements so students can focus on their studies more rather than First2 obligations.*
>
> *I think just understanding that we're actually STEM students. Because I feel like … First2 needs to still understand that students have classes and exams, and either make evaluations [and meetings] on a weekend or during a club meeting … or something to that effect because I feel like they've just lost the idea that we're still STEM students.*
>
> *And then another thing is some of the requirements … maybe a little bit more advance notice on when things like this [evaluation or network meetings] do pop up. … And I think just maybe having a little bit more leniency on what I can replace, should I need to miss an all-students meeting.*

Several students also advocated for better access to First2 Network members, including leaders, industry representatives, higher education faculty, and students at other institutions so that they can build and strengthen their professional and personal networks and identify more research opportunities. Illustrative quotes follow.

> *I would say maybe have more involvement between the upper hierarchy of the network [and students] … so that way they could have some sort of interaction and know if they*

> *needed something answered or if they needed access to other resources or opportunities to help further their studies or their research.*
>
> *As I continue with my undergraduate education, I want better access to industry leaders and graduate school professors so that I could have more variety in my options.*
>
> *I think one thing I would like to see; it might be more of a campus thing than a First2 thing though. I'd like to have a match system with research … because I'm on my own to find research and it's hard for me to go up to someone and be like, "Hey, are you doing any research that I can help with?" So it'd be nice if First2 could pair with the universities to see if anyone was interested in doing a match system.*
>
> *The network is at this point huge, with all these different campus clubs. And I think it would be really interesting if they were able to kind of group us by majors so that way you can network with other people in a similar field. … I think it'd be really cool to get to outreach with the other clubs and get to meet people that are in similar classes or have similar career goals as you.*

There were also a number of idiosyncratic suggestions offered by students. Some are illustrated below.

> *The funding has been nice. I would like the option maybe of summer funding for research because it is so hard to get into some summer research internships.*
>
> *I would say … in the meetings, just to focus on research. Maybe examples, maybe telling people basic things. Like freshmen coming in, like, what's an abstract, what's this, how are you supposed to go about doing research? Or, if you're having this issue with your research mentor at your college, what's a possible solution? Things like that, I think, would go a long way. And of course the research would help progress me in my STEM program.*
>
> *I feel like they push research a lot and I feel like they could probably provide more opportunities to share your research or present your research. I feel like they don't do a lot in terms of teaching you how to do that or how to get involved in research symposiums or how to write papers or how to present posters.*
>
> *I think the leadership needs to take more of our suggestions into consideration because it seems like they do what they want regardless of what we say most of the time.*

What is one thing that the First2 Network is doing especially well for students? Participants identified numerous things they perceived the network was doing especially well for students. Given the uniqueness of each response, all of the comments are provided verbatim in Table 17.

Table 17. Verbatim Comments on What the First2 Network is Doing Well

Comments
They are providing a network of professionals to be connected to.
Listening. I feel like every concern we bring up is being heard and I feel like leadership makes us an important part in any discussion.
Being able to fund us to do research.
The network does well in giving students opportunity to speak, especially for those who like to speak up in various ways, whether the feedback is positive or negative.
I think it is doing a great job putting out opportunities for student[s] within and outside the network. They always try to make us aware of scholarship and internship opportunities.

Comments
I would say it's nice that, I mean, the payment isn't great in terms of research, but it's a nice jumping off place in terms of, if you later want to go pursue a NASA grant or something, it gives you the opportunities to do so. It gets your foot in the door with research, which I think is extremely important and networking.
I know on our monthly meetings, I think it was a while back, we had asked for more interconnectedness to students across institutions. So, that's been really fun. We usually play some sort of a game during our meeting, whether it be Kahoot! or anything like that. So that really helps the support group and just expand your connectedness with people throughout the state. That's been really fun, those little activities.
I like that the scholars and directors and even upperclassmen in, at least in my own group, are willing to help and tutor others if they need it, or even a mental health check. We're always there if they need it and even with each other, so I'm glad to have that supportiveness.
I would say this is primarily just the campus, or not the campus, the club that we have on campus, they're just doing a very good job of getting us focused and knowing all the stuff that we have to do to be First2 Network or a part of the First2 Network. So that doesn't really necessarily tie to the First2 Network as a whole, but I believe at the WV Tech First2 club is very good and is definitely helping me in my college experience.
I think that the club specifically is a really good resource to help you grow, but if I would've had this opportunity as a freshman, it would've allowed me to grow a lot more and develop like [a] web of networking earlier on. And I think that is something that's really important. I enjoy that aspect.
I think the campus club is where they're doing it right. The WVU club does a really good job on checking in with all of us and having that mentor relationship with upper classmen. They do sessions where they'll help us pick our classes for next year or currently they have us all sorted based on common, foundational STEM classes that almost everyone's required to take. So they have study groups like that for each class. So you can go to the study group and help get your hours, stuff like that is really helpful and really supportive when you're taking really hard classes. And it's nice to have someone that understands that and is willing to help you or help tutor you or give you connections to get resources if you need help.
I think they're doing a great job of getting people to connect with each other. I haven't had a problem asking people for help, or anything like that, like I would in a classroom. So I know, the people that I know right now I'll probably end up knowing for the rest of my life because I actually have a good connection with them rather than a one-off class with somebody that I met, like I would have for 13 weeks and then just leave them. So I kind of feel like you have a deeper connection with people around you due to First2.
I would just have to agree about just personal connections with people. Of course like any club or organization, I've met people that I would otherwise never have seen. Hearing their stories or advice, or giving them advice. Like the camaraderie aspect of it.
F2N is providing upmost opportunities to students to do research and get involved.
Helping them a lot, supporting them, being their structure, and just someone that they could rely on most of the time, just someone to go to if they need help with anything, not only as a professor, but as a counselor.
I think like we've said before, the whole idea of having a support system for STEM students is a really good idea. That's working out well.
The opportunities that the network is providing for students. And like I said, I mean, I had been here longer before I'd heard ... But just seeing what others are getting to do and knowing about the opportunities that are available for scholars and mentors, such as like paid research and working summer things and just getting that experience and networking down. And I think that's something that's like going really well and helpful for the students.
I feel like people are like being exposed to a lot of things like that. They wouldn't really be exposed to as much if like they didn't go out and like go to something else, like a fair, like a career fair or something.
I think the funding is a big one, that a lot of us who are being funded feel. As well as the access to providing students with, like everyone's been saying this whole time, peer support and in helping each other out, which is something that some people in college don't have. And it's great that the network can provide us with that.

Any final comments to make anonymously via a survey link? Five participants took advantage of the opportunity to provide anonymous comments through the optional survey link that was

shared at the end of each interview. Given the sensitive nature of some of these comments, they are reported verbatim in their entirety.

> *I believe something the First2 Network could also improve upon would be fairness — across institutions and among students, whether they be a scholar or director. I have noticed some favoritism occurring within the network, whether it be an institution or [an] individual student.*
>
> *Really wish we would focus more on the "underrepresented" part on LGBT and women, and people of color.*
>
> *We need to uproot leadership. They don't take any student suggestions because they're all buddies and they all just agree with each other. They also don't hold each other accountable. The network is stagnating because of this.*
>
> *I believe that the First2 campus clubs are doing a phenomenal job of helping me progress in STEM. I also am glad for this network for connecting me with my research professors because I am getting vital information for the field that I am going into. But I believe that the higher-ups of the First2 hierarchy provide information in a less-than-ideal manner. In my personal experience, I hardly know of anything that is happening in the network, unless my campus club leaders tell me. This is most likely just because of the use of Slack. Personally, I do not like the service at all.*
>
> *I believe it is necessary for me to share the unfortunate lack of focus on research and careers in the First 2 Network, replaced by social theories and political theory. I joined the First 2 Network believing that it would aid me in my research other than just the funding I receive, but it is not. I have been decently active participating in group meetings and All-Student Meetings but research is not brought up. Unfortunately, what is brought up is equity theory and how folks are disadvantaged. I am not bringing up the Black History month discussion either, that is different and was appropriate, I even learned a thing or two. An example of what I am talking about was inside one of the quizzes a director made saying that the quote "I see no color" is a microaggression, when in reality it is a quote about equality. Skin color should not matter because everyone is created equal, clearly that is not what First 2 believes noting the constant mention of race. Instead, meetings should discuss certain aspects about research and tips to get through college. How do we publish research? What makes a good research paper? What are common mistakes people make in college and how to fix them? Certain things like that. I don't need to constantly hear about how none of my parents went to college and how I am oppressed and disadvantaged. A good deal of folks are upset about this and are just too afraid of speaking up in meetings because they may face repercussions. I do appreciate the side volunteer projects and the bonding that goes on between students made possible by First 2, it creates a sense of community. The idea of First 2 Network is a great one and I love it. Having first-generation students come together and form a network to support each other while actively being supported by the staff so they can do research in the STEM field. But what First 2 Network is doing is getting these people that may have lower incomes due to being first-gen who would seek any extra dollar, like myself, and paying them with taxpayer dollars to sit and listen to the staff push their agenda on them. I really want positive change and I am not saying that everyone is the network is guilty of this, I am just giving the effects. I wish the best and apologize if this is new news or is a lot to take in.*

4.3.5 Intern Focus Group Summary

In sum, respondents most often joined the First2 Network for the immersive experience that involved them in research and eased the transition into college. Feedback about the research internships was primarily positive, with students finding value in the experience and in the networking aspect of the network, although a few students noted the research component did not meet their expectations. Although students noted little effect of the internship on their decision to declare a STEM major, most perceived the internship did increase their confidence in their ability to do STEM coursework. And several perceived the internship had positively influenced their sense of themselves as future scientists or mathematicians and had positively influenced their progression through their STEM major. Participants held strong opinions as to how mission-centric students were to the First2 Network but had diverse views about how much voice students actually had in the network. Some students have been actively engaged in network PDSA activities but that was not a universal experience for all student members. Overall, students recognized the value of the First2 Network in building strong relationships and gaining research experience. Finally, students identified several areas for network improvement, including improved communications and respect for student obligations.

4.4 Student Outcomes

4.4.1 First2 Network Student Persistence Rates

During the First2 Network's fourth year, network leadership members conceptualized and established a data-sharing system whereby students participating in some aspect of network activity provided informed consent for the network to use their Social Security numbers to obtain verified HEPC data about STEM persistence. HEPC set up a secure site through which network leaders uploaded Social Security numbers and agreed to merge those identifiers with their state data set to compile individual-level persistence results. HEPC then aggregated STEM persistence information into a summary report that was shared with the evaluation team.

The overall STEM persistence rate among First2 Network, first-time freshman who provided consent for tracking is 76% (19 of 25 students). The overall STEM persistence rate among First2 Network sophomores and higher who consented to tracking is 85% (39 of 46 students).

STEM persistence rates varied widely for each cohort of first-time First2 Network freshmen. By Spring of 2022, only 50% (1 of 2 students) of the Fall 2018 cohort who provided consent were still pursuing a STEM major. (The persistence and completion rates for the 2018 cohort may in fact be higher because graduation data beyond Spring 2021 are not yet available to HEPC. In addition, the small number of students providing consent means that this estimate cannot reliably describe the experience of other Fall 2018 cohort students in the First2 Network.)

The majority (92%) of Fall 2019 (11 of 12 students) cohort persisted in their STEM majors, whereas only 64% of the Fall 2020 (7 of 11) cohort did so. Eighty-six percent (86%) of the Fall 2021 (18 of 21) cohort remained enrolled and in a STEM program by the Spring of 2022 (this represents the Fall-to-Spring persistence rate and is therefore not comparable to the other persistence rates reported here). The remaining percentages of these students either switched to a non-STEM major, transferred to another institution, or dropped out of college.

4.4.2 West Virginia University Persistence Rates

WVU, one of the First2 Network's primary institutions, has been tracking student persistence in STEM majors by analyzing whether students involved in the network directly or indirectly (through participation in a network PDSA) remained in a STEM major over time. Investigation of

this data set reveals that of the 421 students with a STEM major who either participated in First2 or in a network PDSA, 68% remained enrolled in a STEM major while 32% switched to a non-STEM major.

WVU also has a data system in place that enables users to track STEM student persistence by first-generation status and by rural status. Results are shown below for WVU, with the expectation that similar data from other public higher education institutions in West Virginia will be available next year.

Table 18 presents the number of first-generation and non-first-generation WVU STEM students, along with the average 1-year persistence rates for each group. Figure 48 provides these rates in a visual format, showing a clear pattern of first-generation STEM students having lower persistence rates than their non-first-generation counterparts since 2005, other than a single year's anomaly in 2014. Further, the gap between the two groups seems to have widened for cohorts since 2016, with 2018 showing the largest difference of 17 percentage points.

Table 18. 1-Year Persistence Rates for WVU STEM Students by First-Generation Status

Year	First-Generation		Non-First Generation	
	Number of Students	1-Year Persistence Rate	Number of Students	1-Year Persistence Rate
2005	387	55%	1,567	61%
2006	357	57%	1,642	61%
2007	401	59%	1,590	61%
2008	457	54%	1,994	63%
2009	445	59%	1,638	62%
2010	513	53%	1,829	61%
2011	443	60%	1,932	62%
2012	362	58%	2,259	61%
2013	156	58%	2,177	62%
2014	509	64%	1,832	62%
2015	530	62%	2,217	64%
2016	685	56%	2,059	63%
2017	614	55%	1,866	63%
2018	453	49%	1,663	66%

Figure 48. 1-Year Persistence Rates (Percentages) for WVU STEM Students by First-Generation Status

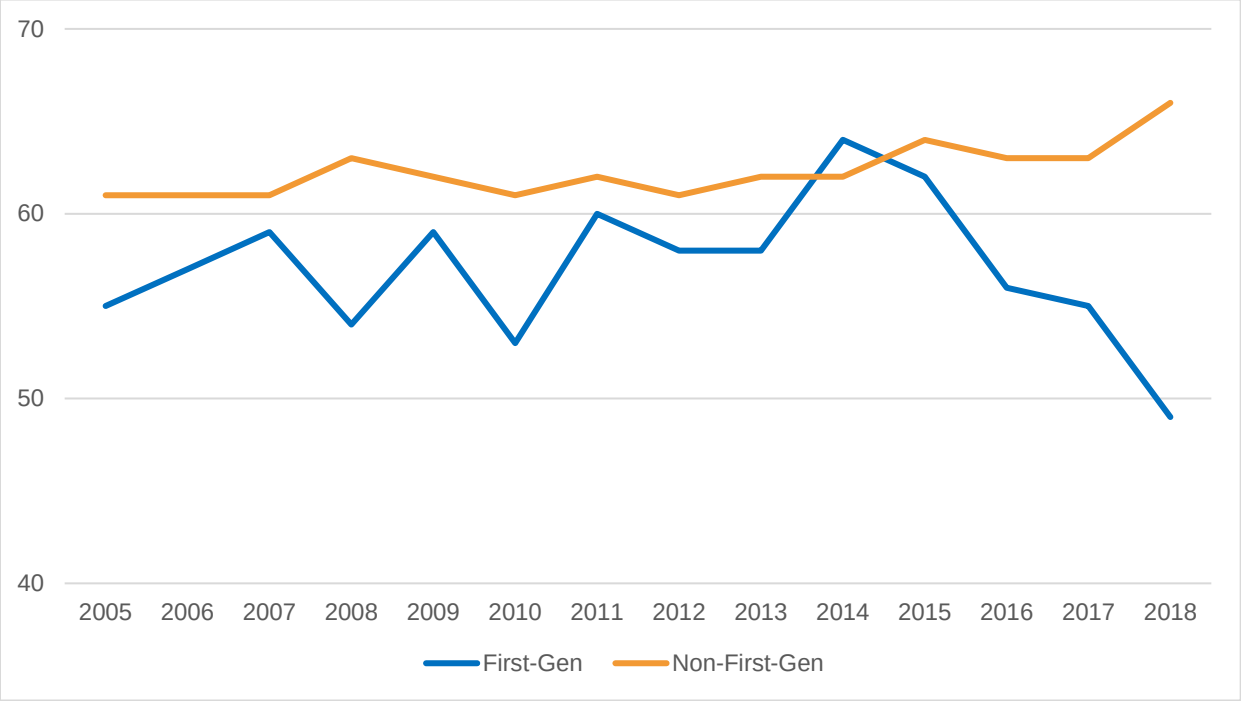


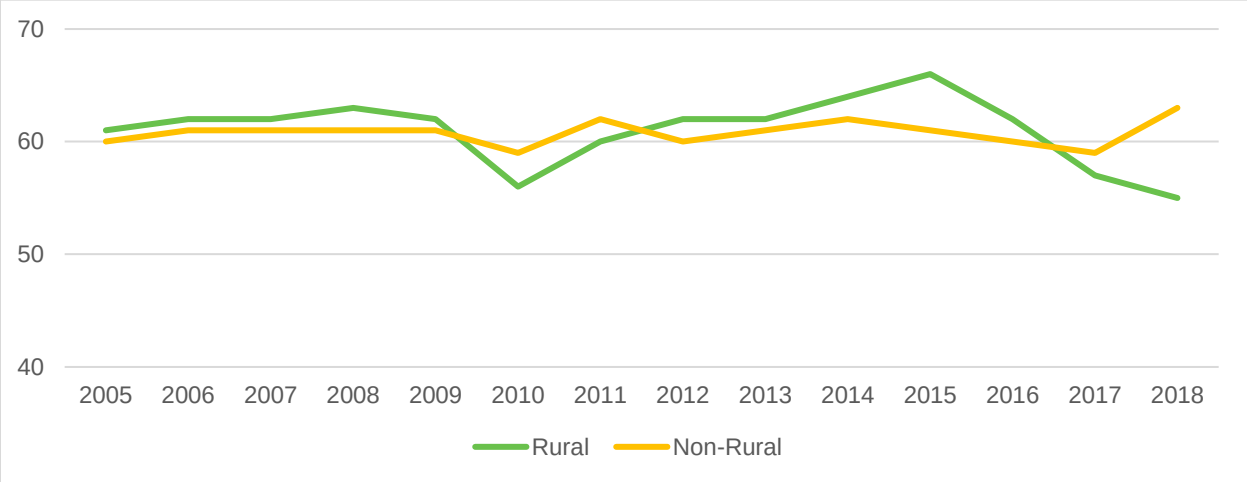
Table 19 presents the number of rural and non-rural WVU STEM students, along with the average 1-year persistence rates for each group. Figure 49 provides these rates in a visual format, showing a less clear-cut pattern of rural and non-rural student persistence rates. Overall, rural cohorts show slightly higher persistence rates for most years. Three cohorts (2010, 2011, 2017) show slightly lower persistence rates for rural STEM students, with 2018 showing the largest gap between rural and non-rural, a difference of eight percentage points favoring non-rural youth.

Table 19. 1-Year Persistence Rates for WVU STEM Students by Rural Status

Year	Rural		Non-Rural	
	Number of Students	1-Year Persistence Rate	Number of Students	1-Year Persistence Rate
2005	182	61%	1,635	60%
2006	201	62%	1,686	61%
2007	186	62%	1,680	61%
2008	208	63%	2,023	61%
2009	185	62%	1,714	61%
2010	226	56%	1,840	59%
2011	182	60%	2,122	62%
2012	187	62%	2,091	60%
2013	182	62%	1,958	61%
2014	159	64%	2,009	62%
2015	189	66%	2,225	61%

Year	Rural		Non-Rural	
	Number of Students	1-Year Persistence Rate	Number of Students	1-Year Persistence Rate
2016	177	62%	2,241	60%
2017	159	57%	2,031	59%
2018	175	55%	1,768	63%

Figure 49. 1-Year Persistence Rates (Percentages) for WVU STEM Students by Rural Status



4.4.3 Statewide STEM Readiness, Persistence, and Completion Rates

One metric the First2 Network tracks is the percent of STEM students across West Virginia persisting in their programs of study, regardless of their participation in network activities. Because the network also seeks to influence the readiness of STEM students for college and STEM program completion, this report also includes STEM readiness and STEM completion rates.

These state-level data are provided by HEPC DSR and disaggregated by variables of interest to the First2 Network for which data are available. Data are organized by College Readiness (STEM readiness rate), STEM Persistence (retention rate), and STEM Completion (graduation rate). Appendix C provides more complete details by College Readiness (Tables 1a–1e for readiness data for 2016–2020 freshmen), College Participation (Table 2 for Fall-to-Fall and Fall-to-3rd Fall retention rates for 2016–2020 freshmen), and College Persistence (Table 3 for graduation rates for 2012–2016 freshmen).

These data provide point-in-time information as part of the examination of trends throughout the First2 Network. In general, several consistent trends are apparent in these data:

- Pell recipients have significantly lower rates of readiness, persistence, and completion than their non-Pell counterparts.
- STEM students have consistently higher readiness and persistence rates than non-STEM students, but results are mixed for completion rates.
- In general, results by rurality indicate slightly lower readiness, persistence, and completion rates for rural youth as compared to non-rural youth.

To highlight areas of interest within readiness, persistence, and completion, Figures 50–55 are presented on the next several pages. Note that all these depictions focus on students based on whether they were a STEM major or a non-STEM major during their first year.

For College Readiness (Figures 50–51), Figure 50 shows that STEM students have higher rates of STEM readiness than Non-STEM students, regardless of rurality, for all four freshmen cohorts. Rural STEM and Non-Rural STEM scores increased from the 2016 cohort to 2017; then show a generally decreasing pattern through the 2020 cohort. The Non-STEM groups (both Rural and Non-Rural) both show an increase in STEM readiness rates for each successive cohort from 2016 to 2018, then rates drop or stay the same for the 2019 cohort (Rural and Non-Rural, respectively) before both decrease for the 2020 cohort.

Figure 50. STEM Readiness Rate (Percentage) by Freshmen Cohorts: Rurality by Major

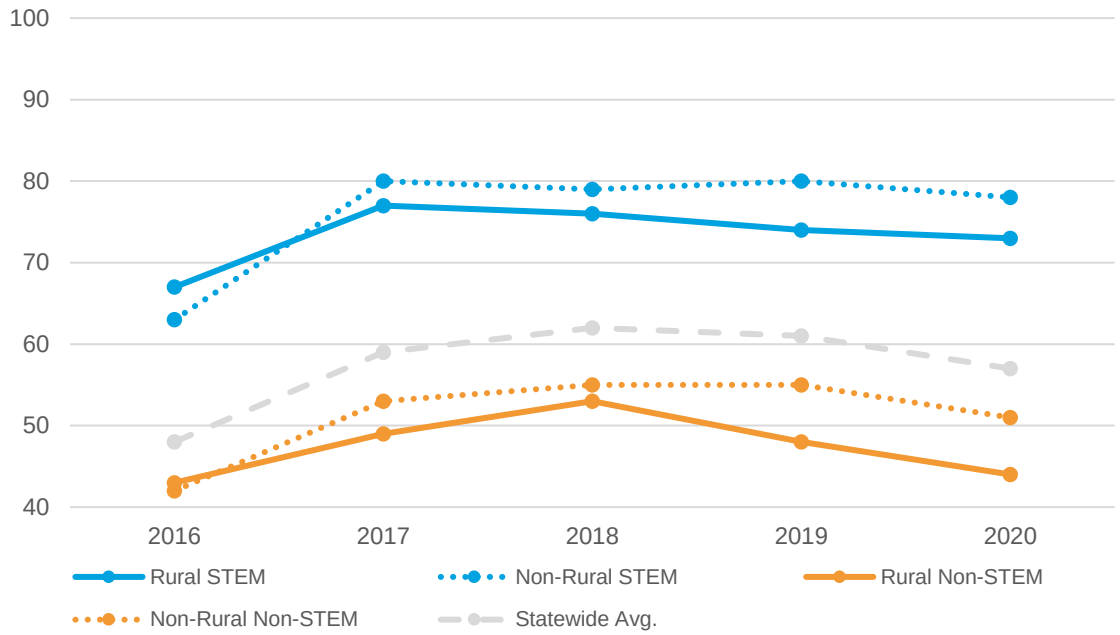
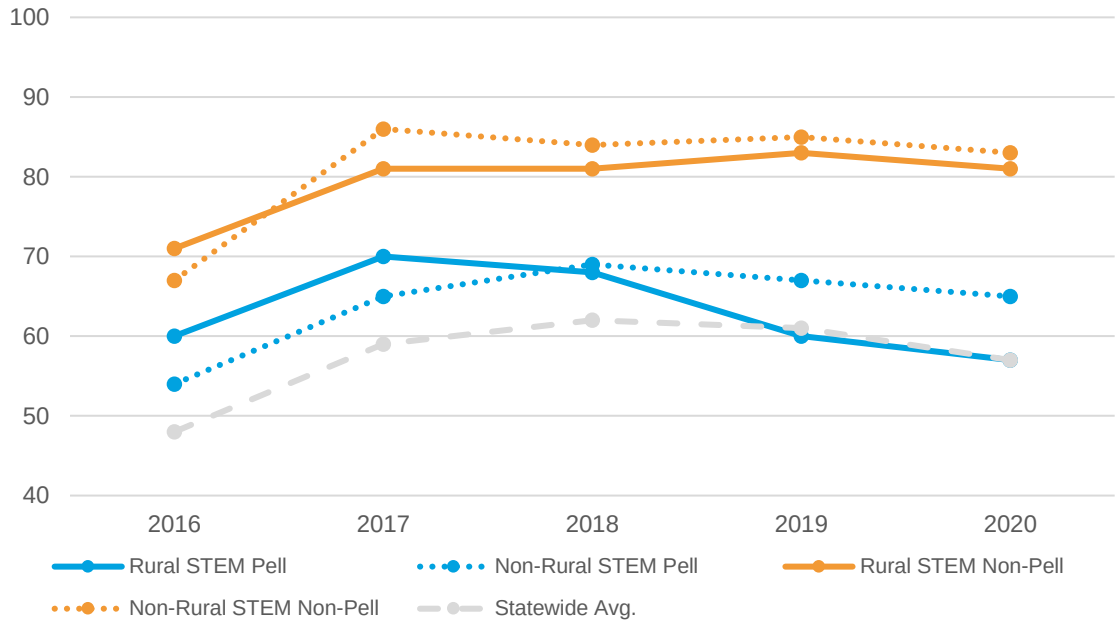


Figure 51 shows that for STEM students, Pell recipients have lower STEM readiness rates than their non-Pell counterparts, regardless of rurality, for all five cohorts. All four groups show varying patterns of increases, decreases, or nonchanging rates across the five cohorts, but all four groups show a decline for the 2020 freshmen cohort. The largest change is the 19-percentage point increase from 2016 to 2017 for Non-Rural STEM Non-Pell youth.

Figure 51. STEM Readiness Rate (Percentage) by Freshmen Cohorts: Rurality by STEM Major by Pell



For College Persistence (Figures 52–53), Figure 52 shows that STEM students have slightly higher retention rates than Non-STEM students, regardless of rurality, for all five cohorts. All four groups show a decrease in retention rates from the 2016 to 2017 cohorts, then increases from 2017 to 2018 and from 2018 to 2019, before reflecting a decrease from 2019 to the 2020 cohort.

Figure 52. Fall-to-Fall Retention Rate (Percentage) by Freshmen Cohorts: Rurality by Major

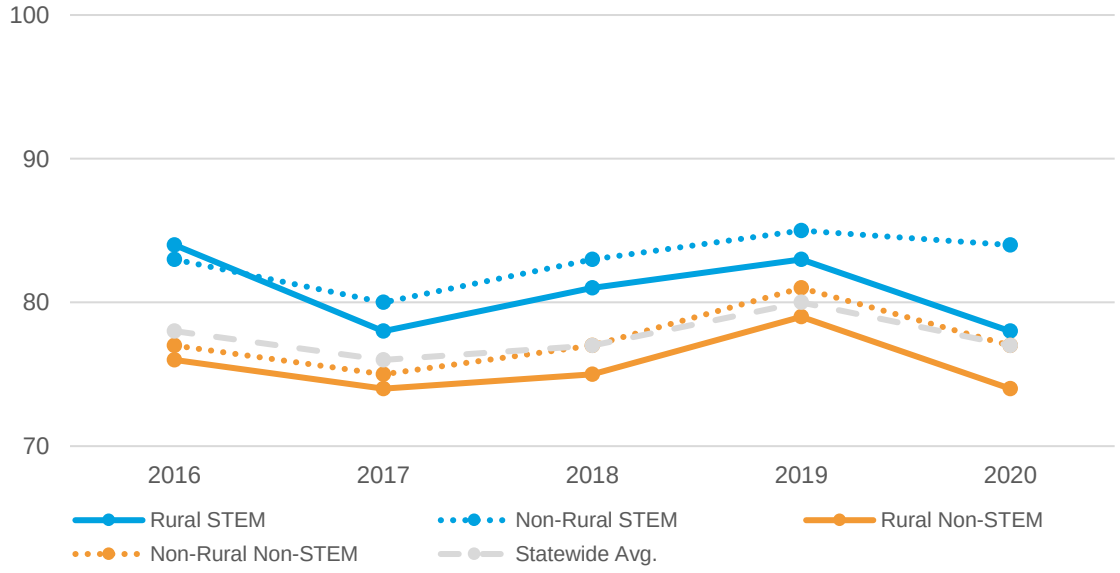
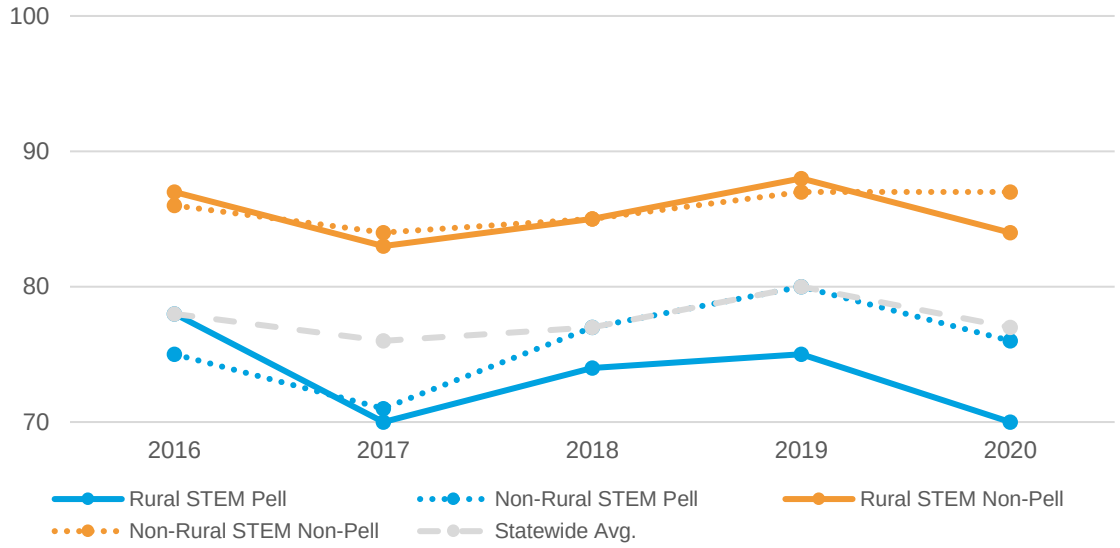


Figure 53 shows that for STEM students, Pell students have lower retention rates than their Non-Pell counterparts, regardless of rurality, for all four cohorts. All four groups show a decrease in retention rates from the 2016 to 2017 cohorts, then increases from 2017 to 2018 and from 2018 to 2019, before showing a decline for the 2020 cohort (except for the Non-Rural STEM Non-Pell group, which remained the same for 2020).

Figure 53. Fall-to-Fall Retention Rate (Percentage) by Freshmen Cohorts: Rurality by STEM Major by Pell



For College Completion (Figures 54–55), Figure 54 shows that STEM students have lower graduation rates than Non-STEM students, regardless of rurality, for four of the five cohorts (2013–2016); the 2012 freshmen cohort had slightly higher graduation rates for STEM youth compared to Non-STEM. All four groups show varying patterns of increases, decreases, or nonchanging rates across the five freshmen cohorts.

Figure 54. 4-Year Graduation Rate (Percentage) by Freshmen Cohorts: Rurality by Major

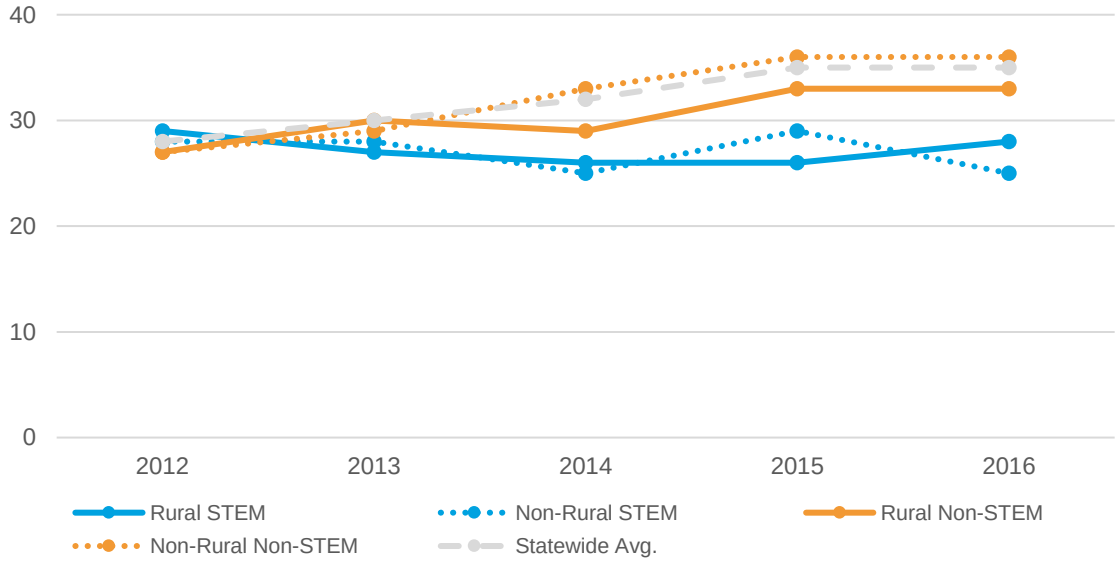
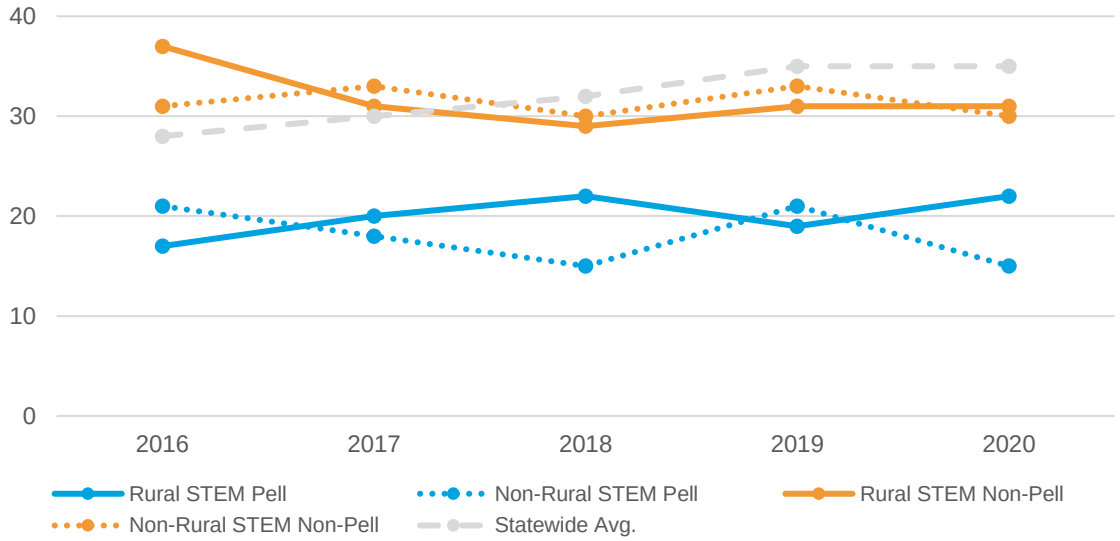


Figure 55 shows that for STEM students, Pell recipients have lower graduation rates than their Non-Pell counterparts, regardless of rurality, for all five freshmen cohorts. All four groups show a variety of increases, decreases, or nonchanging rates across the five freshmen cohorts.

Figure 55. 4-Year Graduation Rate (Percentage): Rurality by STEM Major by Pell



4.4.4 Student Outcomes Summary

The overall STEM persistence rate among First2 Network, first-time freshman who provided consent for tracking is 76% (19 of 25 students). The overall STEM persistence rate among First2 Network sophomores and higher who consented to tracking is 85% (39 of 46 students).

WVU data permit analyses of STEM persistence among first-generation students more broadly. At WVU, 1-year persistence rates are lower for first-generation students compared to non-first-generation students for 2005–2018 cohorts, with 2018 showing the largest difference. On the other hand, the 1-year persistence rates show little difference between rural and non-rural WVU STEM students for 2005–2018 cohorts, with 2018 showing the largest difference. Among all WVU students who participated in the First2 Network in any manner, the STEM persistence rate was 68%.

Analyses of all West Virginia students enrolled in public institutions indicate that Pell-eligible and rural youth had lower rates of STEM readiness, persistence, and completion than their non-Pell-eligible and non-rural counterparts. Not surprisingly, STEM students had higher STEM readiness and persistence rates than non-STEM students.

IV. Conclusions and Recommendations

This section synthesizes findings from evaluation of the First2 Network's third year of implementation and offers recommendations based on those conclusions for network leaders to consider.

1. Conclusions

1.1 Context in which the First2 Network Operates

Much about the context in which the First2 Network operates remains consistent since its launch. West Virginia continues to be poorer, less diverse, and less educated than the nation in general. West Virginia is still designated as an EPSCoR state, one indicator of limited STEM capacity. On the other hand, new efforts to improve and support STEM education have emerged. For instance, policymakers passed several STEM education bills during the 2022 legislative session and the state boasts new STEM education improvement initiatives.

1.2. First2 Network Structures and Processes

The First2 Network included 866 members, an increase of 78% from 487 in Year 3, 206% from 283 in Year 2, and 501% from 144 in Year 1. Students now comprise about a third of the membership (32%), compared to Year 3 at 43%. Faculty/staff membership remained fairly stable (33% in Year 4, 35% in Year 3). The percentage of members with unknown institutional roles rose dramatically, from 6% in Year 3 to 33% in Year 4.

The number of interns declined from Year 3 to Year 4, similar to the decline from Year 2 to Year 3. A total of 183 interns have participated in First2 Network summer experiences since 2019 (and completed a pre or post intern survey): 37 in Year 4, 50 in Year 3, 69 in Year 2, and 27 in Year 1. The representation of conventionally underrepresented racial/ethnic students in the Year 4 research internships is higher than their representation in the state at large (21% Black/African American and 8% Hispanic/Latinx, compared to state averages of 4% Black/African American and 2% Hispanic/Latinx). More than half of Year 4 interns (57%) self-identified as first-generation and female (57% each), 51% reported being Pell-eligible, and 49% hail from rural places.

The First2 Network made substantial progress in tightening its focus on improvement science. Not only was the driver diagram revised, but PDSA change ideas were aligned to those revised drivers and a PDSA coaching team was established to support First2 members in their improvement science efforts.

The Network continued its progress toward fully implementing all five elements of collaborative infrastructure. Network documents and member feedback indicate that members continue to promote a shared vision through an array of communication and outreach activities. These include hosting three network events; promoting social media (website, newsletter, Twitter); and presenting at six local or state conferences. Previous network partnerships were maintained and new partnerships established in Year 4, including its first community and technical college and five new industry partners, as well as becoming the mentor backbone for the WV Jobs Network. Efforts for obtaining and reporting shared metrics continued in Year 4: (1) an agreement with NSF to use WVU first-generation data as a proxy for statewide data, (2) to pursue a change in statewide data collection to establish a common definition and collection strategy for first-generation status, (3) enhanced coaching and support for network PDSA efforts, and (4) establishing a secure system for tracking First2 students' persistence data through HEPC.

During Year 4, First2 students continued their leadership efforts within the network through their paid service roles, their participation in the Student Leadership working group, and their efforts to create a policy on First2 student expectations. Changes in network leadership included transition of co-chair positions and a transition from working groups to institutional teams. Sustainability and scale-up efforts focused on implementation of the strategic plan, including

planning to dissolve the Leadership Team and transfer authority to the Steering Committee, establishing a new partnership with the CINSAM at Northern Kentucky University, securing other funding, and continuing the transition toward institutional teams.

In terms of working group functions, the November 2021 administration of the Working Group Self-Assessment had the largest number of respondents (67) since the survey was first administered in May 2019, and nearly two-thirds of those respondents were student members. These results seem to mirror the growing pains experienced by the network during Year 4, with mean subscale scores reflecting a mix of higher and lower ratings than the previous two November administrations (2019 and 2020). The Do and Act subscales showed constant improvement in ratings for each November administration (2019, 2020, and 2021); Plan, Collaborate, and Building Capacity showed higher ratings in 2021 compared to 2019; and Study, Disseminate, and Equity remained identical or nearly identical between 2019 and 2021. Further, for the five items focused on individuals' contributions to the working group, four showed slight but consecutive decreases for each November administration (2019, 2020, and 2021).

Steering Committee survey feedback presented a mix of increasing and decreasing ratings compared to Year 3 but most perceptions still fall in the range of the "Making Progress" category. However, these results do seem to reflect a degree of flux as network transitions occurred during Year 4. Most promising were perceptions that the right people were on the Steering Committee, that individuals were leading a working group or keeping abreast of working group activities, and that individuals communicated with others about the network efforts.

The First2 Network offered multiple events during Year 4, including a virtual fall conference, a winter virtual PDSA workshop, and a spring virtual and in-person conference. Feedback was very positive for the fall and spring conferences, with average ratings close to or above 4.0 on a 5-point agreement scale. For both conferences, the most common theme for future improvement was to adjust the schedule, i.e., more transition time between sessions, more breaks, more time for discussion and networking. The virtual PDSA workshop was also well received, but again participants noted a need for more time for the breakout room discussions.

1.3. Systems Targeted by the First2 Network

Members of the First2 Network undertook a number of efforts to improve the systems that can enable or constrain the early STEM persistence of rural, first-generation students in West Virginia. During Year 4, these included pathway improvements such as FSU securing an S-STEM award, the network becoming the backbone for the WV Jobs Network, and securing additional education and industrial partners. Structural improvement efforts in Year 4 included the network's contribution in developing and advocating for passage of West Virginia SB 228, which provides students with a year of tuition waiver for every year of AmeriCorps service completed, and serving as a partner in West Virginia HEPC's Science and Technology Plan, which sets a 5-year vision for state investment and action in scientific research, innovation, and capacity building.

Two specific examples of systems change were showcased in greater detail in the report—a three-phase initiative at Marshall University to ease transition challenges for incoming freshmen and the state legislation (SB 228) that grants tuition waivers for AmeriCorps service. The Marshall initiative has led to identification of several major information gaps and the production of a Frequently Asked Questions document to share with high school seniors and college freshmen to address those issues. The AmeriCorps initiative provides 1-year tuition waivers for every 1,200 hours of service. The idea for SB 228 grew out of First2 leaders' work with STEM students and high-need youth and adults. After initially stalling as a West Virginia State House

bill in 2021; the network continued advocating for this legislation and sought out a senate sponsor in 2022. Slated to launch in fall 2022, students can earn up to a maximum of 4 years of enrollment.

One systems change sought by the First2 Network is the establishment and operation of a fully functional, sustainable backbone organization housed at HEPC DSR. Both the mentor (SRI) and backbone (HEPC DSR) organizations continued this work in Year 4, both in building HEPC DSR capacity and in HEPC DSR carrying out those responsibilities. Mentor and backbone activities focused heavily on improvement science and sustainability planning this year. An improvement science team will be providing support for institutional teams completing PDSAs, following coaching on this support strategy by SRI staff. There was general consensus that capacity had been built in the areas of network communications and conferences and in initial steps to track first-generation status statement, remaining needs were identified. These included cross-network sharing of institutional information, conducting and tracking PDSA efforts, a sustainability plan that included streamlined leadership responsibilities, and additional funding and staffing. Staffing was also raised as a remaining area of need in Year 3; both years highlighted the need for more support in the area of grant writing and data analysis.

Another systems change pursued by the network is the development of a sustainable statewide collective that ultimately helps members make changes to their institutions that better support the STEM persistence of rural, first-generation students. As networks develop and their collaborative efforts mature, what members value about their participation evolves, progressing from the value of networking itself to valuing the ways network involvement enables institutional change. First2 members in Year 4 continued to most value networking and community-building, followed by gaining new knowledge and applying learning and practices. Year 4 reflected the highest number of respondents to the Network Value Survey, but all five subscale scores showed slight decreases from Year 3.

1.4. Impact of the First2 Network

During Year 4, the First2 Network continued to expand, growing to 866 members. At the same time, the strength of connections among members improved, with mean ratings suggesting that relationships are at a Coalition level (characterized by frequent communication, shared resources, and shared decision-making). Building STEM social capital throughout the state to pursue improved STEM persistence is an important impact of the First2 Network.

Summer research internships for rising freshmen are one of the network's key change ideas. Students participating in the six internships for which data were available at the time of this writing rated their experiences highly. All respondents agreed that the experience positively influenced how they feel about their chosen college. The most highly rated aspects of internships were opportunities to collaborate with faculty members and the research training provided by faculty members. Participants made statistically significant improvements in their sense of school belonging, knowledge about research, and personal skills, according to mean pretest and posttest scores.

Intern focus groups indicated that students valued summer research experiences and opportunities to network with other students and with faculty, although a few students reported that the research component of summer internships did not meet their expectations. Students noted that the internships played little role in their decision to declare a STEM major; most reported that the summer research experiences improved their confidence in their ability to do STEM coursework. Several also said that the internship strengthened their sense of themselves as future scientists or mathematicians and continued to support their progression through their

STEM major. Participants strongly supported the First2 Network's commitment to engaging students as co-creators of solutions to the problems contributing to STEM attrition but had diverse views about how much voice and power students actually had in the network. Some students have been actively engaged in network PDSA activities, but that was not a universal experience for all student members. Finally, students identified several areas for network improvement, including communications, respect for student obligations, and clearer power sharing with students.

The First2 Network sought informed consent for the network to use their Social Security numbers to obtain verified HEPC data about their progress. The overall STEM persistence rate among First2 Network, first-time freshman who provided consent for tracking is 76% (19 of 25 students). The overall STEM persistence rate among First2 Network sophomores and higher who consented to tracking is 85% (39 of 46 students). The clearest comparison may be with WVU data on the STEM persistence of first-generation students between 2005 and 2018, with rates ranging from 49% to 64% (in contrast to the rates among non-first-generation students, which varied between 61% and 66%). Thus—although data are limited due to the small number of consenting students and perhaps confounded by selection bias—estimates suggest that First2 Network students persist in their STEM majors at higher rates than both their first-generation and non-first-generation peers at WVU.

Data from WVU beginning with the 2005 cohort indicate clear disparities in the STEM persistence of first-generation and non-first-generation students. In addition, the gap between the two groups has widened since the 2016 cohort; the largest disparity appeared among the 2018 cohort with a difference of 17 percentage points (49% among first-generation students and 66% among non-first-generation students).

On the other hand, the role of rurality is less clear among WVU cohorts. Rural STEM persistence rates, with a few exceptions, were higher than non-rural STEM persistence rates between 2005 and 2016. But among the 2017 and 2018 cohorts, rural students persisted in their STEM majors at lower rates than non-rural students. The gap grew to eight percentage points in the 2018 cohort, with only 55% of rural students persisting in STEM compared to 63% of non-rural students.

As in prior years, statewide analyses in which Pell-eligibility is employed as a proxy for first-generation status indicate that Pell-eligible STEM students have lower STEM readiness scores and lower STEM persistence and graduation rates. Although rural STEM students earned lower STEM readiness scores and had lower persistence rates across the state, STEM graduation rates tended to be similar for rural and non-rural students.

2. Recommendations

As the First2 Network begins its fifth year and progresses toward sustainability, network leaders and members may want to consider the following recommendations.

- Continue to build the capacity of institutional teams to engage in First2 Network activities, including collaborating with students as full partners in co-creating solutions to the challenges of STEM attrition, using improvement science processes and tools to test and iterate identified solutions, and scaling up solutions that are demonstrated as effective.
- Offer members opportunities to learn about systems change (as distinct from changes at the individual or classroom levels) so that the First2 Network members can envision the larger scales on which they might focus their improvement efforts. Provide examples of systems changes that might be amenable to PDSAs.

- Complete sustainability planning and implement sustainability activities so that the First2 Network can evolve as INCLUDES funding comes to an end. Needs include transitioning leadership responsibility from the Leadership Team to the Steering Committee, pursuing additional funding, and determining and addressing backbone and other staffing needs. Continue documenting formal decisions about how to structure, fund, and communicate about the First2 Network once INCLUDES funding is expended.
- Revisit the roles of the backbone and the mentor backbone to ensure a smooth transition of responsibility for backbone support of the First2 Network to HEPC DSR.
- Recommit to the role of students as full partners in the First2 Network. Provide guidance to institutional teams about practices and processes that can amplify student voice. Continue providing accommodations for student participants to ensure their full participation in the network, such as planning meetings around significant college calendar dates. Encourage non-students in the network to engage regularly with students during regular Student Leadership meetings, on institutional teams, and at conferences to discuss relevant issues, understand student perspectives, and co-create collaborative action.
- Continue efforts to ensure that state public higher education institutions consistently collect data about students' first-generation status. Plan for regular data disaggregation by first-generation status so stakeholders have access to information about academic outcomes among first-generation students as well as about any disparities between first-generation and non-first-generation students.
- Celebrate and communicate widely about Year 4 successes. Create opportunities to share success stories from the network with new audiences. Devote some time during network conferences to highlight what the network has learned about improving STEM persistence among first-generation students, how the network has put its learnings into practice, and what has resulted from such endeavors. As the network progresses toward full implementation of its strategic and sustainability plans, leaders and members should consider ways to communicate about its new structures (e.g., institutional teams) so that others interested in its work know how to become involved.

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[1] Appalachian Regional Commission. (2020). *County economic status and number of distressed areas in West Virginia, fiscal year 2021: Appalachian West Virginia.* https://www.arc.gov/wp-content/uploads/2020/07/CountyEconomicStatusandDistressAreasFY2021WestVirginia.pdf

[2] United States Census Bureau. (n.d.). *QuickFacts.* https://www.census.gov/quickfacts/fact/table/US/PST045219

[3] United States Census Bureau. (n.d.). *QuickFacts: State and county, West Virginia.* https://www.census.gov/quickfacts/fact/table/US/PST045219

[4] Appalachian Regional Commission. (2020). *County economic status and number of distressed areas in West Virginia, fiscal year 2021: Appalachian West Virginia.* https://www.arc.gov/wp-content/uploads/2020/07/CountyEconomicStatusandDistressAreasFY2021WestVirginia.pdf

[5] United States Census Bureau. (n.d.). *QuickFacts.* https://www.census.gov/quickfacts/fact/table/US/PST045219

[6] United States Census Bureau. (n.d.). *QuickFacts: State and county, West Virginia.* https://www.census.gov/quickfacts/fact/table/US/PST045219

[7] Appalachian Regional Commission. (2022). *County economic status and number of distressed areas in West Virginia, fiscal year 2023: Appalachian West Virginia.* https://www.arc.gov/wp-content/uploads/2022/06/CountyEconomicStatusandDistressAreasFY2023WestVirginia.pdf

[8] United States Census Bureau. (n.d.) *QuickFacts: West Virginia.* https://www.census.gov/quickfacts/fact/dashboard/WV,US/PST045221

[9] United States Census Bureau. (n.d.). *QuickFacts: United States.* https://www.census.gov/quickfacts/fact/dashboard/US/PST045221

[10] United States Census. (n.d.). *QuickFacts: West Virginia.* https://www.census.gov/quickfacts/fact/dashboard/WV,US/PST045221

[11] Southern Regional Education Board. (2020). *West Virginia snapshot 2020* [Infographic]. https://www.sreb.org/sites/main/files/file-attachments/west_virginia_snapshot_2020.pdf?1594651694

[12] United States Census. (n.d.). *QuickFacts: West Virginia.*

https://www.census.gov/quickfacts/fact/dashboard/WV,US/PST045221

[13] Southern Regional Education Board. (2021). *West Virginia featured facts: From the SREB book on higher education*. https://www.sreb.org/publication/west-virginia-featured-facts

[14] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. (2020). *Digest of education statistics: Table 2014.10.* https://nces.ed.gov/programs/digest/d20/tables/dt20_204.10.asp

[15] Douglas, S., & Walker, A. W. (2015). *Coal mining and the resource curse in the eastern United States. Social Science Research Network.* http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2385560_code59895.pdf?abstractid=2385560&mirid=1

[16] Eller, R. (2008). *Uneven ground: Appalachia since 1945*. University Press of Kentucky.

[17] United States Census Bureau. (n.d.). QuickFacts: West Virginia. https://www.census.gov/quickfacts/fact/table/WV/PST045221

[18] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. (n.d.). *The Nations Report Card (2020-21)*. https://www.nationsreportcard.gov

[19] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. (2021). *Digest of education statistics: Table 203.70*. https://nces.ed.gov/programs/digest/d21/tables/dt21_203.70.asp?current=yes

[20] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. (2020). *Digest of education statistics: Table 204.20*. https://nces.ed.gov/programs/digest/d21/tables/dt21_204.20.asp

[21] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. (2022). *Digest of education statistics: Table 204.70.* https://nces.ed.gov/programs/digest/d21/tables/dt21_204.70.asp

[22] United States Census Bureau. (2021). *2010 census urban and rural classification and urban area criteria.* https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html

[23] Showalter, D., Hartman, S., Johnson, J., & Klein, R. (2019). *Why rural matters 2018-2019: The time is now.* The Rural School and Community Trust. http://www.ruraledu.org/WhyRuralMatters.pdf

[24] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2017). *Selected statistics from the public elementary and secondary education universe: School year 2015-16.* https://nces.ed.gov/pubs2018/2018052/tables.asp

[25] Showalter, D., Hartman, S., Johnson, J., & Klein, R. (2019). *Why rural matters 2018-2019: The time is now.* The Rural School and Community Trust. http://www.ruraledu.org/WhyRuralMatters.pdf

[26] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2017). *Selected statistics from the public elementary and secondary education universe: School year 2015-16.* https://nces.ed.gov/pubs2018/2018052.pdf

[27] Showalter, D., Hartman, S., Johnson, J., & Klein, R. (2019). *Why rural matters 2018-2019: The time is now.* The Rural School and Community Trust. http://www.ruraledu.org/WhyRuralMatters.pdf

[28] Showalter, D., Hartman, S., Johnson, J., & Klein, R. (2019). *Why rural matters 2018-2019: The time is now.* The Rural School and Community Trust. http://www.ruraledu.org/WhyRuralMatters.pdf

[29] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2017). *Selected statistics from the public elementary and secondary education universe: School year 2015-16.* https://nces.ed.gov/pubs2018/2018052.pdf

[30] West Virginia Department of Education. (n.d.). *State assessment summary.* ZoomWV. https://zoomwv.k12.wv.us/Dashboard/dashboard/7301

[31] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. *Data tools: State profiles (State performance compared to the nation in grade 4 mathematics)*. https://www.nationsreportcard.gov/profiles/stateprofile?chort=1&sub=MAT&sj=&sfj=NP&st=MN&year=2019R3

[32] Southern Regional Education Board (2020). *Charting a course to 2030: West Virginia state progress report – A turning point.* https://www.sreb.org/sites/main/files/file-attachments/wv_2020_state_goals.pdf?1594651710

[33] Southern Regional Education Board (2020). *Charting a course to 2030: West Virginia state progress report – A turning point.* https://www.sreb.org/sites/main/files/file-attachments/wv_2020_state_goals.pdf?1594651710

[34] West Virginia Department of Education. (n.d.). *Graduation rate trend.* Zoom WV. https://zoomwv.k12.wv.us/Dashboard/dashboard/2111

[35] ACT. (2019). *The condition of college and career readiness 2019.* http://www.act.org/content/dam/act/unsecured/documents/cccr-2019/National-CCCR-2019.pdf and ACT. (2018). *The condition of college and career readiness 2018.* https://www.act.org/content/dam/act/unsecured/documents/cccr2018/National-CCCR-2018.pdf#:~:text=THE%20CONDITION%20OF%20COLLEGE%20AND%20CAREER%20READINESS%20NATIONAL,at%20some%20time%20from%20grade%2010%20to%2012.

[36] ACT. (2019). *The condition of college and career readiness 2019.* http://www.act.org/content/dam/act/unsecured/documents/cccr-2019/National-CCCR-2019.pdf and ACT. (2018). *The condition of college and career readiness 2018.*

[37] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2021). *Digest of education statistics: Table 219.85a.* https://nces.ed.gov/programs/digest/d20/tables/dt20_219.85a.asp?current=yes

[38] West Virginia Higher Education Data Portal Explorer (n.d.). *College-going rate of WV public high school graduates at a glance* [Infographic]. West Virginia Higher Education Policy Commission. http://www.wvhepc.edu/resources/data-and-publication-center/cgr/

[39] West Virginia Higher Education Policy Commission. (n.d.) Institutions. http://www.wvhepc.edu/institutions/

[40] West Viriginia Community & Technical College System. (n.d.) Colleges. https://www.wvctcs.org/colleges

[41] https://www.wvicu.org/

[42] West Virginia Higher Education Policy Commission. (n.d.) Institutions. http://www.wvhepc.edu/institutions/

[43] Southern Regional Education Board. (2018). *Challenge to lead 2020 goals for education: West Virginia state progress report – Looking closer*. https://www.sreb.org/sites/main/files/file-attachments/2018progress_wv.pdf

[44] Southern Regional Education Board (2020). *Charting a course to 2030: West Virginia state progress report – A turning point.* https://www.sreb.org/sites/main/files/file-attachments/wv_2020_state_goals.pdf?1594651710

[45] West Virginia Higher Education Policy Commission & West Virginia Community and Technical College System. (2019, January 15). *Academic readiness report*. http://www.wvhepc.edu/wp-content/uploads/2019/06/AcademicReadinessReport_2018_AMENDED_15Jan2019.pdf

[46] West Virginia Higher Education Policy Commission & West Virginia Community and Technical College System. (2018). *West Virginia higher education report card 2018.* http://www.wvhepc.edu/wp-content/uploads/2019/01/ReportCard_FINAL_8Jan2019.pdf?

[47] West Virginia Department of Education. (n.d.). *COVID recovery timeline* [Infographic]. https://wvde.us/covidtimeline/

[48] Annie E. Casey Foundation. (2022). *2022 KIDS COUNT data book: State trends in child well-being.* https://assets.aecf.org/m/resourcedoc/aecf-2022kidscountdatabook-2022.pdf

[49] ACT. (2019). *The condition of college & career readiness 2019: West Virginia key findings.* https://www.act.org/content/dam/act/unsecured/documents/cccr-2019/West-Virginia-CCCR-2019.pdf

[50] ACT. (2019). *The condition of college & career readiness 2019: West Virginia key findings.* https://www.act.org/content/dam/act/unsecured/documents/cccr-2019/West-Virginia-CCCR-2019.pdf

[51] Education Alliance. (n.d.). *STEM Works: What is STEM works?* http://educationalliance.org/stem/

[52] WVNews. (2021, November 3). WVU, W.Va. Dept. of Education partnership advances K-12 classrooms computer science classes to among the top in the nation. https://www.wvnews.com/news/wvnews/wvu-w-va-dept-

of-education-partnership-advances-k-12-classrooms-computer-science-classes-to/article_2052d6cc-3cc4-11ec-8bd3-bbebb7912153.html

[53] https://m3twv.org/

[54] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2009). *Stats in brief: Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education* (Report No. NCES 2009-161). https://nces.ed.gov/pubs2009/2009161.pdf

[55] National Science Foundation. (2018). *NSF INCLUDES: Report to the nation.* https://www.nsf.gov/news/special_reports/nsfincludes/pdfs/INCLUDES_report_to_the_Nation.pdf

[56] National Science Foundation. (2018). *NSF INCLUDES: Report to the nation.* https://www.nsf.gov/news/special_reports/nsfincludes/pdfs/INCLUDES_report_to_the_Nation.pdf

[57] Latham, N. (2014). *A practical guide to evaluating systems change in a human services system context.* Center for Evaluation Innovation. https://www.evaluationinnovation.org/publication/a-practical-guide-to-evaluating-systems-change-in-a-human-services-system-context/

[58] Kania, J., Kramer, M., & Senge, P. (2018). T*he water of systems change.* FSG.

[59] Latham, N. (2014). *A practical guide to evaluating systems change in a human services system context.* Center for Evaluation Innovation. https://www.evaluationinnovation.org/publication/a-practical-guide-to-evaluating-systems-change-in-a-human-services-system-context/

[60] Wenger, E., Trayner, B., & de Laat, M. (2011). *Promoting and assessing value creation in communities and networks: a conceptual framework.* Rapport 18, Ruud de Moor Centrum, Open University of the Netherlands. https://www.asmhub.mn/uploads/files/11-04-wenger-trayner-delaat-value-creation.pdf

[61] Bergstrom, A., Clark, R., Hogue, T., Perkins, D., Slinski, M., & Associates. (1995). Collaboration framework: Addressing community capacity. National Network for Collaboration https://www.uvm.edu/sites/default/files/media/Collaboration_Framework_pub.pdf