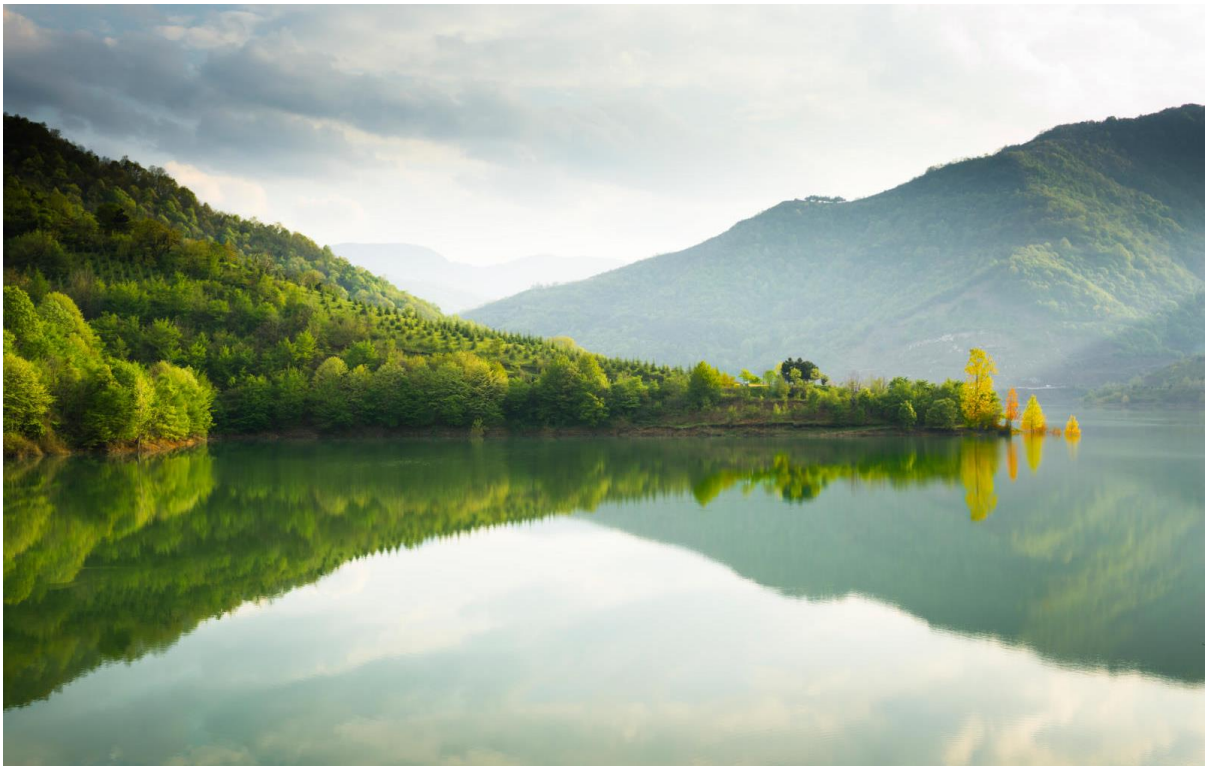

Evaluation of the First2 Network

Year 3 (2020–2021)

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I. Executive Summary

The First2 Network is a *collective impact* alliance seeking to improve the early persistence of rural, first-generation science, technology, engineering, and mathematics (STEM) college students in their programs of study across West Virginia. The Network was established to address a troubling problem identified by research, namely that attrition from STEM majors is most likely to occur during students' first two years of college, and that students whose parents did not attend college—first-generation college students—are at even higher risk of attrition.

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.

Key Findings from Year 3 Evaluation

- 238% increase in membership from Year 1, from 144 to 487
- Students represent 43% of network membership
- Year 3 summer interns were more racially/ethnically diverse than the overall WV student population, and more than half identified as first-generation
- Members conducted 64 Plan-Do-Study-Act cycles to test practices hypothesized to improve STEM persistence
- Higher levels of STEM social capital among members in Year 3 than in previous years
- Following First2 Network internship participation, 2021 interns demonstrated statistically significantly higher mean scores on measures of their research attitudes, knowledge, skills, and behaviors
- Fall-to-Spring STEM persistence rate of 2020 interns for whom the evaluation team could obtain data was 78%, comparable to statewide Fall-to-Fall STEM persistence rates. The evaluation team will provide an addendum to this report when data about Fall 2020-to-Fall 2021 STEM persistence are available.

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 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 third year of operation (October 1, 2020 through September 30, 2021). 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 First Network leaders and members to consider as they begin Year 4 are offered.

First2 Network Members

- Year 3 interns are diverse
  - 16% identify as Black/African American, 4% as Hispanic/Latinx, 4% as American Indian/Alaska Native, 2% as Asian/Asian American, with 86% identifying as white
  - At least 42% are eligible for federal Pell grants (a proxy measure of low-income status)
  - 56% are first-generation college students
  - 40% hail from rural communities and 42% from towns
- Network members represent a wide array of West Virginia STEM stakeholder entities
  - 43% are students
  - 35% are university faculty or staff
  - 6% are K-12 educators
  - 2% are state government/state education agency staff and 2% represent education non-profit organizations
  - The remainder hail from industry, foundations, and other state entities

Context. The COVID-19 pandemic continues to be a significant contextual factor in the life of the First2 Network. A few summer research experiences were facilitated online as they had been in Year 2, but most were held in person, and both conferences were likewise held virtually. Students reported facing the sorts of educational access challenges that have become widespread nationwide—unstable broadband, coursework that did not transition to virtual formats successfully, lack of connection to other students and to campus life. On the other hand, some network members reported that the use of virtual meetings and conferences improved their access to network activities since participation did not require travel.

COVID-19 aside, much about the context in which the First2 Network operates remains consistent. West Virginia remains poorer, less diverse, and less educated than the nation in general. West Virginia remains an EPSCOR state, one indicator of limited STEM capacity. During the 2021 state legislative session, policymakers introduced several STEM education bills, but none were passed.

First2 Network Structures and Processes. The First2 Network included 487 members, an increase of 72% from 283 in Year 2 and of 238% from 144 in Year 1. More than two-fifths (43.1%) of members were students, and over a third (34.9%) were university faculty or staff.

The number of summer research interns declined between Year 2 and 3. A total of 159 interns have participated in First2 Network summer experiences since 2019. Thirty-one participated in Year 1, 74 in Year 2, and 54 in Year 3.

The representation of conventionally underrepresented racial/ethnic students in the Y3 First2 Network summer research internships is higher than their representation in the state at large. A total of 16.0% identified as Black/African American, 4.0% as Hispanic or Latinx, and 4.0% as American Indian/Alaska Native.

More than half (56.0%) of interns self-identified as a first-generation college student. Two-fifths (40.0%) of interns hail from rural places and a similar percent (42.0%) report coming from towns. Two thirds (67.0%) of Year 3 interns were women.

The First2 Network made substantial progress toward full implementation of all five elements of collaborative infrastructure. Network documents and member feedback indicate that members embraced a shared vision, which they promoted via an array of communication and outreach activities. The network continued to expand its partnerships, signing MOUs formalizing institutional partnerships and engaging with national STEM education and first-generation collaboratives. In addition, the network made progress toward establishing processes for obtaining and reporting shared metrics via a data dashboard and toward improving communication about metrics from project research and evaluation. Adults and students alike were offered leadership development opportunities and leadership roles in the network. To support expansion, sustainability, and scale, the First2 Network established an EPSCoR workshop planning team for outreach to other EPSCoR jurisdictions, developed and began implementation of a strategic plan, and facilitated advisory committee and industry advisory board meetings.

In terms of the functioning of working groups, mean subscale scores on the Working Group Self-Assessment have consistently improved since Year 1. The extent to which working groups engage in collaboration continues to be the most highly rated subscale. On the other hand, the Measurement Team identified several issues that the network might address to improve the use of improvement science across the network, including strengthening oversight of improvement science activities, alignment of change ideas to the driver diagram, quality control of change ideas and PDSAs, and capacity building across the backbone organization to support improvement science.

Steering Committee members have observed important progress in the committee's work over the course of Year 3. Although some governance and communication issues remain to be resolved (e.g., maintaining clear focus on network goals, ensuring active participant engagement, ensuring everyone has an equal voice, reducing burnout), respondents tended to think that governance and communication had improved since the network's first year. Steering Committee members also reported that they had nearly or fully achieved their roles in leading work groups, understanding the responsibilities of Steering Committee membership, and championing the First2 Network by communicating with others in the state and elsewhere about its work. They also cited progress toward achieving goals associated with other Steering Committee roles.

First2 Network conferences continue to be well-received by participants, offering opportunities to interact with colleagues and learn about broadening STEM participation. Attendees in both October 2020 and May 2021 rated the events highly regarding format and content. Interestingly, a larger percentage of participants in the May 2021 than the October 2020 conference indicated that they were new to the network (20% compared to 6%).

Systems Targeted by the First2 Network. The First2 Network aims to change the systems that influence STEM persistence. Members of the First2 Network undertook an array 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 3, these included attempts to improve the pathways, and the linkages among such pathways, along which students travel across their academic experiences. Notable efforts were jointly developing a grant proposal with the WVU Physics Frontier Center and five community colleges to partner in a STEM engagement effort;

creating a West Virginia STEM assets map to document STEM pathways available to students and identify service gaps; helping students to facilitate peer support and campus clubs to help first-generation students acclimate to STEM majors; establishing an Industry Advisory Board to facilitate co-creation of clearer pathways from STEM education to STEM careers; planning to establish "institutional implementation teams" to coordinate student support for first-generation students on partner campuses; and building relationships with other state STEM collaboratives and industry including to jointly plan and coordinate STEM education efforts.

In terms of structural change, the First2 Network strove to create structural enablers to support improvements to STEM persistence. Such activities included contributing to a state legislative bill that would provide students completing one year of AmeriCorps service with one year of tuition to a state public college, supporting students who need to stop out of school to work, care for family members, and/or earn money to attend school, limit their postsecondary absence, and afford another year. This is particularly enabling for first-generation college students, who are more likely to need to work or care for families than students who are not first generation.

One systems change sought by the First2 Network is the establishment of a fully functional, sustainable backbone organization housed at HEPC DSR. Both the mentor backbone and backbone organizations achieved considerable progress toward this goal during Year 3, with the mentor organization providing substantial coaching, counsel, assistance, and training. Cross-network communication was also viewed as improved. On the other hand, representatives of both entities reported a need for additional HEPC DSR backbone staffing to accomplish the many tasks at hand, with a particular need for a staff member to coordinate data and shared metrics responsibilities.

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 Network members in Year 3 continued to value the networking and community building afforded by their participation, followed by the ability to gain new knowledge. But for the first time in the network's three years of operation, the mean rating for valuing the applied learning and practices afforded by network involvement was above 3.0 on the 4-point scale. This suggests that what members value about the network is evolving.

Impact. An important impact of the First2 Network is the development of stronger STEM social capital across West Virginia. STEM social capital includes the social connections between STEM stakeholders—relationships, reciprocities, networks—that facilitate potential access to tangible resources, such as STEM educational opportunities, scholarships, internships, research projects, jobs, and funding. Compared to the project's first and second years of operation, the First2 Network has more members, more multidirectional relationships among members, and stronger collaboration, all indicating growth in the STEM social capital of members.

Students participating in the eight 2021 summer internships demonstrated statistically significant growth between pre- and posttest on four measures. By the end of the research experience, students rated their knowledge about research, attitudes toward research, personal skills, and research skills at statistically significantly higher levels. In addition, interns rated their internship experiences favorably, with 15 of 16 items about these experiences earning mean ratings above 4.0 of the 5-point rating scale. (The lowest-rated item—The recruitment

information adequately prepared me for what to expect for this experience—earned a mean of 3.83.) Valued most highly by interns were community building and networking opportunities that enabled them to build relationships with similar students, mentors, and STEM faculty—that is, the opportunity to build their STEM social capital.

According to focus group feedback from students who participated in the 2020 internships, student experiences tended to be very positive, even with the transition to virtual formats. Interns were pleased to have built their STEM social capital and to have engaged in real research. Most students also reported that their participation in the internship influenced their decision to major in a STEM field, bolstered their confidence in doing STEM coursework, and continued to influence their progress through their STEM major.

The Fall-to-Spring STEM persistence rate for 2020 interns about whom the evaluation team could obtain data was 78%, a rate comparable to statewide Fall-to-Fall STEM persistence rates. The evaluation team will provide an addendum to this report when data about Fall 2020-to-Fall 2021 STEM persistence are available.

Because state institutions do not consistently collect or report data about students' first-generation status, the evaluation team employs a proxy group to create a rough estimate of STEM outcomes for rural, first-generation STEM students—rural, Pell-eligible students. This is, as are all proxies, imperfect, given that not all Pell-eligible students are first-generation college students and not all first-generation students qualify for Pell grants.

According to statewide data, rural, Pell-eligible STEM freshmen in the 2016 and 2017 cohorts in WV institutions met the ACT STEM readiness benchmark at higher rates than non-rural, Pell-eligible STEM freshmen. But this pattern was reversed among rural, Pell-eligible STEM freshmen in the 2018 and 2019 cohorts, when the rates of STEM readiness among non-rural, Pell-eligible freshman surpassed them. The STEM Fall-to-Fall retention rate among rural, Pell-eligible STEM freshmen in the 2016 cohort was higher than non-rural Pell-eligible STEM freshmen. But in the 2017, 2018, and 2019 freshmen cohorts, non-rural Pell-eligible students had higher STEM retention rates. Finally, there is no consistent pattern in terms of STEM completion rates, which vary among rural and non-rural Pell-eligible students who were freshmen in the 2012 through 2015 cohorts. However, the data clearly suggest that Pell-eligibility is associated with lower STEM readiness and persistence, regardless of whether students are rural or non-rural. In addition, rural STEM students tended to have lower STEM readiness and persistence rates than non-rural STEM students, with the exception of students in the 2016 cohort. In sum, rurality and Pell-eligibility appear to be associated with lower levels of readiness to undertake college-level STEM coursework and with lower levels of persistence in STEM majors.

Emergent Challenges. Several interrelated themes emerged from analysis of Year 3 data that indicate challenges the First2 Network confronts as it continues to undertake the complex collective impact and improvement science work of learning how to improve early STEM persistence for rural, first-generation STEM students.

- **Network growth versus core activities.** The need to balance network growth and sustainability activities with the core work of the network (namely, iteratively testing and scaling change ideas to improve the early STEM persistence of rural, first-generation students) appears to be an important tension within the network. The energy and resources necessary for ongoing outreach, recruitment, and engagement for the purpose of expansion are different from those required for careful facilitation of improvement science. In the context of limited resources, it may be useful for network leaders to review and renew this balance at regular intervals.

- **Systems thinking versus improvement science.** Systems thinking directs members toward considering the large systems and contexts in which rural, first-generation students experience challenges to their STEM persistence. Thus, members reflect on and deliberate the implications of state policies and politics, the ways in which resources are distributed across the state, and how systemic forces limit the participation of underrepresented students in STEM, for example. Improvement science, on the other hand, directs its users to focus on small, repeatable practices that—while they may contribute to larger systems and contexts—are more amenable to change. This tension seems endemic to projects that seek to ameliorate the conditions associated with entrenched and complex social issues ("wicked problems") that are at once systemic and embedded in the details of individuals' lived experience. It also risks a common project phenomenon—scope creep—whereby a project's purview expands beyond its original scope. Such a project comes to include goals, targets, activities, requirements, and/or deliverables that were not included in its initial conceptualization. These new project features jeopardize the project's ability to achieve its original goals, deliver services or products on time, manage its budget, and help its staff remain energized and focused.
- **Collaborative leadership versus decision making imperatives.** The tension between the commitment to collaborative, distributed leadership and the need to make quick decisions is one with which the Leadership Team appears to struggle. Agenda items may go unaddressed, and decisions may be delayed, because the relevant issues are complex, members have different perspectives, and there is rarely sufficient time to ensure all interested parties can communicate fully and come to consensus. This can frustrate participants, contribute to burnout and attrition, and create competition for airtime during meetings.
- **Wide recruitment versus targeted recruitment.** First2 Network members confront a challenge between recruiting as many students as the First2 Network can support with the need to prioritize the difficult-to-identify rural, first-generation students given that WV public institutions of higher education do not collect information on first-generation status in a consistent manner. As a result, the percentage of interns who are first-generation college students has declined since Year 1. On the other hand, the network elected to expand its focus to include other underrepresented student groups, and seems to have succeeded in its effort, with large percentages of women and students in racial/ethnic minority groups among its interns.
  One implication of these demographics for the First2 Network is that it increases the complexity of network efforts to improve STEM persistence; the challenges to early STEM persistence faced by various student subgroups can be quite different. For example, white first-generation students will not experience systemic racism (e.g., in the form of de facto tracking into lower-level math classes or paucity of STEM role models) or become the target of interpersonal racial prejudice. On the other hand, this also represents an opportunity for network clarity about the problems it seeks to address, sharpening analysis and activity to those challenges that may be common to student subgroups. Inadequate high school math preparation, whether due to lack of access to higher-level courses or to qualified teachers, is a risk factor hampering the success of all student subgroups served by the First2 Network. Alternatively, the network might use this opportunity to sharpen its recruitment efforts to increase the percent of first-generation students receiving support.

- **Student voice versus the "adultier adult" (non-student) world.** First2 Network members face a tension between their commitment to elevating student voice in the network and the logistical, organizational, and cultural barriers to operationalizing that commitment. Recognizing these barriers, the Student Leadership working group conducted a PDSA to test an effort to engage adult members through a pre-conference trivia game. Few adultier adults participated, so students pivoted to another change idea—an "asynchronous conversation" with Leadership Team members to ask each other questions about the network. These student led PDSAs suggest that students appreciate the opportunity to be involved meaningfully in the life of the network and seek to help the adultier adults bring their student voice commitments to fruition.

Recommendations. Network leaders may want to consider the following opportunities for improvement as they embark on the project's fourth year of operation.

- **Re-focus effort on the First2 Network aim and core activities.** The First2 Network may want to consider re-centering attention on its primary aim—learning how to improve the early persistence of rural, first-generation STEM students in their majors. This might require the curtailing of activities that are more distally related to the network's aim, re-allocating resources to support activities that are clearly aligned with the aim, and communicating regularly with members about the aim and activities intended to achieve it. Members may want also elect to review and refine the driver diagram that informs the network's improvement science cycles, ensuring that it accurately reflects new understandings of the problem of early STEM attrition and appropriately guides members' attention to drivers and change ideas that they hypothesize can improve persistence.
- **Strengthen organizational capacity and support for high-quality improvement science activity.** Given the centrality of improvement science to the First2 Network's strategy for learning about how to improve the early STEM persistence of rural, first-generation students, network leaders might consider re-allocating resources to support a staff member to "own" improvement science. The individual in such a role could provide an array of services depending on network needs—PDSA oversight and quality control, assistance with measurement, coaching and consultation, and ensuring alignment and coordination across working groups, among other activities deemed appropriate. Network leaders might consider supporting this role within the backbone organization to facilitate the sustainability of improvement science expertise after grant completion.
- **Devote more time and resources to synthesizing and reporting improvement science and research findings across the network.** In Year 4, the First2 Network should consider establishing standard procedures and timelines for synthesizing and reporting what is learned from PDSAs and research. This might include both informal and formal reports, including website blog posts, newsletter articles, research briefs, podcast episodes, and webinars. Steering Committee members reported that they value the Deep Dives during which working groups provide 15-minute briefings about their activities and learnings every quarter; network leaders may want to explore how to leverage these updates into communications with the larger network membership. The value of improvement science and research can only be realized when findings are shared widely, clearly, and in actionable language.

- **Consolidate and finalize the student tracking system.** The First2 Network made some progress during Year 3 toward establishing a system for student tracking. In Year 4, the network PIs should continue their effort to coordinate and streamline a network system for collecting, maintaining, and accessing basic and STEM persistence information about participating students. The system is currently not centralized, exists in the form of multiple data sets, is managed by different organizations, and is not easily accessed for reporting purposes. A centralized database should permit easy data entry via one platform, the ability to enter data over time as students progress, a variety of access levels so not all users can obtain sensitive personal information, and sufficient reporting functionalities to meet network needs. A consolidated system will moreover position the network to track and support students and to report evidence of its effectiveness to funders present and future.
- **Acknowledge and celebrate strides the First2 Network has made since Year 1.** The challenges of establishing a statewide network in a largely rural EPSCoR state have been considerable, even with INCLUDES funding and the dedication of network personnel. Nonetheless, network leaders have built and nurtured a steadily growing collective impact community, taught members how to use improvement science, engaged students in a wide range of experiences and activities, and raised the awareness of state educators and policymakers about the importance of broadening STEM participation. Since March 2020, network leaders and members have made this progress during the uncertainty and stress of a worldwide pandemic. Acknowledging and celebrating these achievements seems worthwhile given the substantial energy members have devoted to helping each other learn how to ensure the success of rural, first-generation STEM students.

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 two years of college. Research also suggested that, among those majoring in STEM disciplines, first-generation students— students whose parents did not attend college—face considerable obstacles to their college success. 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, many West Virginia STEM students matriculating to college are likely to be the first in their families to attend.

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

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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.

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, network students serve in 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 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 on-going 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.

III. Findings

This section summarizes analyses of data collected during Year 3 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 backbone and mentor backbone organizations, the Network Value Survey, pre- and post-tests of 2021 interns, focus groups conducted with 2020 interns, 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

The First2 Network seeks to improve the persistence of West Virginia's rural, first-generation college STEM students in their programs of study—and it does so in relationship to a particular geographic, demographic, socioeconomic, historical, and political context. For example, the "Mountain State" of West Virginia is among the most economically and educationally challenged states in the nation, yet it also has a long history of labor struggle, a rich cultural legacy, and some of the country's most forward-thinking education equity efforts (such as the 1982 *Recht* decision, which sought to establish education funding equity among the state's school districts). Based on information from public reports and databases, the following subsections provide an overview of the state's socioeconomic, historical, and political contexts, overall educational context, and general STEM education context.

1.1 Socioeconomic, Political, and Historical Context

The only state falling entirely within the federally designated Appalachian region, West Virginia rivals Kentucky as the poorest state in the region. A total of 18 of the state's 55 counties are considered *distressed*, with high unemployment, low per-capita income, and high poverty rates; 10 are *at risk* of economic distress; and 26 are *transitioning* between strong and weak economies.[1] Average per capita income in 2019 was $26,480, below the national average of $34,103[2], with 16% of the state population falling below the federal poverty line.[3] At the same time, while 88% of West Virginia residents 25 years of age and older are high school graduates,[4] in 2017, 70% of adults did not have a post-secondary credential.[5] In school year 2018-19, half (50%) of public school students qualified for free/reduced-priced school meals.[6]

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.[7] 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.[8]

The state is notably racially/ethnically homogenous compared to other states. With a 95% white population,[9] 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 2019). Of its 267,796 K-12 public school students, 90% are white, 4% black, less than 1% Hispanic[10], 1% are English-language learners (ELLs)[11]; and 18% are students with disabilities.[12]

More than half (51%) of the state population lives in rural areas,[13] and 42% of West Virginia students attend public K-12 schools in rural places,[14] with half (50%) of the state's schools located in rural communities.[15] Only roughly one quarter (22%) of West Virginia students attend schools in towns,[16] and earnings in households in rural school districts average barely more than twice the poverty level.[17] 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.[18] 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.[19]

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 2015 and 2018—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 2015 to 2019, with about half of students scoring as proficient or higher. Despite improvement from 2014 to 2018 in grades 4, 8, and 11 for General Summative Assessment math performance, fewer than half of 4th graders, slightly more than a third of 8th graders, and about half of 11th graders are proficient or higher in math.[20] West Virginia National Assessment of Educational Progress (NAEP) results from 2009 to 2017 reveal a slight increase in grade 4 reading over time, but in 2019 that number decreased slightly, with only 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 29% 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 between low-income students and their more advantaged peers, and between black and white students, persist.[21]

The state shows some growth in its efforts to ensure college and career readiness, however. Graduation rates have improved over time (85% in 2013–2014 to 91% in 2018–2019), while the rate of white and African American four-year high school students graduating on time increased (90% and 86% respectively, in 2017–18, and 912% and 88%, respectively, in 2018–2019).[22] The average ACT score of 2019 West Virginia high school graduates was 20.8, similar to the 2018 average of 20.3.[23] 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, however, 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.

The 2018 high school dropout rate for West Virginia was above the national average (6% and 5%, respectively),[24] and the college-going rate for state public high school graduates steadily declined between 2009 (56%) to 2014 (51%) and increased only slightly in 2015 (51%) and 2016 (52%). College-going rates in 2017, 2018, and 2019 remained relatively unchanged (51%, 50%, and 51% respectively).[25]

West Virginia's postsecondary students are served by 13 public four-year institutions,[26] 9 public community and technical colleges,[27] and 8 independent four--year colleges.[28] 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 one-year persistence rate for the 2015 cohort of full-time, first-time bachelor's degree-seeking freshmen at public four-year institutions was 85%.[29] West Virginia is in last place among SREB states in overall first-year persistence with a rate of 77% for 2016. West Virginia's HEPC DSR reports a 31% on-time graduation rate for first-time freshmen pursuing bachelor's degrees, compared to 41% nationally.[30] 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.[31]

1.3 STEM Education Context

West Virginia high school students indicate higher levels of interest in STEM than nationally, according to a 2018 report by ACT—58% versus 45%.[32] Only 30% of test takers achieved the Mathematics Benchmark and only 32% the Science Benchmark. Even more concerning, just 12% 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 three or more years of math courses appeared to be associated with increased likelihood of meeting the Mathematics Benchmark: 33% of 2018 West Virginia graduates with three or more years of math met the Benchmark, compared to 10% among students taking fewer than three years of math. Similarly, completing a physics course in high school appeared to be associate with higher average scores on the math portion of the ACT: 2018 West Virginia graduates taking physics earned an average science score of 21.3, whereas students not taking physics earned an average score of 19.9.

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 STEM education (STEM-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 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. In addition, prior to the launch of the First2 Network as an NSF-funded Alliance, West Virginia had not been involved in national collective impact STEM education and equity networks, such as STEM Ecosystems or GlobalMindED. Since then, the First2 Network applied successfully to become a designated STEM ecosystem and has entered into a partnership with GlobalMindED to offer academic coaching training to higher education faculty and staff in the state.

The Senate and House Education Committees of the West Virginia legislature introduced three STEM education bills during the 2021 session:

- SB 235 Middle School Technical Education Program Act
- SB 239 Establishing vocational-technical programs in middle schools
- HB 2586 Expanding the amount of promise scholarship funds awarded to persons majoring in STEM

All three, however, remain in Pending status.

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 still is needed to understand the 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. Improving STEM retention nationally and in West Virginia in particular is thus crucial to ensuring a stable STEM pipeline and underrepresented young people's fair access to STEM educational opportunities.

2. First2 Network Structures and Activities

2.1 Participants

As of August 2021, the First2 Network included 487 members (see Table 1), an increase of 72% from 283 in Year 2 and of 238% from 144 in Year 1. More than two-fifths (43%) of members were students, and over a third (35%) were university faculty or staff. Although in smaller percentages, the First2 Network membership also included K-12 educators, state government staff (including state education agency personnel), and representatives from education non-profits, a national laboratory, as well as industry and foundations representatives. Information about the institutional roles of 27 members was unavailable.

Table 1: First2 Network Member Institutional Roles

Role	N	Percent
Student	210	43.1%
College/University Faculty or Staff	170	34.9%
Unknown	27	5.5%
K-12	30	6.2%
State government/state education agency	9	1.9%
Education non-profit	9	1.9%
Industry	15	3.1%
Foundation	4	0.8%
National Lab	5	1.0%
Independent consultant	2	0.4%
Backbone mentor	3	0.6%
INCLUDES Hub	2	0.4%
NASA education outreach	1	0.2%
Total	**487**	**100.00%**

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

An important component of First2 Network effort 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 two-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 to

- 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/or school administrators
- Join academic year research programs to begin or continue STEM research activities
- Participate in professional meetings and conferences

A total of 149 interns have participated in First2 Network summer experiences since 2019 (see Table 2). Thirty-one participated in 2019, 74 in 2020, and 54 in 2021.

Fifty of the 54 2021 interns, or 93%, responded to the pre-test administration of the survey, one section of which requested demographic information. Two thirds (67%) of 2021 interns who responded to the survey were young women, and a majority (86%) identified as white. A total of 16% identified as Black/African American, 4% as Hispanic or Latinx, and 4% as American Indian/Alaska Native. Readers should note that interns were offered the opportunity to select more than one racial category, so percentages total to 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 two fifths (42%) of 2021 interns were eligible for a federal Pell grant, nearly a third (32%) were not Pell eligible, and more than a quarter (26%) were uncertain about their Pell eligibility status. More than half (56%) of interns self-identified as being a first-generation college student. Two-fifths (40%) of interns hail from rural places and a similar percent (42%) hail from towns.

Table 2: First2 Network Intern Survey Respondent Demographics, 2019-2021

	2019 Intern Respondents N = 30		2020 Intern Respondents N = 69		2021 Intern Respondents N = 50		Total Intern Respondents N = 149	
	N	Percent	N	Percent	N	Percent	N	Percent
Male	9	30.0%	22	31.9%	14	28.0%	45	30.2%
Female	21	70.0%	46	66.7%	33	66.0%	100	67.1%
Other	0	0.0%	1	1.4%	1	2.0%	2	1.3%
Non-binary[!]	--	--	--	--	2	4.0%	2	1.3%
Prefer not to provide[!]	--	--	--	--	14	28.0%	14	9.4%
White*	21	70.0%	56	81.2%	43	86.0%	120	80.5%
Black/African American*	5	16.7%	4	5.8%	8	16.0%	17	11.4%
Hispanic/Latinx*	0	0.0%	2	2.9%	2	4.0%	4	2.7%
Asian/Asian American*	0	0.0%	5	7.2%	1	2.0%	6	4.0%
American Indian/Alaska Native*	1	3.3%	0	0.0%	2	4.0%	3	2.0%
Middle Eastern or North African*	0	0.0%	0	0.0%	1	2.0%	1	0.7%
Native Hawaiian or other Pacific Islander*	0	0.0%	0	0.0%	1	2.0%	1	0.7%
Other*	0	0.0%	2	2.9%	1	2.0%	3	2.0%
Pell eligible	10	33.3%	33	47.8%	21	42%	64	43.0%
Not Pell eligible	7	23.3%	22	31.9%	16	32.0%	45	30.2%
Don't know/No reply	14	46.7%	14	20.3%	13	26.0%	41	27.5%
First generation	23	76.7%	40	58.0%	28	56.0%	91	61.1%
Rural	13	43.3%	33	47.8%	20	40.0%	66	44.3%
Town	9	30.0%	18	26.1%	21	42.0%	48	32.2%
Suburb	2	6.7%	15	21.7%	8	16.0%	25	16.8%
City	2	6.7%	3	4.3%	1	2.0%	6	4.0%

[!]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. Over the course of this year, the network included four working groups engaged in PDSAs: Student Leadership, Faculty-Student Engagement, Immersive Experiences, and College Readiness.

During Year 3, working group members conducted 64 PDSAs. Fifty-three were conducted during Year 2, for an overall total of 117 (Year 1 PDSAs were not counted because much of the network activity centered on planning and project launch activities).

A representative of the Measurement Team, however, shared four observations during a summer Leadership Team meeting about the network's improvement science activities that suggest areas for improvement. These observations included:

- No single person is funded by the First2 Network to lead, support, coordinate, and align improvement science efforts; rather diffuse responsibility is shared among staff of the PI organizations and working group co-chairs.
- The Measurement Team, with the assistance of the mentor backbone organization, developed and delivered trainings and resources to network members about improvement science and how to conduct PDSA cycles. However, the capacity of the First2 Network backbone organization to support improvement science activities has not been built.
- Although the network developed a driver diagram early in its lifecycle, its members do not use the driver diagram to inform, guide, or focus their PDSA work.
- The network has not instituted any mechanism for quality control of proposed change ideas or PDSA measures.

The Leadership Team agreed to begin addressing these issues by reviewing and revising the driver diagram.

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[33]

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 (e.g., instructional videos about how to conduct improvement science activities), and tweets from the network Twitter account. The Fall 2020 edition of HEPC DSR's STEM magazine, *The Neuron*, distributed to all post-secondary faculty in the state, included a summary of findings from the Year 2 evaluation of the network. The Winter 2021 edition featured commentary from a First2 Network member about the value of research experiences early in undergraduate students' college careers. In addition, members of the First2 Network presented information about the network's efforts at a range of public events, including the following:

- West Virginia Science Teachers Association Conference, October 2020. First2 Network members conducted two presentations, one providing an overview of the network's use of improvement science and the other discussing the network's effort to develop a searchable inventory of STEM assets across the state.
- Carnegie Foundation on Teaching and Learning Summit, April 2021. First2 Network members facilitated a session entitled "Improving STEM Persistence Through NICs Within a NIC."
- American Chemical Society Conference, April 2021. First2 Network members conducted a symposium entitled "Early Research Experiences for STEM Retention - Models and Promising Practices" Fifteen talks were presented in two sessions, six of them by First2 members, with opening and closing remarks and a panel of First2 Network members.
- West Virginia Academy of Sciences, April 2021. First2 Network sponsored a "Science Education" track at this annual meeting and delivered two sessions, with 4 oral presentations in each session, about promising practices to support STEM student success.
- West Virginia Council of Teachers of Mathematics Conference, April 2021. First2 Network members offered an overview of the network, discussed how members use improvement science, and invited participants to join.
- West Virginia Student Success Summit, July 2021. First2 Network members presented information about the network and discussed early evaluation findings.

First2 Network members also contributed to the National INCLUDES Network. In addition to participating in several affinity groups and a leadership team, First2 Network members participated in a national webinar and follow-up Twitter event on "Best Practices In Virtual Internships."

2.3.2 Partnerships

Partnerships provide a "platform for collaborative action,[34] 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 seven institutions of higher education in the state through Memoranda of Understanding (MOUs): FSU, Marshall University (MU), the

University of Charleston (UC), the West Virginia School of Osteopathic Medicine (WVSOM), West Virginia State University (WVSU), WVU, and the West Virginia University Institute of Technology (WVUIT). GBO also signed a MOU with the network. During Year 3, the network formalized partnership MOUs with two additional institutions: Glenville State College, and Davis and Elkins 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 and established new partnerships with several other STEM entities in the state. These include Solvay Corporation, the West Virginia IDeA Network of Biomedical Research Excellence (WV-INBRE), the Education Alliance, Chemours, and the West Virginia Space Grant Consortium.

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—as well as evaluator participant observation of meetings of the Leadership and Measurement Teams, and review of the network's data dashboard prototype—indicates that the First2 Network made substantial progress in finalizing core shared metrics.

As reported last year, the First2 Network defined three levels of STEM persistence outcomes, hypothesizing that the network will influence STEM persistence in progressively larger scales across the state. These measures are as follows:

- **Micro:** The early STEM persistence rate of students who directly participate in First2 Network activities
- **Meso:** The early STEM persistence rate of students at participating First2 Network institutions
- **Macro:** The early STEM persistence rate of students in all West Virginia colleges

In addition, the Measurement Team conceptualized and prototyped a data dashboard to display information about the network. Another indicator of progress is the implementation of a new process for obtaining First2 Network student STEM persistence data. This process transfers responsibility from the evaluation team to the First2 Leadership Team for obtaining informed consent from students and STEM persistence data from HEPC DSR. This transition will ensure that First2 Network staff have the capacity and an established procedure for acquiring the data needed to track progress toward goals.

Evaluation results are only useful to the network insofar as they are reported to members. To that end, the Evaluation Team provided rapid-response evaluation summaries following administration of data collection instruments. These included summaries of evaluation findings from the October 2020 and May 2021 First2 Network conferences; two administrations of the Working Group Self-Assessment; the Steering Committee Survey; and student focus groups. Similarly, the Research Team produced at least 10 manuscripts, conference presentations, and theses on their First2 Network findings, according to a review of network quarterly reports to NSF.

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 provide leadership opportunities to members and to communicate about its efforts to leaders and potential champions.

The Student Leadership working group, for example, offers students opportunities to inform network leadership about their needs and concerns, to test and improve practices, and to provide each other with peer support. Representatives of the Student Leadership working group also attend Steering Committee meetings and present alongside "adultier adults" (the network jargon for members who are not students) at conferences.

The network communicates about its work through various media, including the project's web portal (www.first2network.org), Twitter and Facebook accounts, a YouTube channel, a monthly newsletter, and an evaluation podcast. In addition, the Steering Committee, Leadership Team, working groups, and ad hoc groups facilitate regular meetings.

2.3.5 Expansion, Sustainability, and Scale Up

Planning for expansion to other EPSCoR states and for self-sustenance after grant's end were priorities during the First2 Network's third year. Document review indicates that the network leadership has pursued these goals in several ways.

To invite other EPSCoR states to learn from the network, members established and facilitated a planning committee for an EPSCoR workshop in 2022. The committee included First2 Network staff and members, as well as representatives of other EPSCoR states. In March 2021, the committee surveyed EPSCoR administrators and other STEM professional from EPSCoR jurisdictions to assess their interest in a workshop and confirm a theme for the event. The committee is now developing a workshop proposal.

Second, the network continued to engage the Advisory Committee established during Year 2. Committee members review high-level aspects of the network (such as its strategic plan, partnerships, communications, etc.) and support its progress toward sustainability. The network also established an Industry Advisory Board to strengthen relationships between the network, STEM educators, and STEM industry representatives, and to involve industry in supporting students to persist in STEM.

Third, the First2 Network completed a strategic plan. The plan is "a roadmap to guide the development of infrastructure, partnerships, and sustainability over the course of the next 2 years," and specifies the goals, objectives, measures of success, timelines, roles, and responsibilities needed to progress toward longer-term sustainability.

Publication and presentation of First2 Network research and evaluation findings is a fourth strategy for expansion and sustainability. Similarly, sharing lessons learned and new insights with others interested in broadening STEM participation is a means by which to promote the work of the network and engage potential new members. Year 3 publications of research and evaluation findings include:

- Hanna, J., Carreon, H, Fultz, M., Harvey, E., Howley, C. W., Norton, M., Richards-Babb, M., Riley, S., Sine, A., & Heatherly, S. A. (2021). Potential impact of short-duration research

experiences on STEM self-efficacy among early stage first generation college students. *Scholarship and Practice of Undergraduate Research*, 5.

- Howley, C. W., Campbell, J., Cowley, K. S., & Cook, K. (2021). Pathways and structures: Evaluating systems changes in an NSF INCLUDES Alliance. *American Journal of Evaluation*, *42*.
- Stewart, J., Cochran, G. L., Henderson, R., Zabriskie, C., DeVore, S., Miller, P., Stewart, G., & Michaluk, L. (2021). Mediational effect of prior preparation on performance differences of students underrepresented in physics. *Physical Review Physics Education Research, 17*(1).
- Yang, J., DeVore, S., Hewagallage, D., Miller, P., Ryan, Q. X., & Stewart, J. (2020). Using machine learning to identify the most at-risk students in physics classes. *Physical Review Physics Education Research, 16*(2).

First2 Network members presented the following research papers at conferences this year:

- Symposium organized by the First2 Network: Early Research Experiences for STEM Retention: Models and Promising Practices. American Chemical Society National Meeting, April 9, 2021.
    - Pacheco, C., Richards-Babb, M., & Zalman, P. Research apprenticeship program (RAP) at WVU: An undergraduate research experience.
    - Payne, H. Engaging and retaining undergraduate STEM majors: Research Rookies program model.
    - Jimenez-Esquilin, A., & Lafferty, J. A case study of the impact of bridging a summer research immersive into a freshman level course-based undergraduate research experience.
    - Fultz, M., & Lucas, J. Engaging rising freshman through citizen science.
    - Richards-Babb, M., Pacheco, C., & Walden, K. Celebrating research at culminating institutional symposia – Best practices for virtual events.
- American Evaluation Association conference, October 2020.
    - Cowley, K. S., Darrah, M. A., Humbert, R., & McJilton, L. Using Social Network Analysis to illuminate a growing state network.
    - Howley, C. W., Campbell, J., & Cowley, K. (October 2020). Pathways and structures: Evaluating Systems Change in an NSF INCLUDES Alliance.
- Physics Education Research Conference
    - Hewagallage, D. S., & Stewart, J. What does the Force and Motion Conceptual Evaluation pretest measure?

The Research Team authored whitepapers as well, documenting learnings from the project's research effort:

- Darrah, M., Humbert, R. and McJilton, L. (2020) Programmatic and non-programmatic aspects of immersive experiences that encourage students' pursuit of STEM pathway.
- Darrah, M., Humbert, R. and McJilton, L. (2020) Understanding levels of first-generation students' backgrounds and factors that impact decisions to attend college and study STEM.

Finally, one First2 Network member completed a dissertation based in part on his work with the First2 Network during the pilot phase:

- Miller, T. A. (2021). Enabling and threatening factors affecting persistence A qualitative and quantitative study on rural first-generation STEM students' and STEM faculty's

perspectives [ProQuest Information & Learning]. In *Dissertation Abstracts International Section A: Humanities and Social Sciences* (Vol. 82, Issue 5–A).

2.3.6 Document Review Summary

Review of Year 3 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. New partnerships, some formalized via MOUs, suggest that the First2 Network continued to build working relationships with other STEM-interested entities in service of the network's aim. The First2 Network also appears to have made progress during Year 3 toward creating a data dashboard to display shared metrics and implementing a new process for obtaining STEM persistence data. Network members were offered an array of leadership opportunities in working groups, and an array of communication media help support ongoing engagement with members and the wider public. Finally, the First2 Network appears to have made a concerted effort during Year 3 to shore up its sustainability through consultation with an advisory committee and an industry advisory board, a strategic plan, and continued research publication and presentation. Network members are planning expansion to other EPSCoR states through, as a first step, hosting a workshop for EPSCoR jurisdiction on issues of mutual interest in terms of building capacity for a statewide network of continuous improvement to broaden STEM participation.

2.4 Elements of Collaborative Change Interviews

In March 2021, 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 about how to broaden STEM participation, largest achievements to date), whereas 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 COVID-19 pandemic.

2.4.1 Elements of Collaborative Change Interviewees

The six First2 Network members participating in the Elements of Collaborative Change interviews during April and May 2021 represented diverse role groups. Interviewees included one university faculty member, one education outreach specialist, one high school teacher, a STEM coach for a local education agency, one college student, and a representative of a non-profit organization. Three interviewees reported participation in a First2 Network working group.

2.4.2 Shared Vision and Common Agenda

> *There's a real shared vision about trying to get to these goals that they've set—ambitious goals that I hope we can meet.* – Network member

Interviewees were unanimous in their agreement that network members embraced a shared vision and common agenda. As one such member stated, "I think everyone is extremely united on the mission that we're about." Similar comments were also offered:

> *I don't think I've met anyone who seems to have this different vision than what is often displayed whenever we're in one of those statewide calls or even the more local calls.*
>
> *There's a real shared vision about trying to get to these goals that they've set—ambitious goals that I hope we can meet.*

Another respondent described a strategy that one working group used, as part of supporting the network's overall mission, to further nurture members' understanding of the challenges that first-generation college students face:

> *The group I am working in has completely developed a common mindset by reading a book on first-generation college student experiences and tried to identify problems and how we can help middle school and high school educators—what can they do? What are the gaps and how can we help prepare those students for college? [We] identified goals we can work towards.*

When asked to describe the network's shared vision and common agenda, all respondents demonstrated a clear understanding of the network's purpose. As one respondent elaborated,

> *… the First2 organization is an organization to promote undergraduate research and try to help underrepresented and first-generation, primarily, students get through their first 2 years in a STEM major at a university because those first 2 years are often some of the hardest to get through especially for first-generation students, especially in STEM fields. So, the belief is that if they can get through those first 2 years, they can go on to get their bachelor's degrees or master's or even a doctorate.*

2.4.3 Partnerships

[T]hey've given a lot of thought to building activities that engage each of us as partners at the space where we are. – Network member

Asked about the ways in which and to what extent the First2 Network engages partners with diverse perspectives, organizational affiliations, and roles, five of the six interviewees reported that the network engages a variety of partners including representatives from a diverse range of institutions and roles, including business and industry, the non-profit sector, higher education, informal education groups, students, and teachers. As one such respondent noted,

> *…you've got the big universities, the smaller colleges, you've got High Rocks, so many…you know, that aligning the resources is so key and it could be a challenge, but the First2 Network has sort of offered a neutral convening space for everyone to come together around this common core and, you know, if one person's situation improves, everybody's does.*

However, another respondent said, "I don't know if I have the knowledge to answer that question." Yet another responded s/he was not knowledgeable of partners beyond the university and college network but added that the network "seems very inclusive in trying to get

as many people involved and reaching as many people across the state as possible." One respondent suggested the network needs to "expand the types of partners we have outside of the education sector."

Two respondents commented on the inherent diversity of West Virginia in terms of geography and a variety of backgrounds, suggesting that this, in itself, contributes to the diversity of people represented in the network. And according to one of those respondents, "Finding people and making those opportunities, even those that do exist here, would be a way that we can improve our diversity." Another respondent expressed that the network's commitment to diversity is "pretty high and…. they are certainly open to that [diversity]. S/he continued,

> *I know that with the summer internships there are diverse organizations that are providing experiences for students. In my own personal experience, we did a little experiment with some collaboration with informal education groups, specifically like with our county extension agent and I collaborated on some projects to help teachers with activities particularly during the remote learning time and we also formed a little group of sort of a collaborative group of people representing other information educators/organizations locally to work on some support projects for teachers. So, I would say it's pretty good.*

Interviewees were also asked how, and to what extent, the First2 Network engages partners in meaningful change activities. Although two respondents shared that they weren't sure they could respond to this question since they hadn't really interacted with partners, one of those expressed interest in learning more about the partners in the state to be able to direct students to more opportunities. And while another respondent was not sure "to what extent" partners are engaged in activities, s/he was aware that the network engages in outreach to various organizations to "try to bring in some outside perspective" and "promote some idea to members or the network or those working with the network to try to improve the network itself or, at the very least, the students that are involved in it." Other respondents cited examples of partner engagement in network activities and described various means of outreach to and engagement of partners in network activities.

> *I think they're doing a good job of engaging partners and asking for meaningful contributions. For example…WVDE is working with me and we're trying to plot the GPS coordinates for all the incubators and business incubators around the state so that when you click on it you see it come up and you can tell how close or how far you are. That's really a benefit to me. Your students are getting experience doing it…. I just thought that was an incredible idea that they had pulled the team together. That's just one example but that tells me they've given a lot of thought to building activities that engage each of us as partners at the space where we are.*
>
> *I know that our work group has partnered with the WVSTA [West Virginia Science Teachers Association] and with the state math organization as well to provide some…well, we did a presentation at the state conference to engage teachers in doing their own projects to see if that would help with college recruitment efforts, especially for first-gen students, of course….I know my experience is just with that workgroup and I know that through those organizations and also we have a representative on that committee from HSTA [Health Sciences & Technology Academy], the health folks, and so I think there is a lot of*

collaboration with those groups, and I think they're well represented in the workgroup.

2.4.4 Shared Metrics

[I]t seems like everybody has a shared goal and everybody has an idea of what the end goal is. – Network member

All but two interviewees commented on the use of shared metrics to support shared learning and improvement. Two respondents were familiar with the use of data emerging from PDSA cycles, with one respondent sharing that the use of PDSA "seems to be consistent throughout the network to assess these change ideas" and that members are encouraged to put the PDSA cycles into the networked NILS system on the website so that all participants can how change ideas align with the network's mission and vision.

Other interviewees shared the following:

There could always be room for growth, but that's just the general…like obviously, you can always grow larger. You can always offer more. But it seems like everybody has a shared goal and everybody has an idea of what the end goal is, which would be the end metric. I'm sure for specific things, like for the scholarships, I'm sure that there is a rubric, a metric that they use, to say who is getting that. I'm sure for example, the summer research programs, I'm sure that they have an outline of "these are the goals" for all of the research programs, regardless of what college it's located at. I'm not aware of what those are, but I'm sure that they have them. I mean…I don't know…I've worked with similar programs that always end up having like these are basically the outlines, these are the goals.

I believe that they have certainly done a good job organizing all the sorts of tools that they need to have available to measure the success they've been having so far, and they've clearly been working on them a long time. But as to whether it's enough, that's really not something I can say with [a] level of certainty.

2.4.5 Leadership and Communication

I definitely see that being very effectively implemented, especially with the way they label every student in the organization a student leader, because they are trying to promote that idea that everyone who is part of this organization has the potential to be a leader and should be a leader. – Network member

Asked how the network builds leadership among partner organizations or individual members, four interviewees agreed that the network provides members with leadership and service opportunities, as well as support in those areas. As one member put it,

I feel that throughout my experience with the network, I've been encouraged to take on leadership roles within my own change ideas and there is a lot of

> *support there. Everybody has been very willing to, you know, get very excited about all of these ideas. They're very encouraging, very supportive.*

Additional illustrative quotes follow:

> *They offer a lot of opportunities. I know when we were on the social media, there's a lot of groups that you can join. There's a lot of different sections of it that if you get to the head and lead a certain project, you can.*
>
> *I can only speak to my experience and that's pretty much within that one work group. We discuss projects and things and people that are involved in a partner organization or people that have expertise in a particular area that we're trying to explore are encouraged to take on a leadership role in particular projects…. Anybody that is willing to step up is certainly encouraged and supported.*
>
> *…I definitely see that being very effectively implemented, especially with the way they label every student in the organization a student leader, because they are trying to promote that idea that everyone who is part of this organization has the potential to be a leader and should be a leader.*

And although a fifth respondent indicated that there were attempts made to build leadership among network members and partners, s/he was unable to provide a specific example.

Interviewees were then asked about their perceptions of the extent, and in what ways, the network ensures cross-network communication to build trust, assure progress toward achievement of shared goals, and sustain collective momentum across First2. Three respondents cited the First2 Network conferences as a primary means of ensuring communication and ongoing momentum, with one respondent noting,

> *One of the major ways is I believe the fall and the spring…the First2 Network has large seminars, convention-type things. That's where they will try to bring in outside organizations or like state officials and show them what we're doing by also bringing in as many people as they can from around the state who are part of the network just showing off what we do or what we've done and leading up to that there will be a couple of weeks of (and I'm sure usually these are in person, but they've been virtual) meetings with students from all over the state and as many people as they can get involved. It does a really good job showing the campuses and other organizations what everyone else is doing and then also showing to people on the outside what we do within the network. I think it does a really good job kind of connecting everyone to see what everyone is doing.*

Three respondents cited the First2 Network website as an important and effective means by which network members could communicate and collaborate, with one such respondent noting that the website is "basically a social network" and the "number one news source and communication" tool that allows members to stay informed of network activities. Two respondents referred to interaction in and among working groups, as well as invitations to meetings with different parts of the network, as being effective in building and sustaining cross-network communication and collective momentum. Said one working group member,

> *…with one of the ideas that I had I did feel like I was brought into other parts of the organization to share what we were doing and kind of how we could work together to keep things moving forward toward the big goal of the network.*

Another respondent pointed out that though it was sometimes difficult to keep up with meetings and activities, the network is effective at communicating with members:

> *Well, it seems like it's a fairly elaborate, well-thought-out process. I mean, there are a lot of moving parts to this as you know. I probably can't speak to all of that, but If I had one criticism it would be…and it's my fault really…it's just trying to keep up with all the different working groups and understand when I'm plugging in and where and what I should be watching for. They do a great job of letting us know when we should be there, when we should attend, but sometimes I feel like "well, I should know when this is happening" but it's sort of a do you take time to get on the website and look…. well, no, I'm kind of doing my to-do list and what was due yesterday and the day before. But I think they communicate with us well and, if anything, maybe more than I need but you can't really have too much communication when you're letting people know about a project that has so many moving parts and is a statewide initiative aimed at such a worthy goal.*

One respondent commented on the communication among the colleges and universities involved in the First2 Network, specifically indicating that cross-campus connections and sharing of resources have nurtured and helped sustain the involvement of faculty hailing from a small institution.

2.4.6 Expansion, Sustainability, and Scale

> *I've been really encouraged to get involved with some institutions that haven't participated much, so I think there really is a push to try to get some of these smaller community college schools in some of these more rural areas get involved just in any capacity to try to reach more people.* – Network member

Interviewees' perceptions of ways the network is adapting its work to address challenges from the COVID-19 pandemic were generally positive about the transition to a virtual environment. As one such respondent noted, the network "expanded rapidly, when COVID kept us out of work, into the virtual environment." Other representative comments regarding the move to virtual teaching and learning were that the network "adapted as best they could" and "it seems like they've adapted really well." Others noted that the provision of information online about such topics as scholarships or meetings was successful. Two respondents viewed the use of a virtual format during the pandemic as perhaps making communication easier in some instances and engendering increased involvement in the network. One such respondent suggested that the network "may have found that in some instances for students, who knows, maybe that is an easier way for some of them to communicate." Another respondent noted,

> *It finally gave people who wanted to get involved with First2 the opportunity to get involved virtually and learn about what's happening. The timing of this was really good because people could go to the website and browse and attend virtual conferences and finally get a chance to see what and how to participate. Felt it sounded really good when I first learned about the network and being able to share virtually will help people get involved.*

The network's efforts to continue the summer research internships during the pandemic were touted by two respondents.

> *When I started working with them, there really hadn't been a plan for how to run the summer immersion, which is usually a 2-week in-person, at the campus event. When they had to move online, the whole organization did a really good job of planning around having to have virtual events. You know, every site had their own way of doing it, but there were several meetings I was involved with that were statewide…'how are we going to do this'…just planning out how to shift what is usually in person, working with people hands on, to be distributed throughout the state—students from all over the place. And I think they did a really did a good job turning that around as they did.*
>
> *I know that offering the summer research is a really big issue. I know, personally, I work in a different lab in the summer through [another program] and that was our issue was how are we going to do summer research. So, being able to still offer those types of opportunities, I mean, that's huge.*

And one interviewee shared that "now that things are lightening up, I know that some of the immersive experiences that they have really worked hard to get those in person again and trying just to adapt and do what they can for as many people as possible."

Interviewees also shared their perceptions of the ways in which the network is expanding the reach of its efforts and working to scale its promising practices across the state and elsewhere. Three respondents pointed to the network's outreach efforts and expressed their sense of encouragement as work groups expand their work on projects, as follows:

> *I think that the way I see that expanding is that the more projects the workgroups do, those all involve outreach. I know that in our workgroup the outreach is to K-12 teachers and guidance counselors in particular so I think that will be an expanding awareness among those groups, particularly STEM teachers and guidance counselors—those have kind of been our focus. So, I would see that as outreach.*
>
> *I know again, the idea that I had…I've been really encouraged to get involved with some institutions that haven't participated much, so I think there really is a push to try to get some of these smaller community college schools in some of these more rural areas get involved just in any capacity to try to reach more people.*
>
> *My vision is limited to what we're doing in [the] college readiness working group and that is getting teachers from across the state by doing sessions at different conferences and having them implement our change ideas in the classroom so we can get information in the classroom. That's what we're doing to expand, and I see this working.*

When asked how the network's response to COVID-19 has affected its reach throughout the state and elsewhere, one respondent "assumed that it has" and that "they would have been very careful to build in as much alternative touch/alternative outreach with not being able to gather in person," while another respondent shared that it doesn't seem as if the work was interrupted. S/he noted, "They've continued to push forward to the best of their ability. To the extent to which that happened, I don't know. It appears as though they haven't let up at all."

Network members were next asked how the network planned to sustain its work after INCLUDES funding ends. Three interviewees were unaware of sustainability plans, but two respondents spoke about ensuring students are informed and assisting educators to become more knowledgeable about change. According to one respondent, applying for additional funding and

collaborating with additional colleges, companies, and teachers would help the network to scale up and expand once the current funding ends. Another respondent suggested additional strategies:

> *One of our goals in sustaining is to help inform students about being a first-gen college student and what that means and learning to take pride in it that, hey, I'm a first-generation college student and I belong. There's a lot to be said about that and sustaining and getting kids into college and helping them sustain their program of study. I think that is going to come through helping our educators with change ideas and helping them provide the knowledge we [a working group] gained from reading the book [on the experiences of first-generation college students] and helping us shape that into what's good for their community. Seems we'll see a lot evolve out of this.*

2.4.7 Network Progress: Learning about Broadening STEM Participation

I'm learning…just how hard it is to promote STEM…especially in the state where sometimes we find educational resources to be somewhat scarce, it can be very hard to promote many of the things like many of the STEM fields because of the resources they require. – Network member

Asked what they were learned about broadening STEM participation because of their participation in the network, four respondents cited new knowledge about challenges related to promoting STEM and making STEM subjects more attractive to students, as well as maintaining students' enthusiasm for pursuing STEM subjects as they transition from the earlier grades to high school and college. As these First2 members explained,

> *I learned a lot about the statistics, like the one where we have more students…we have like the leading percentage per capita of students in the nation who are interested in STEM jobs. I never would have thought that. I was like, I don't know why, but in my mind, I was like oh, maybe California, Silicon Valley, you know, these other places in my brain would be more interested in STEM than us. But the fact that we are, that's huge. Just knowing the desire is there, like when they're kids and we say, "what do you want to be," they'll tell you something in the STEM field and then somehow throughout the years, something happens—whether it's in high school or whether it's in college or whether they started with that major, but they don't continue, like some ball somewhere is dropped. So, I think just knowing those statistics and knowing that we have like fertile ground and just for some reason our crops aren't growing, and we have to figure out, like, hey, what's happening because we know that the ground is fertile. We know that they want to be STEM majors but just how do we grow that?*
>
> *I think since I'm a math professor, my sole focus for most of my years has been math. I think one thing this has done for me is to see STEM much wider than math and really looking at trying to look at connections between the STEM fields to make those seem more relevant to students if that makes it more attractive.*

> *Middle school kids in particular like science and they think its engaging but when they realize how much time and effort it takes to really understand and to implement—it can actually be overwhelming for them, and they could lose interest by actually seeing the work that science is. So, that's one thing I've learned. How do we inform our youth about all these opportunities they have without intimidating them away from taking that route? That's just something I've learned in the last couple of years from doing STEM fairs and surveys. We got STEM partners to show what it's like to do the job they do—the more informed students become, the less interested they become. I was interested in science from the get-go. Seeing such a number of students whose interest wanes over the years.*
>
> *I'm learning…just how hard it is to promote STEM…especially in the state where sometimes we find educational resources to be somewhat scarce, it can be very hard to promote many of the things like many of the STEM fields because of the resources they require. And if you don't have those resources, it can be hard to fully present how interesting or exciting they can really be. So, it's a difficult job to promote that. And once students are in college, it is almost too late at that point.*

And while another respondent also recognized those challenges, s/he expressed optimism about new opportunities in the state (e.g., the Virgin Hyperloop in Tucker County) that might inspire students to pursue STEM careers, noting that students need to be informed of these new opportunities and that the network has come along "at just the right time to be ready to leverage some of this activity to inspire our students and keep them interested in a career that they could stay here [in West Virginia] and do." S/he continued that "if the kids get excited about working for someone like working for Virgin Hyperloop or one of the others, you cannot underestimate the power that could have on a new generation of students."

Two respondents reported learning about characteristics of first-generation students, with one noting that being a first-generation student is not necessarily associated with economic issues. This respondent reported the s/he became aware of other issues first-generation students face, such as the pressure to succeed in college, family ambivalence about college because they need their child's help at home, or even inconsistent moral support from family members who "just don't get" why a student might want to pursue higher education.

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 questions. Three respondents commended the network, including leadership, with one noting that "my experience with the network has been very positive. I've been really impressed with the work they've been able to do around the state. It's very exciting and something that I enjoy being a part of" and another sharing that the network includes "some impressive leaders." Another such respondent stated,

> *GEAR UP, HSTA, all of those have provided great models for how to engage students and I feel like the First2 Network is sort of that on steroids. The timing has been good. The leadership, I think is fantastic and I hope it can achieve its goals and anything we can do.*

This same respondent shared that s/he hopes leadership will not be hesitant to "be direct with those of us who want to see [the network] succeed" and that "it's good to be reminded" of and asked to participate in activities and tasks.

2.4.9 Elements of Collaborative Change Interview Summary

In sum, network 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 and common agenda, and although one interviewee was not aware of the ways in which and to what extent the network engages partners, others observed that the network engages partners with diverse perspectives, organizational affiliations and roles, and engages those partners in meaningful change activities. According to interviewees, the network successfully adapted its work to address the challenges of transitioning to a virtual environment during the COVID-19 pandemic with some noting the transition seemed to engender increased network involvement. However, half of those interviewed were unaware of network sustainability plans. Further, several interviewees provided positive feedback on what they had learned about broadening STEM participation because of their involvement in the network. Overall, perceptions of the network's progress remain positive.

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. The instrument was administered to participating working group members in November 2020 and May 2021 during Year 3, with future surveys to be conducted semi-annually of program implementation. Prior to 2020, the survey was administered quarterly, in May, July, and November 2019. For this quarter, Quarter 6 (Q6), the online survey link was 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, Student Leadership. (The Capacity Building working group was dissolved last year, and as a result no data are reported here for Year 3.)

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 components of its collective impact work. Dimensions 2 to 5 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

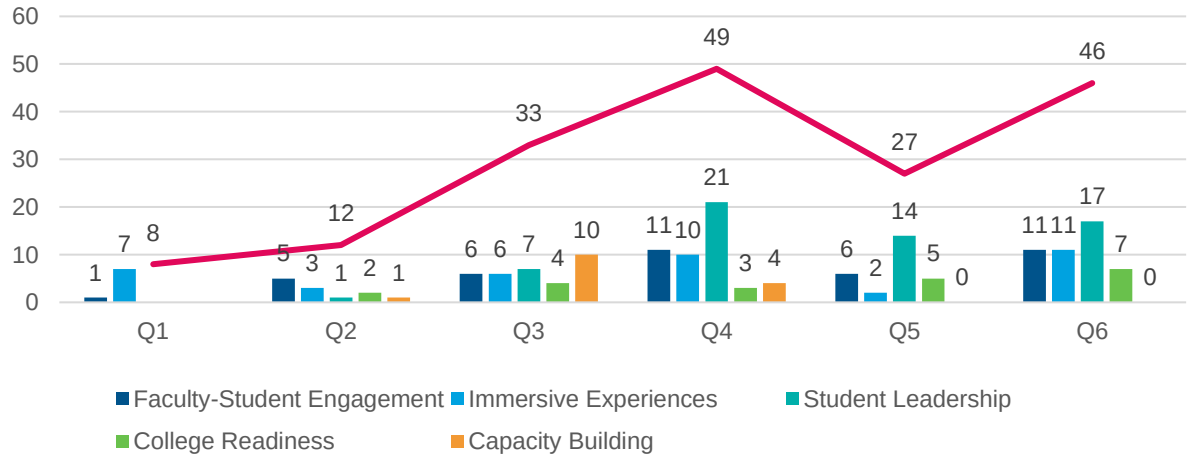
increasingly higher ratings on the five-point response scale. Analyses include descriptive statistical approaches (means and percentages).

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.

Forty-six working group members completed the self-assessment in May 2021 (Q6) (34% of 137). In this most recent administration, three respondents self-identified as student alumni, bringing the total number of responses to 49, the same number as this time last year.

Figure 1 below presents the number of respondents by working group. The largest number of responses in Q6 hailed from the Student Leadership working group, with a total of 17 out of 55 respondents. The second largest number of Q6 responses were generated by the Faculty-Student Engagement (11 out of 25) and Immersive Experiences working groups (11 out of 38), and the third largest came from the College Readiness working group (7 out of 19). Using working group membership numbers on the First2 Network portal to calculate response rates, the Faculty and Student Engagement working group had the largest percentage of member respondents (44%).[1]

Figure 1. Working Group Response Levels by Quarter

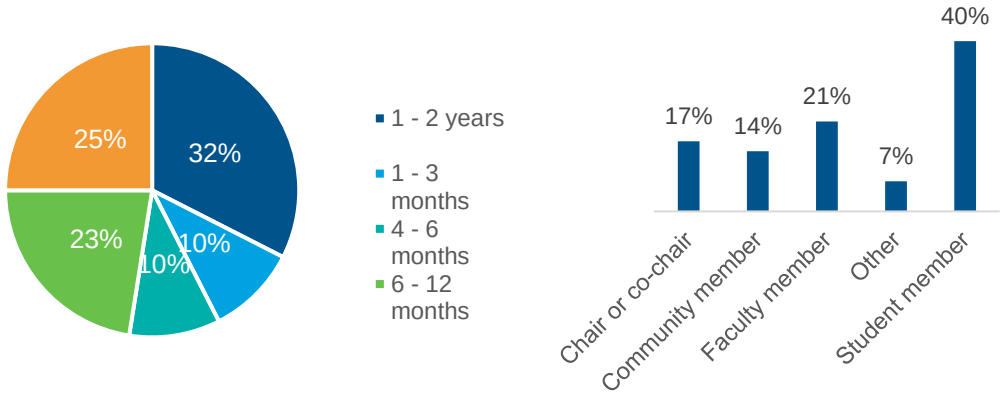


2.5.1 Respondents

Eighty-two percent of respondents (40 of 49) answered the question about how long they have served as a member of the working group (see Figure 2), and 42 responded about their role in the working group. More than half (57%) of respondents had more than one year of participation in the working group, and two-fifths (40%) identified as student members (see Figures 2 and 3 below).

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

Figures 2 and 3. Member Years of Participation and Role in Working Group, Q6

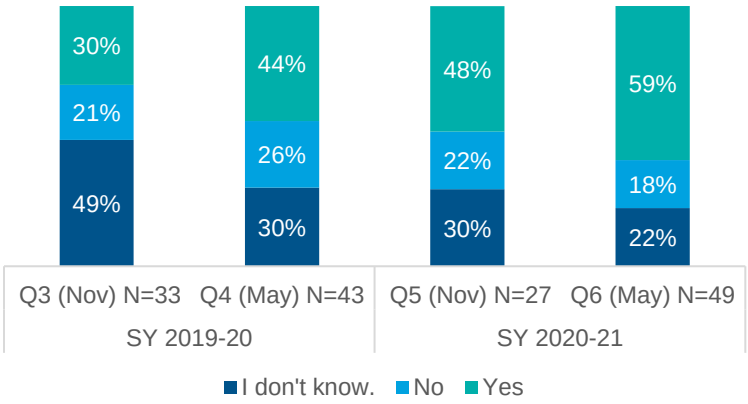


Note: Percentages may not equal 100% due to rounding.

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 49 Q6 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 four administrations in Year 2 (Q3-November 2019 and Q4-May 2020) and Year 3 (Q5-November 2020 and Q5-May 2021). Working group participation appears to have steadily increased since the Q3 administration of the instrument.

Figure 4. Percent of Self-Assessment Responses by Working Group, Q3 – Q6



In the most recent administration, more than half of the 49 respondents who reported that they engaged in change activities provided additional information about these change efforts. Most respondents highlighted their efforts to enhance student experiences in the classroom or during summer programs. Specifically, replies focused on mentor recruitment, mentor training, faculty office hours incentivization, tests of syllabus ideas, student scholarship application completion, and numerous summer activities including immersive experiences. Many respondents also reported working collaboratively; for example, one such respondent described "working in a subgroup about technology and computer science network-building."

2.5.3 Longitudinal Analysis of Dimension Mean Ratings

The evaluation team analyzed Working Group Self-Assessment mean dimension ratings across three years, focusing on the following quarters: May 2019 (Q1), May 2020 (Q4), May 2021 (Q6). 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 Q1, Q4, and Q6. 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 growth over time, with mean ratings of all dimensions (with one exception) increasing between baseline and Q6. The exception is the Collaborate dimension, which was always highly rated and dipped only minimally from the Q1 baseline of 4.66 to 4.62 in Q6.

The Disseminate dimension posted the second highest mean rating, which improved from 2.79 in Q1 to 4.5 by Q6. The strongest item, *the working group contributes to network dissemination efforts (4.6)*, reflects ongoing dissemination efforts through publications submitted and presentations held during this past year (see Figure 5). As one respondent explained, "We've had guest speakers at our meetings, which has helped us share ideas and learn from other organizations." Another respondent reported, "We had a face-to-face meeting in January, where results were disseminated, and this was very useful. Attendance was modest because of the time of the year and weather, but I personally valued this experience."

Figure 5. Average Dimension Rating by Dimension and Quarter

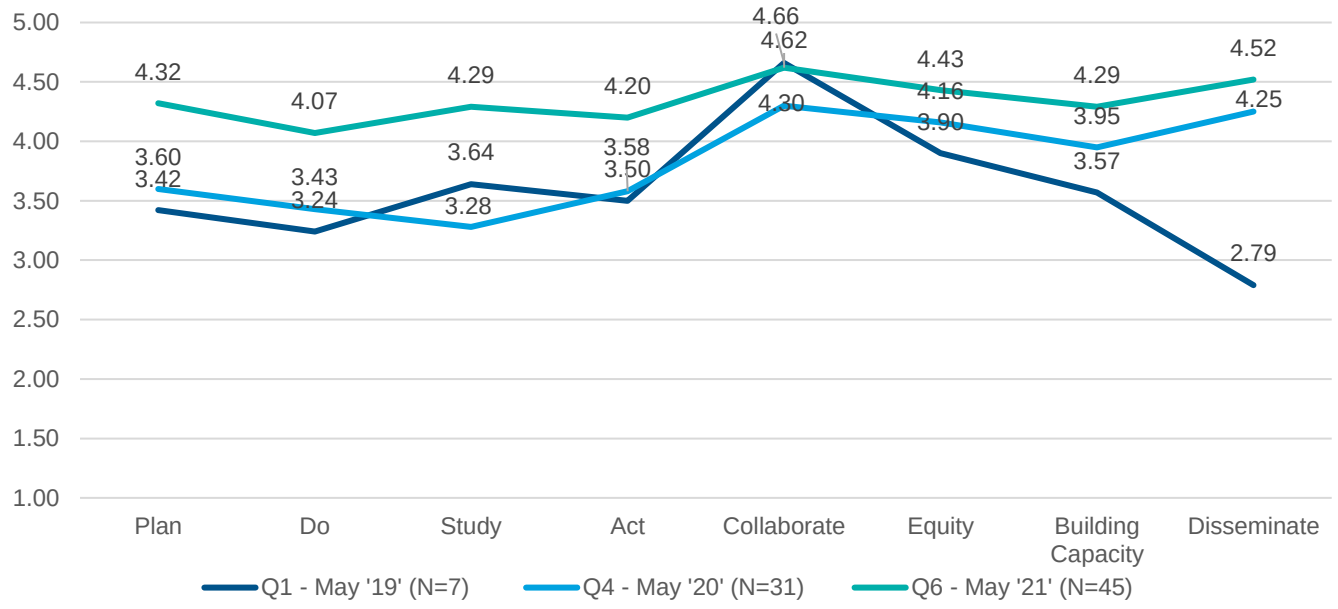


Table 3 displays mean ratings from May 2019, May 2020, and May 2021 for each Working Group Self-Assessment dimension as well as for each individual indicator within each dimension.

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

Dimension	Indicator	May 2019 Mean	May 2020 Mean	May 2021 Mean
Plan	The working group agrees to focus upon a shared aim.	4.29	4.36	4.58
	The working group conducts research to clarify and further specify problems of practice prior to identifying and assessing strategies for addressing those problems.	3.50	3.77	4.73
	The working group develops a driver diagram to depict its theory of change.	3.00	3.42	3.97
	The working group uses PDSA cycles to spur improvement in testable iterations.	3.33	3.48	4.33
	The working group makes decisions about PDSA measurement that balance rigor and feasibility.	3.00	2.95	4.25
	Average Dimension Rating:	**3.42**	**3.60**	**4.32**
	Number of Respondents:	**6**	**22**	**42**
Do	The working group uses PDSA forms to record expected outcomes of each improvement strategy implemented.	3.33	3.75	4.19
	The working group establishes processes for collecting, organizing, analyzing, and synthesizing data during PDSA cycles.	3.33	3.48	4.17
	The working group helps participating institutions implement improvement strategies for addressing problems of practice.	3.50	3.36	4.08
	The working group consistently collects data on a short list of indicators to measure results from the improvement strategies implemented at participating institutions.	2.88	3.14	3.85
	Average Dimension Rating:	**3.24**	**3.43**	**4.07**
	Number of Respondents:	**7**	**21**	**36**
Study	The working group members ask questions of those affected by the work about what the data mean.	3.67	3.40	3.85
	The working group analyzes data collected about improvement strategies and compares them to projections developed in the Plan step.	3.60	2.70	4.00
	The working group shares findings in ways that take account of the needs of the network and its members.	3.67	3.30	4.33
	The working group considers the extent to which the analyzed data do or do not represent progress toward the overall aim.	3.60	3.70	4.06
	Average Dimension Rating:	**3.64**	**3.28**	**3.94**

Dimension	Indicator	May 2019 Mean	May 2020 Mean	May 2021 Mean
	Number of Respondents:	**8**	**10**	**36**
Act	The working group determines whether the improvement strategy being tested should be adopted, adapted and re-tested, or abandoned.	3.50	3.93	4.30
	The working group decides what should be adjusted and studied next, if the improvement strategy needs to be adjusted.	3.50	3.73	4.28
	The working group decides whether the improvement should be tested in new contexts and/or at larger scales if the improvement strategy is successful.	3.50	3.67	4.17
	The working group iteratively tests what related processes or supports are needed to ensure that effective improvement strategies produce improvements reliably.	3.50	3.00	4.03
	Average Dimension Rating:	**3.50**	**3.58**	**4.20**
	Number of Respondents:	**4**	**15**	**35**
Collaborate	The working group members represent the demographic and geographic diversity of our state.	4.42	4.03	4.40
	The working group includes rural, first-generation students.	4.85	3.97	4.45
	The working group includes STEM professionals who were themselves rural, first-generation students.	4.57	4.10	4.50
	The working group members meet together regularly.	4.85	4.63	4.80
	The working group ensures that student perspectives are considered.	4.71	4.38	4.61
	The working group establishes routines that promote collaborative decision-making and guard against power imbalances.	4.42	4.23	4.70
	The working group members establish norms of interaction that support collaborative decision-making and equitable participation in all phases of the work.	4.71	4.30	4.66
	The working group members recognize and respect one another's perspectives and diverse forms of expertise.	4.71	4.74	4.82
	Average Dimension Rating:	**4.66**	**4.30**	**4.62**
	Number of Respondents:	**7**	**31**	**45**
Disseminate	The working group develops and shares knowledge and theory that furthers the research base.	2.86	3.79	4.54
	The working group contributes to network dissemination efforts.	2.86	4.67	4.60

Dimension	Indicator	May 2019 Mean	May 2020 Mean	May 2021 Mean
	The working group shares results in ways that take into account the needs of relevant audiences.	2.71	4.40	4.59
	The working group develops and shares new tools and/or routines that can be adapted to support improvement work in other settings.	2.71	4.15	4.34
	Average Dimension Rating:	**2.79**	**4.25**	**4.52**
	Number of Respondents:	**7**	**15**	**37**
Reflect on Equity	The working group activities take into account members' work demands and roles in their respective organizations.	3.71	4.19	4.48
	The working group focuses attention on policies, practices, and culture that are reinforcing patterns of inequity in the state.	4.00	4.15	4.48
	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.	4.00	4.05	4.34
	Average Dimension Rating:	**3.90**	**4.16**	**4.43**
	Number of Respondents:	**7**	**21**	**40**
Building Capacity	The working group member organizations allocate resources to support partnership work.	3.71	4.04	4.11
	The working group members develop professional identities that value engaging in sustained collaborative inquiry with one another to address problems of practice.	3.86	4.08	4.42
	The working group members assume new roles and develop the capacity to conduct network activities.	3.43	3.91	4.45
	The working group establishes conditions in participating institutions that lead to sustained impact beyond the life of the network.	3.57	4.00	4.18
	The working group's work contributes to changes in participating education institutions' norms, culture, and routines around the use of research.	3.29	3.71	4.32
	Average Dimension Rating:	**3.57**	**3.95**	**4.29**
	Number of Respondents:	**7**	**24**	**38**

Note: N for scale excludes respondents who selected the *Not Applicable* response option.

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.

Table 4 presents the degree to which each working group rated each PDSA phase as a strength. High mean ratings of 4.0 – 4.5 (*This is more of a strength than a weakness for our working group)* and medium ratings 4.6 – 5.0 (*This is a strength for our working group)* are represented by the darkest blue to indicate that working group members tend to view the PDSA phase as a strength. Means of low-medium ratings 3.0 – 3.9 (*This is neither a weakness nor a strength for our working group)* are represented by a slightly lighter shade of blue. Finally, low mean ratings of 2.1– 2.9 (*This is more of a weakness than a strength for our working group)* are represented by the lightest shade of blue. Readers should note that means of 1.0 to 2.0 are not represented in the table because no PDSA phase earned mean ratings lower than 2.0 on the five-point scale.

Overall, the Student Leadership and Immersive Experiences working groups had the highest mean ratings across all PDSA phases. For both working groups, the most highly rated phase was the Plan phase. The College Readiness working group had the highest mean ratings of the Study and Act phases of all working groups, but overall, the Act phase received the lowest ratings from each working group. Heat map visualization (see Table 4) is followed by a closer analysis of the data associated with each phase of PDSA cycles.

Table 4. Heat Visualization of Engagement in PDSA Phases by Working Group, May 2021

Working Group	Plan	Do	Study	Act
Student Leadership	High	Medium	Medium	Low-Medium
Student Alumni	Medium	Medium	Medium	Medium
Immersive Experiences	High	Medium	Low-Medium	Low-Medium
Faculty & Student Engagement	Medium	Low-Medium	Medium	Low-Medium
College Readiness	Low-Medium	Low	Medium	Medium

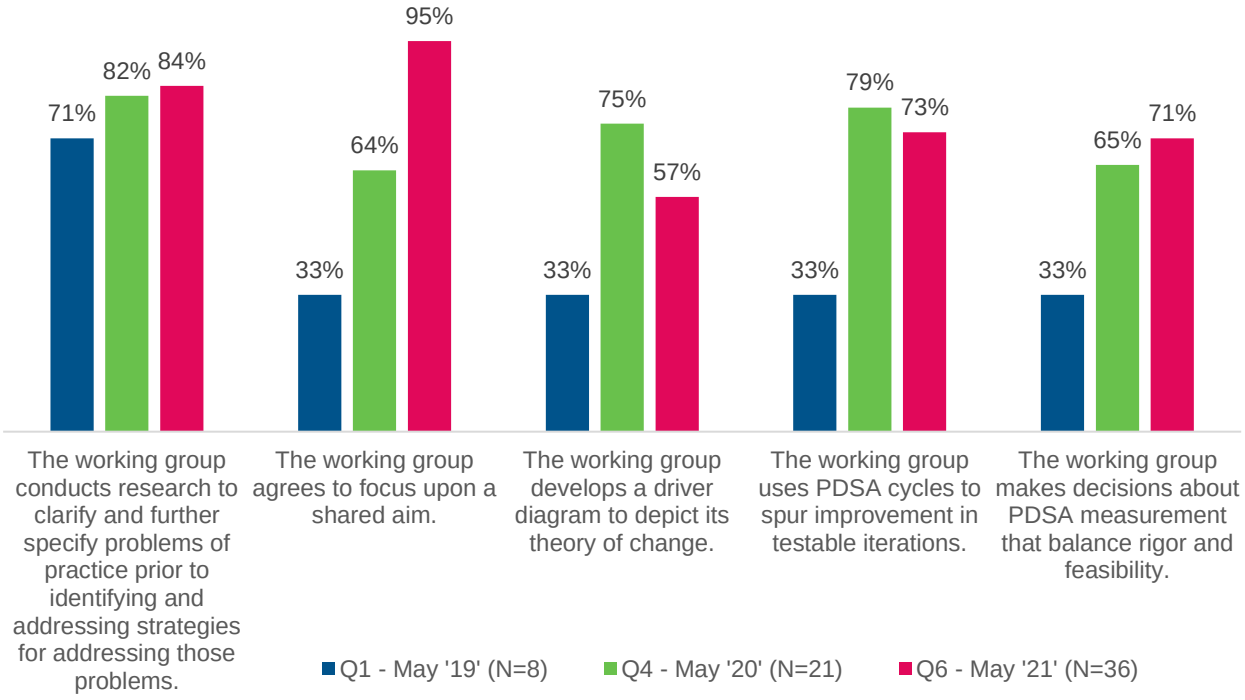
III.2.5.4.1 The *Plan* Phase

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 May of 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: May of 2019 2020, and 2021. Three of the five activities associated with the Plan phase had higher mean ratings in 2021 than in the prior two years, while mean ratings for the remaining two indicators declined.

Members reported that COVID-19 played a role in the decrease of activity levels and likely the cause of lower strength ratings. As one respondent explained, "COVID-19 is jeopardizing lots of working group efforts, but it is pretty surprising what has been accomplished despite COVID-19."

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



Specifically, working group members were three times as likely in 2021 than in 2019 (95% and 33%, respectively) to agree that *focus[ing] on a shared aim* is a strength for their working group. By 2021, 3 out of 4 respondents considered the *development of a driver diagram to depict its theory of change* to be a strength or more a strength than a weakness for their working groups, compared to only 33% in 2019 who thought so. Another notable increase is in respondents' assessment that their working group *uses PDSA cycles to spur improvement in testable iterations*, with 35% reporting this in 2019 compared to 73% by 2021.

A few members described challenges associated with conducting the Plan phase, including the need to complete forms to secure stipends, difficulties presented by the COVID-19 pandemic, and the tendency of faculty to be overcommitted. But respondents also described facilitators of the Plan phase: allotment of sufficient time in meetings to work on PDSAs, First2 Network support for leveraging shared efforts, and good working group organization.

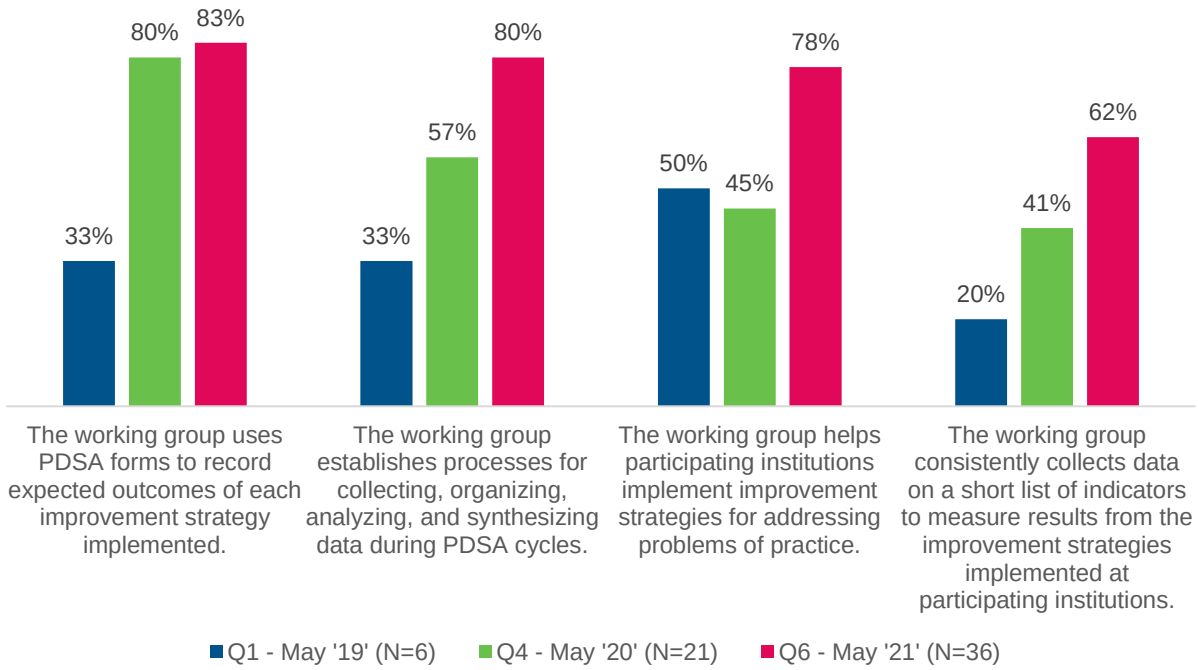
III.2.5.4.2 The *Do* Phase

The percentage of respondents who considered Do phase activities as strengths has grown since the network's inception. Mean ratings for all activities associated with this PDSA 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 (83%) did so by 2021. Similarly, mean ratings of *The working group establishes process for collecting, organizing, analyzing, and synthesizing during PDSA cycles* steadily improved from 33% in 2019 to 57% in 2020 to 80% in 2021.

One respondent shared that data collection during this phase was supported by "discussion among active members." On the other hand, another respondent suggested that her/his working group needed "more frequent meeting[s] designed only to discuss current PDSAs."

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



III.2.5.4.3 The *Study* Phase

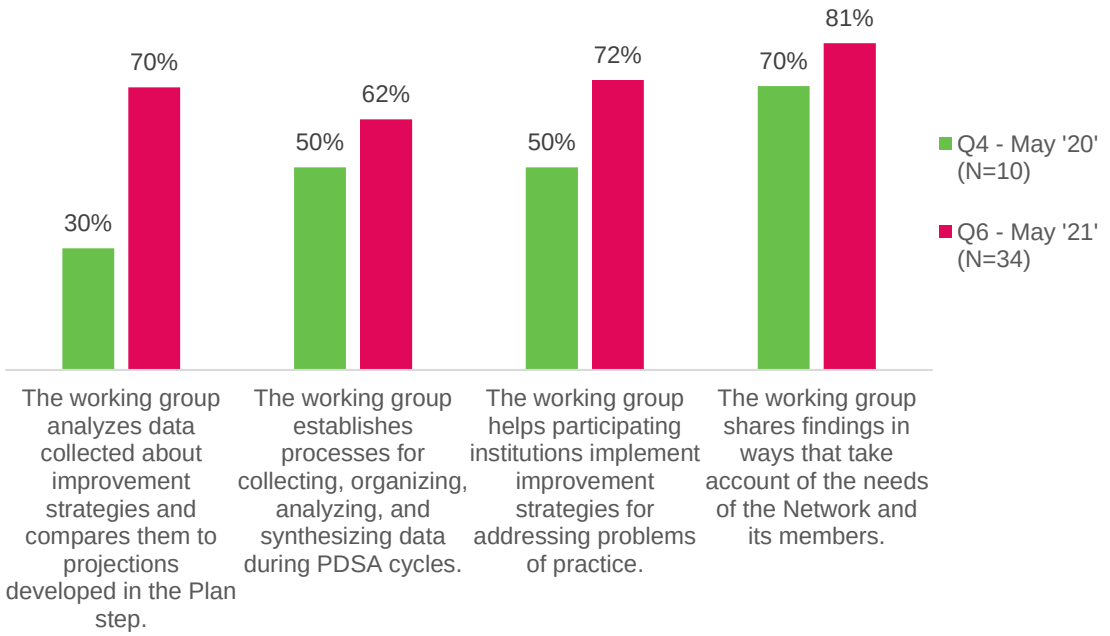
Beginning in Year 2, working group members began to implement the Study phase of PDSA cycles through study elements, participating in activities such as analyzing data collected about improvement strategies and comparing them to predictions developed during the Plan phase. Because so few respondents in 2019 indicated that their working groups had conducted Study activities, the following analysis is limited to data collection during 2020 and 2021.

Figure 8 shows that between 2020 and 2021, the percent of respondents reporting that *The working group shares findings in ways that take into account the needs of the network and its members* increased from 70% to 81%. In addition, the percent of respondents indicating that *The working group analyzes data collected about improvement strategies and compares them to projections developed in the Plan step* increased from 30% in 2019 to 70% by 2021, the activity with the largest gain in the Study phase.

According to one respondent who provided additional information about this phase, "Coming together as a working group and hearing about the efforts of other individuals at other institutions was great! Some really great efforts are in place throughout the State." To continue First2 Network support for this PDSA phase, respondents suggested that allotting time to

"understand the collected data would be beneficial, using members on the Measurements Team" and working with chairs and faculty advisors to understand findings.

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



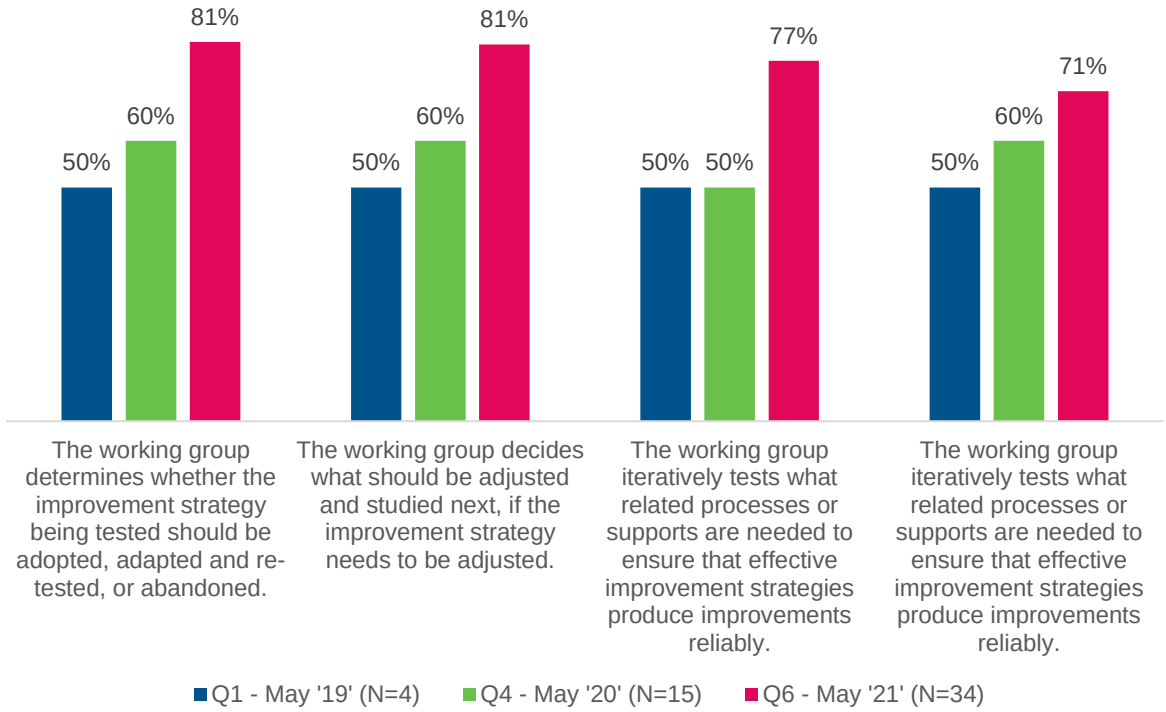
III.2.5.4.4 The *Act* Phase

The majority of respondents (between 71% and 81%) indicated that the activities associated with the Act phase were strengths in 2021 (see Figure 9). In addition, mean ratings of these activities have increased steadily since 2019.

The largest increases in the percentage of respondents rating an activity as a strength were for the following activities, both improving from 50% in 2019 to 81% by 2021: 1) *The working group determines whether the improvement strategy being tested should be adopted, adapted and re-tested, or abandoned* and *The working group iteratively tests what related processes or supports are needed to ensure that effective improvement strategies produce improvements reliably*.

Asked to provide additional information about this phase, one working group member reported that s/he "tried to enforce and incorporate new activities and talks." In addition, several respondents noted that they had not completed the Act phase, the final PSDA phase, by the time of the Working Group Self-Assessment.

Figure 9. Percentage of Respondents Rating Indicators of the Act Phase of PDSA Cycles as a Working Group Strength, 2019-2021



2.5.1 Collaborate

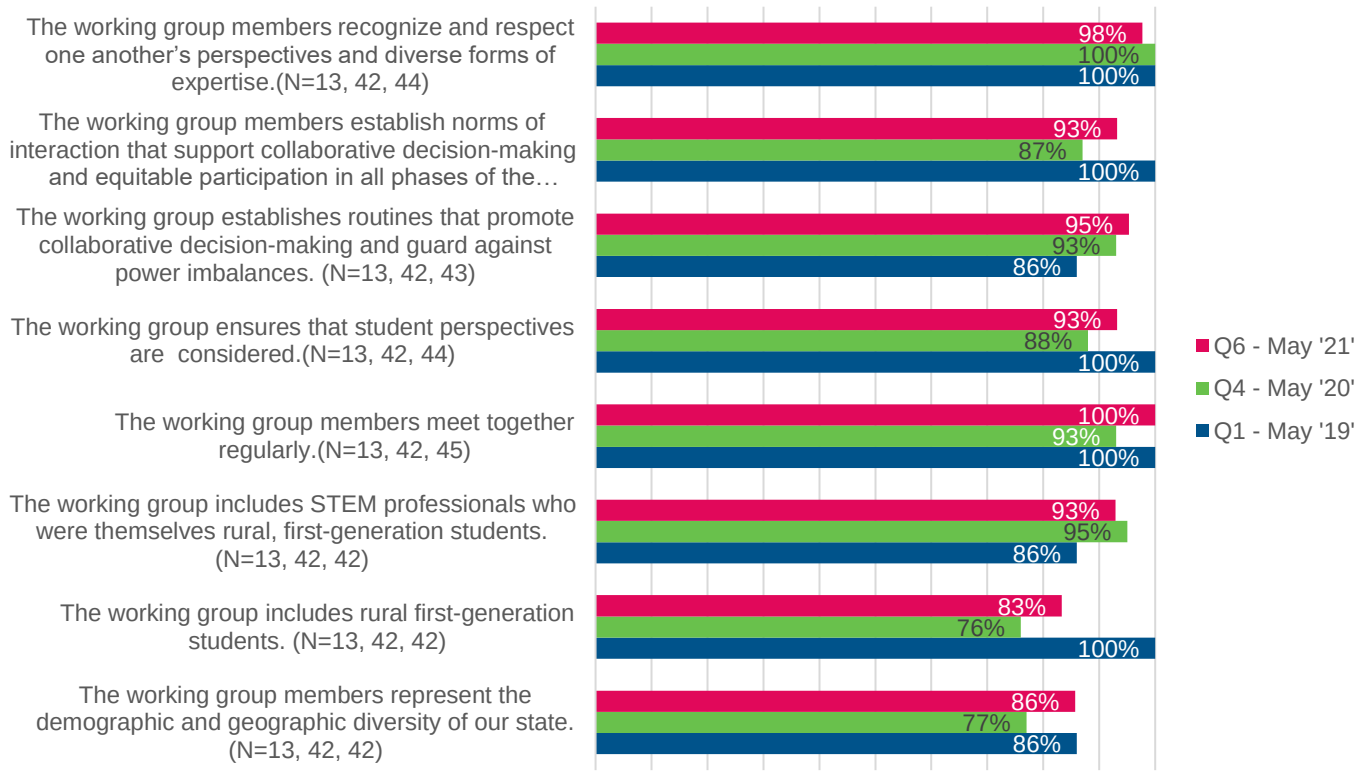
As shown in Figure 10, large percentages of Working Group Self-Assessment respondents have rated activities associated with collaboration highly across all three years of First2 Network operation.

In 2021, the Collaborate activity perceived as working groups' greatest strength was *The working group members meet together regularly*, with 100% of respondents in agreement. Additionally, 98% rated *The working groups recognize and respect one another's perspective* as a strength in 2021, down slightly from the 100% in both 2019 and 2020. The third most important strength in Q6 was *The working group ensures that student perspectives are considered,* with 93% reporting this is a strength in 2021 compared to 88% in 2020.

Notably, there was growth between 2019 and 2021 in *The working group establishes routines that promote collaborative decision-making and guard against power imbalances*, with percentages agreeing that this was a strength rising from 86% to 95%. Ratings of *The working group members represent the demographic and geographic diversity of our state* also improved over time, growing from 77% in 2020 to 86% in 2021, an increase of nine percentage points.

Overall, in six of the eight Collaborate indicators, mean ratings increased between 2020 and 2021. One item—*The working group includes STEM professionals who were rural, first-generation students*—declined slightly between 2020 and 2021, although with 93% of respondents rating this as a strength, concern seems unwarranted.

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



2.5.1 Reflect on Equity

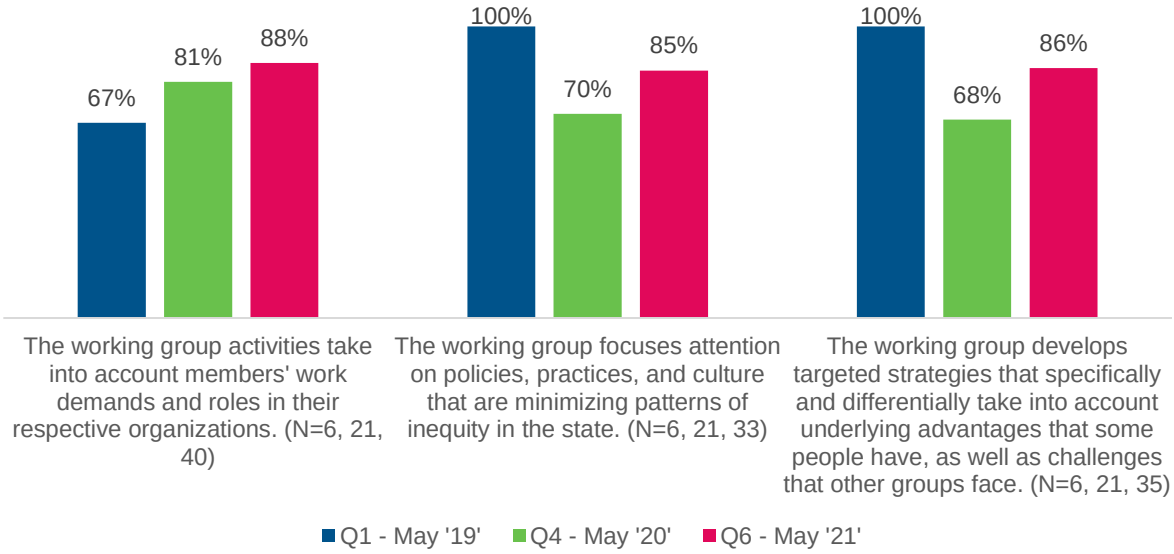
Figure 11 shows respondent ratings for the three items associated with the Reflect on Equity dimension. Most (88%) respondents in 2021 reported that *Working group activities take into account members' work demands and roles in their respective organizations*, compared to 81% in 2020 and 67% in 2019.

The pattern is different for the remaining two items, which dipped between 2019 and 2020 before increasing in 2021. 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 from 100% in 2019 to 68% in 2020, rebounding somewhat to 86% by 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* declined from 100% in 2019 to 70% in 2020, and then increased to 85% 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 attributable to, "more organized diversity and equity discussions." Another respondent commented, "The group is open and inclusive." Another respondent, however, reported challenges associated with recruitment for equity, writing, "We don't know how to recruit for diversity." In general, respondent comments reported the use of intentional working group

"conversation" to facilitate awareness about issues and to promote opportunities for more equitable services to students. Nonetheless, as one respondent cautioned, working groups must avoid "overburden[ing]" or "tokenize[ing] our most marginalized members." The respondent continued by encouraging working group members to "use some collective reflections on our implicit biases and/or study of literature on how to be allies and change agents."

Figure 11. Percentage of Respondents Rating Indicators of the Reflect on Equity Dimension as a Working Group Strength, 2019-2021

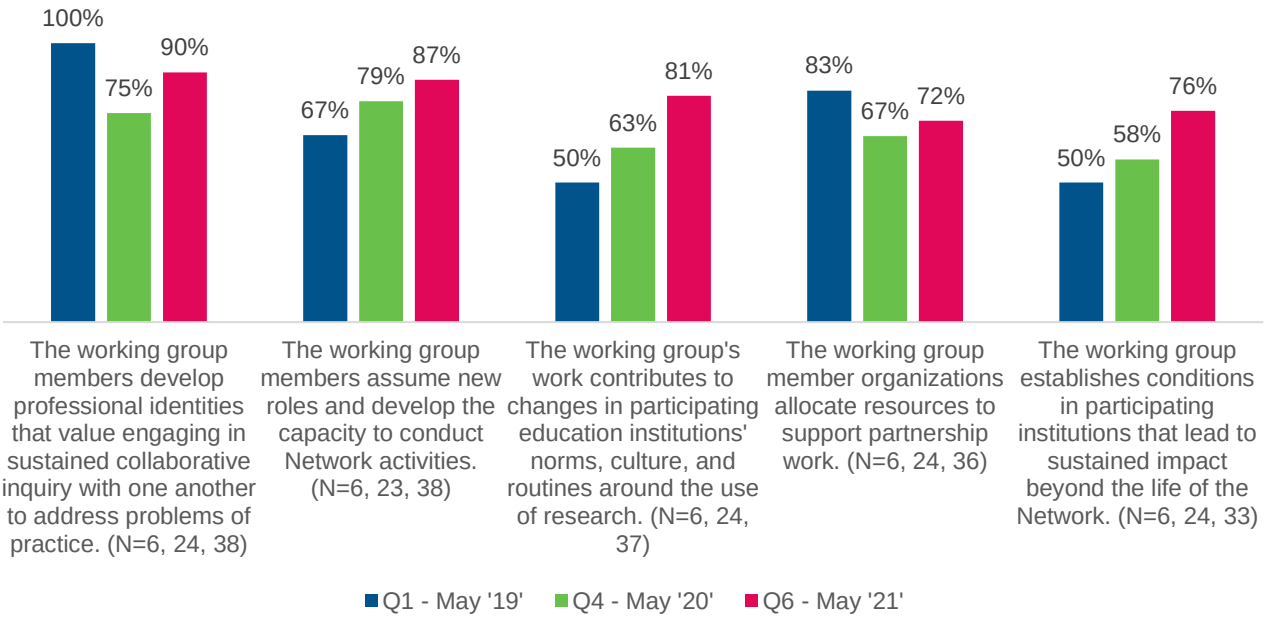


2.5.1 Building Capacity

As shown in Figure 12, more respondents rated three of the five statements associated with the Building Capacity dimension as strengths between 2019 and 2021.

Whereas half of respondents rated *The working group's work contributes to changes in participating education institutions' norms, culture, and routines around the use of research* as a working group strength in 2019, by 2021 81% did so. Likewise, 67% of 2019 respondents reported that *The working group members assume new roles and develop the capacity to conduct network activities* as a strength, but 87% did so in 2021. The percentage of respondents who reported that *The working group established conditions in participating institutions that lead to sustained impact beyond the life of the network* was a strength also improved over time, from 50% to 58% to 76% across the three years of First2 Network operation.

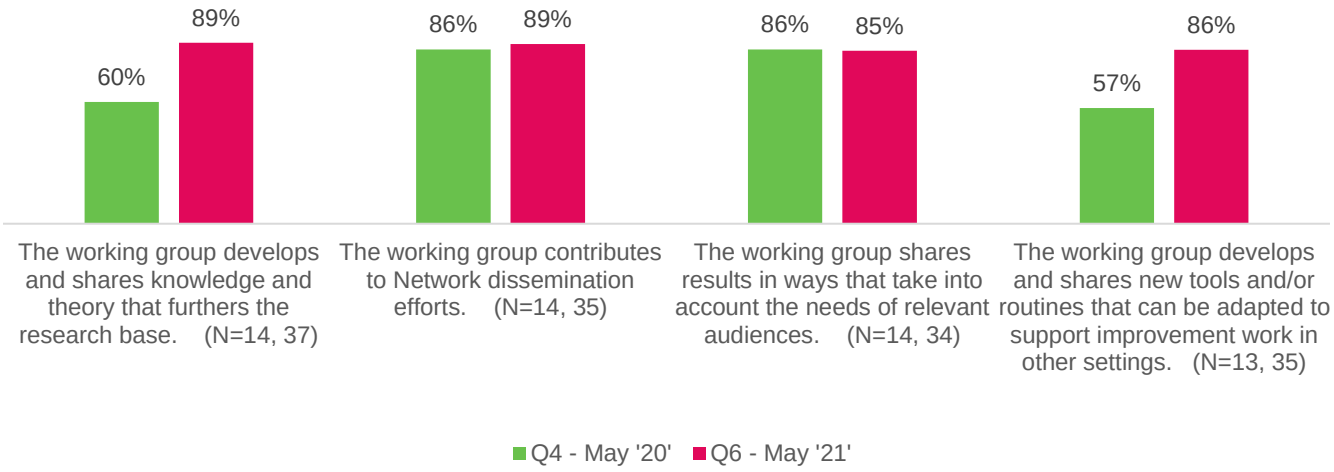
Figure 12. Percentage of Respondents Rating Indicators of the Building Capacity Dimension as a Working Group Strength, 2019-2021



2.5.2 Disseminate

As shown in Figure 13, the two most highly rated indicators of this dimension, at 89% each in 2021, were *The working group contributes to network dissemination efforts* and *The working group develops and shares knowledge and theory that furthers the research base*. The latter indicator also reflected a substantial increase from 60% in 2020. The percent of respondents rating *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 86% in Q4 to 85% by Q6. Overall, a majority of respondents indicated that dissemination had improved. As one respondent elaborated, "The group's [dissemination] efforts are always helpful." (Please note that 2019 data are not presented because so few working group dissemination activities took place during the First2 Network's inaugural year.)

Figure 13. Percentage of Respondents Rating Indicators of the Disseminate Dimension as a Working Group Strength, 2019-2021



2.5.3 Additional Questions

The Working Group Self-Assessment also asked respondents to rate their level of agreement with five statements about their working group experiences. Table 5 presents percentages and means associated with each of these items, arranged by highest to lowest mean scores. The highest mean rating was 4.10 for *The support I have received in this working group is of high quality, relevant, and useful*. The lowest mean rating was 3.77 for *I provided useful resources for other members of this working group*.

Table 5. Percentages and Means of Additional Supports Subscale

[Items are arranged from highest to lowest mean scores.]	Response Frequency Percentages					Mean
	(1) Strongly Disagree	(2) Disagree	(3) Neither Disagree nor Agree	(4) Agree	(5) Strongly Agree	
The support I have received in this working group is of high quality, relevant, and useful. (N=40)	3%	0%	10%	60%	28%	4.10
I received useful resources from other members of this working group. (N=40)	3%	0%	8%	68%	23%	4.08
I meaningfully participated in this working group with other colleagues. (N=40)	3%	5%	13%	55%	25%	3.95
I have contributed to the development of at least one PDSA change activity. (N=40)	8%	3%	25%	35%	30%	3.78
I provided useful resources for other members of this working group. (N=39)	3%	3%	26%	54%	15%	3.77

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

2.5.4 Summary of Working Group Self-Assessment

Findings from the May 2021 administration of the Working Group Self-Assessment indicate growth in the use of PDSAs. The number of respondents grew from 8 respondents to the first administration of the instrument to 49 respondents who completed it and indicated that they had participated in a change activity.

While several respondents selected the *Not Applicable* response option for items pertaining to the PDSA phases, far fewer did so than in 2020. Respondents are less concerned with scheduling challenges than they had been in earlier years and now are considering new issues—the sustainability of PDSA funding and participation of smaller institutions. As one working group member shared, "I'm worried about the sunset of funding for PDSA work."

COVID-19 likely affected the strength of work group operations in key areas. For example, several members mentioned that their working groups necessarily convened fewer face-to-face meetings and supports. Even so, working groups made strides in meeting virtually, including with students, conducting PDSAs, and disseminating the results. For example, 100% of member respondents indicated that meeting regularly was a strength for their working group, attributable to the persistence and strength of working group organization and leadership. Additionally, over half of respondents completed (59% of 49) or contributed to the completion of (65% of 40) PDSA cycles. Finally, students comprised the largest group of respondents (40%), 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, working group chairs, and the backbone organization through "zoom calls hosted by the network." As one member explained, "They made sure I had the help that I needed to complete my PDSA. Put me in contact with the correct people to be successful." Another reported, "NILS and PDSAs are both great ways to document efforts toward administrative, programmatic and teaching changes. I rather enjoy using them at this point."

Respondents noted a few challenges, including competing time commitments and the difficulty of ensuring new member engagement in activities. In addition, three-quarters of Working Group Self-Assessment respondents (75% of 40) reported that they would appreciate resources to better support engagement in the PDSA efforts of their working group (it was unclear whether such respondents were aware of the resources already available on the First2 Network website).

2.6 Steering Committee Survey

The evaluation team administered a comprehensive Steering Committee Survey in March 2019, March 2020, June 2020. The April 2021 administration asked members to rate the status of Steering Committee through 24 statements about Steering Committee 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.

Using a scale of 1 = *Not Started,* 2 = *Beginning/Early Stage,* 3 = *Making Progress,* and 4 = *Fully Achieved,* Steering Committee members reported consistent progress between March 2019 and April 2021 on 10 statements about the Steering Committee (see Table 6 below). One item, *The Steering Committee is successfully adapting programmatic efforts to meet COVID-19*

challenges, was added to the survey this year; therefore, only one year of data is presented for this item.

By April 2021, the highest-rated statement about the Steering Committee was *The Steering Committee meets sufficiently regularly* (with a mean of 4.00), and although this was the highest-rated item in the three previous survey administrations, the April 2021 rating was the highest since March 2019. The next three highest-rated items, each with a mean of 3.70, were *The Steering Committee agreed upon a decision-making process, Steering Committee members trust each other,* and *The Steering Committee is successfully adapting programmatic efforts to meet COVID-19 challenges.* In April 2021, the lowest rated item was *Steering Committee members have a clear understanding of the network's next steps.* Nonetheless, given that a rating of 3 indicates that the Steering Committee is making progress, the mean score for this item (3.30) is not cause for concern.

The largest mean rating increase, indicating the area in which the most progress was achieved, was for the item *The Steering Committee has agreed upon a decision-making process.* The mean rating for this statement increased by 0.79 points, from 2.91 in March 2019 to 3.70 by April 2021. Three additional items were not far behind in terms of progress achieved: (1) *The Steering Committee provides oversight and governance of the First2 Network* (from 2.73 in March 2019 to 3.50 by April 202), (2) *Communication within the Steering Committee is constructive* (from 2.91 in March 2019 to 3.60 by April 2021), and (3) *The Steering Committee has developed a clear vision for the First2 Network* (from 2.82 in March 2019 to 3.50 by April 2021). No items in Table 6, Part I, achieved statistical significance when comparing June 2020 and April 2021 scores, although this is not surprising given the small size of the respondent group.

Table 6. Year 3 Steering Committee Survey Item Means, Part I

	March 2019			March 2020			June 2020			April 2021			March 2019–April 2021
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	Change
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	+0.13
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	+0.09
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	+0.68
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	+0.77

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	+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	+0.43
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	+0.69
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	+0.41
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	+0.66
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	na

***** This item was added in Year 3; therefore, only one year of data is available.

The survey also asked Steering Committee members to rate progress on 14 items concerning their roles on the Steering Committee, using the rating scale of 1 = *Not Started,* 2 = *Beginning/Early Stage,* 3 = *Making Progress,* and 4 = *Fully Achieved*. As indicated in Table 6, Part II, mean ratings for 13 items increased between March 2019 and June 2020. The final item, *I help to support First2 Network programming adjustments to address COVID-19 challenges,* was added to the survey this year; therefore, only one year of data is reported.

In April 2021, the highest mean ratings—indicating that items were fully achieved or making progress—were for *In my role as a Steering Committee member, I lead a working group* (mean = 3.80) and *In my role as a Steering Committee member, I understand the responsibilities associated my Steering Committee membership* (mean = 3.70). The lowest mean rating in April 2021 was a mean of 3.0 for two items: *In my role as a Steering Committee member, I help the network determine how to coordinate the new knowledge that working groups generate* and *In my role as a Steering Committee member, I help to keep network members accountable to one another*. Nonetheless, this mean score on the four-point scale indicates that respondents perceive progress in both instances. No items in Table 4 achieved statistical significance when comparing June 2020 and April 2021 scores.

Table 6. Year 3 Steering Committee Survey Item Means, Part II

	March 2019			March 2020			June 2020			April 2021			March 2019-April 2021
In my role as a Steering Committee member…	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Change**
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	+0.7
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	+0.44
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	+0.58
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	+0.37
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	+1.04
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	+0.73
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	+0.41
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	+0.24
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	+0.09
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	+0.47
I contribute to decisions about how	11	2.64	0.92	13	3.00	0.58	11	3.36	0.81	9	3.33	0.71	+0.69

	March 2019			March 2020			June 2020			April 2021			March 2019-April 2021
In my role as a Steering Committee member…	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Change**
to onboard new First2 Network members.													
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	+0.69
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	+0.24
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	na

* This item was added in Year 3; therefore, only one year of data is available.

On the final portion of the survey, respondents were asked to reply to five open-ended questions about their perceptions of the Steering Committee's progress to date. When asked to describe what is working well on the Steering Committee in March 2019, most comments referred to dedicated members, group cohesion, and early progress in establishing First2 Network processes. By April 2021, respondents lauded agenda/meeting structures and attendance, communication and networking, collaboration and support of others, member representation/clear definition of member roles, and student involvement. Two respondents commented on the Deep Dive portion of the Steering Committee meeting meetings with one noting that this portion of the meeting is still too short in many cases, while another commended Steering Committee members for being well prepared and responding in a timely manner with well-thought-out presentations. Among the responses from members in terms of what is working well on the Steering Committee in April 2019 were these:

> *The networking and collaboration in leadership is working exceptionally well.*
>
> *Roles are more clearly defined, and communication about what working groups are doing has improved over the past year. It was a great idea, to open up and advertise meetings to anyone in the network.*
>
> *Student involvement is good. Also, I like that the last hour of Steering Committee meetings is open to all.*

The second open-ended question asked respondents to discuss issues currently before the Steering Committee and how they are being addressed. Replies from the network's first year focused on too many or inefficient meetings, feeling overwhelmed by network commitments, uncertainty about issues of network governance, and tension about unresolved problems.

Respondents to the April 2021 survey cited the need to address Steering Committee governance and communication issues such as committee size and ensuring equal input among members, increasing knowledge and use of members' expertise and strengths, scheduling meetings at convenient dates/times, and addressing voting issues such as bylaws that limit the number of voting members. Others cited the need for working groups to focus more on core network aims and increase communication among working groups, with one respondent noting that given many competing issues and events, members may not have enough time to focus on the network's main goals. Respondents also mentioned the need to focus on planning for network sustainability, work on strengthening partnerships, and communicate promising practices. Other responses addressed the lack of participation of all network members and a need for events that are not "burning out" student/faculty over the computer.

The third open-ended item on the survey asked respondents how Steering Committee processes and structures could be improved to ensure that it achieves its goals. March 2019 replies focused on clarification of the Steering Committee's role, establishment of a Leadership Team for operational purposes, more streamlined communication, and improved meeting efficiency. In April 2021, participant engagement was key to three respondents:

> *Meetings could be improved to engage all participants. A few people are very engaged, but others are not. I would like to see community building activities in the SC [Steering Committee] meetings and more interactive discussions. The deep dives are not always effective ways of engaging the SC members.*
>
> *Go back to some method for inviting additional agenda items from the membership, in addition to agenda setting by co-chairs and immediate past co-chair and [network staff member].*
>
> *I am worried about sustainability of the S.C. [Steering Committee]. All S.C. members are not going to remain as active as they are now, and we need others to replace them.*

Frequent reiteration of goals and periodic project updates were among other suggestions to ensure the network's aims remain in the forefront and are achievable.

The fourth open-ended item asked respondents how the COVID-19 pandemic is affecting the work of the Steering Committee. One respondent commented on the pandemic's impact on establishing trust and building personal relationships. Several respondents spoke about being more tired, stressed, and even overwhelmed at times, with one noting the impact on student involvement and another commenting,

> *S.C. [Steering Committee] members are working twice as hard and long at their "regular jobs." S.C. members are running out of gas and enthusiasm. At least I am.*

However, other respondents noted that despite needed adjustments, the work is continuing to move forward. One respondent noted the Steering Committee "has done an amazing job of adapting" and others commented that "progress may be slowed due to limited access to each other but [is] still ongoing" and there are "fewer face-to-face meetings but other than that, the work is ongoing." As one member points out,

> *The pandemic is affecting the ability to meet face to face at conferences where many one-on-one relationships are built and tended. However, having Zoom readily available has allowed a larger number of people from greater distances come together more often to meet and discuss issues as needed.*

Few respondents offered suggestions or recommendations when asked how the Steering Committee could better respond to the needs of its members during the pandemic. A member suggested the Steering Committee should be aware of working group members' online workloads, while another respondent suggested determining member needs and suggestions for addressing those needs.

The final open-ended item prompted Steering Committee members to share any additional information about which the survey did not ask. In March 2019, four respondents reported that the First2 Network and the Steering Committee had potential to generate important outcomes, and three respondents noted issues with overwork and burnout. In April 2021, three members replied. One commended the work of the new co-leaders and noted that the project is changing for the better. However, another respondent suggested a greater focus on planning, commenting that "sometimes things are left to the last minute and there is a rush to get everyone to complete tasks." Another respondent commented,

> *Pulling out action items in the minutes is helpful. We keep talking about having additional regularly recurring agenda items to address on rotation - it would be good to get those all out on the table and then schedule them throughout the year.*

2.6.1 Steering Committee Survey Summary

In sum, data from this survey suggest that members have observed considerable and consistent progress over time in the work of the Steering Committee. Although some governance and communication issues remain to be resolved, respondents tended to think that governance and communication had improved since the network's first year. Steering Committee members also reported that they had nearly or fully achieved their role in leading work groups, understood their Steering Committee responsibilities, championed the First2 Network by communicating with others, and made progress toward achieving other goals of the committee.

2.7 October 2020 and May 2021 Conference Evaluations

2.7.1 October 2020 Conference Feedback Form

The First2 Network held a virtual conference on October 8-10, 2020, Engaging STEM Students in a Changing World. A total of 31 respondents completed the online survey following the event.

Eighty-one percent were active members of the First2 Network, with 42% reporting they served on at least one working group and 39% reporting they served in a leadership position within the network. Thirteen percent indicated they were network members but were not involved in any working groups; the remaining 6% were new to the network. Nineteen percent reported that they were students.

The first three rated items focused on the First2 Network and responses were very positive, with mean scores ranging from 4.39 to 4.52 on a five-point scale of *Strongly Disagree* (1) to *Strongly Agree* (5). These items were: they understand their role in the network (4.39), they are committed to doing the work associated with the network (4.43), and they are enthusiastic about participating in the network (4.52). The next set of 12 items focused on the virtual conference. Eight items had mean scores between 4.00 and 4.50, again indicating positive perceptions of the conference. Four items were slightly lower, with scores ranging from 3.23 to 3.97. The highest-

rated item at 4.45 was that the conference included meaningful sessions; the lowest-rated item at 3.23 was that sufficient time was provided for general networking with other members. All three of the network items and eight of the 12 conference items had ratings of at least 75% agreement (combined ratings of *Agree* and *Strongly Agree*). See Figures 14 and 15 below for more detail. (In Figure 14 the three network items are depicted with green bars to differentiate them from the conference items.)

Figure 14. Mean Scores for October 2020 Feedback Form Items

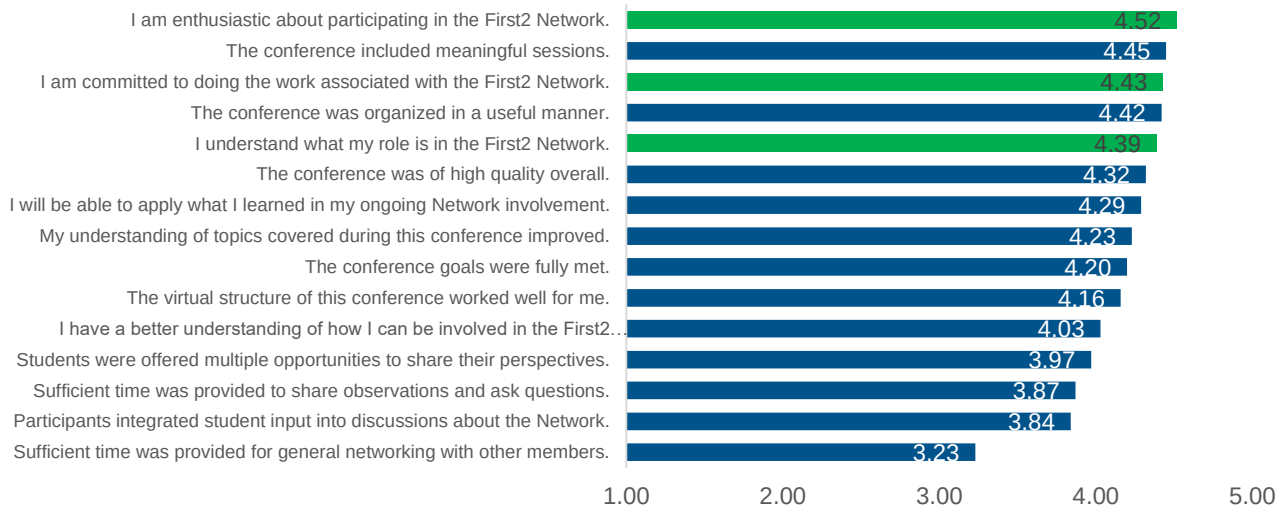
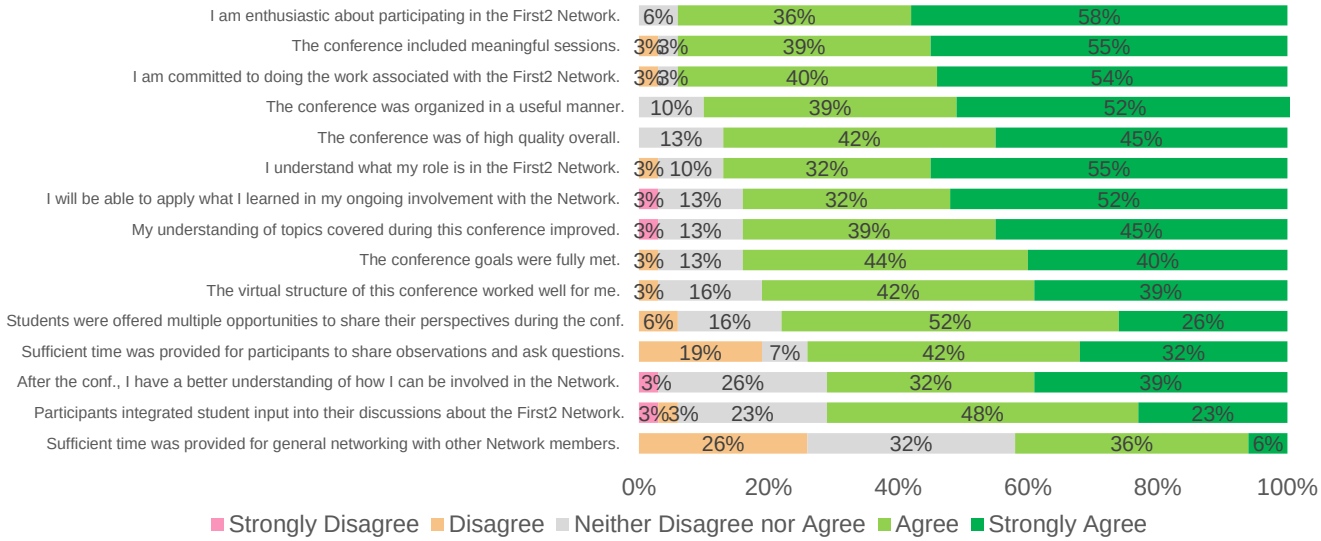


Figure 15. Response Percentages for October 2020 Feedback Form Items



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

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, respondents

noted specific topics or sessions with diversity, industry, students, research, and evaluation among those mentioned most frequently. When asked to identify what did not work as well, respondents most frequently noted that they could only attend some of the sessions due to work or school schedules, and that they would prefer more time for questions and discussions after presentations.

When asked what additional information was needed to work within the First2 Network, responses varied greatly with many not providing a response. A few suggested more details about top network benefits to students and "adultier" adults, industry outreach to education, student leadership opportunities, and summer research opportunities. Results were similar when asked what support was needed from the network for them to become more involved. A few examples included better communication, information about current projects of network members, and "more moments to use my voice."

The final prompt provided respondents an opportunity to make any other comments about the conference. Most comments were complimentary. A few examples noted it was a "great" conference, "very well organized," "well run," and "very well planned." One individual commented, "Great job! Far exceeded my expectations." A few items focused more on suggestions, such as holding a virtual happy hour, having session recordings available immediately afterward, and altering the schedule to promote better attendance.

2.7.2 May 2021 Conference Feedback Form

The First2 Network held a virtual conference on May 10-12, 2021, STEM Student Retention in West Virginia: What are we Learning? Twenty respondents completed the online survey following the event.

Seventy percent were members of the First2 Network, with 40% reporting they served in a leadership position with the network, 25% reporting they were a member of at least one working group, and 5% reporting they were a member of the network but not involved in any working group. Twenty percent indicated they were new to the network, and 10% indicated they were aware of but not involved with the network. More than a third (35%) described their role as industry/nonprofit/government/other, while 30% selected *staff/administrator,* 25% selected *educator,* and 10% selected *student*.

The majority (85%) indicated they already have a First2 Network account on the website and 15% indicated they would register for an account after the conference. Forty percent reported that they frequently use the website, 25% each reported rarely or sometimes using the website, and 10% reported not using the website.

Respondents were asked to indicate all of the conference sessions they attended. Results are shown below in Table 7.

Table 7. Participation Rates in Individual Sessions

Day	Session	Participation Rate
Monday	New to First2	35%
	Drop into a Working Group	55%
	Holler Back: Let's Talk About What We're Learning	65%
	Promising Practices and Shared Learning	70%
	Career Seminar with Industry Leaders	45%
Tuesday	Engaging in Collective Learning	70%
	Diving into First2 Learnings	60%
	Building and Deepening Partnerships	40%
Wednesday	Connecting Professionals Across Institutions to Discuss Their Role in Improving STEM Persistence for Rural, First-Generation Students	70%
	The Role of Student Support Services: Strengthening Involvement on Your Campus	70%
	Drop into a Working Group	40%

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 4.25 to 4.60 on a five-point scale of *Strongly Disagree* (1) to *Strongly Agree* (5): they understand their role in the network (4.25), they are enthusiastic about participating in the network (4.60), and they are committed to doing the work associated with the network (4.60). Nine of the 12 conference items had mean scores at or above 4.00, and three items were below 4.00. The highest-rated item at 4.35 was that the conference included meaningful sessions. The lowest-rated item at 3.50 was that sufficient time was provided for general networking with other members. All three of the network items and ten of the 12 conference items had ratings of at least 75% agreement (combined ratings of *Agree* and *Strongly Agree*). See Figures 16 and 17 for more details. (In Figure 17, the three network items are depicted with green bars to differentiate them from the conference items.)

Figure 16. Mean Scores for May 2021 Feedback Form Items

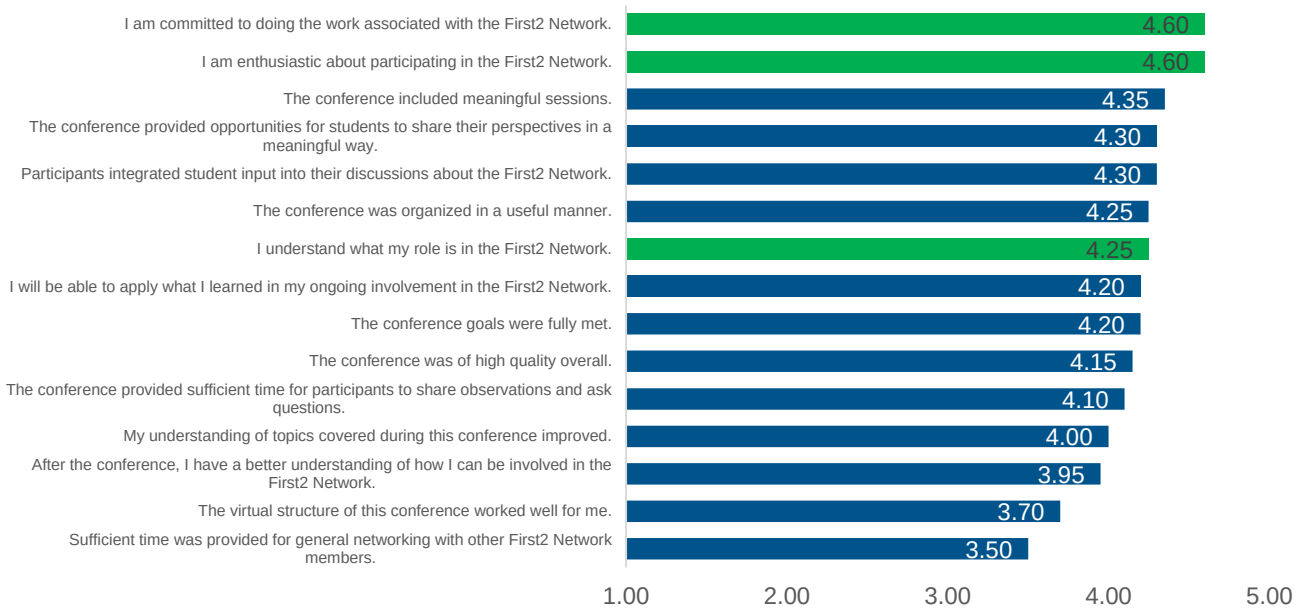
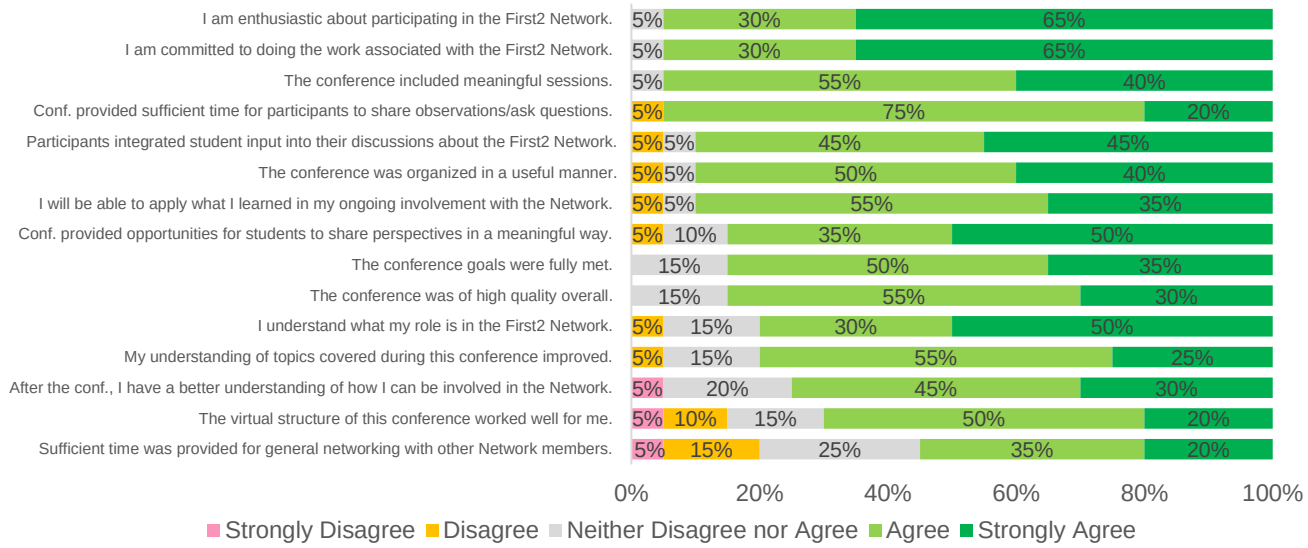


Figure 17. Response Percentages for May 2021 Feedback Form Items



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

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, 14 individuals responded, with several noting the student sessions. When asked to identify what did not work as well, six respondents most frequently noted the virtual setting or the scheduling of sessions.

When asked what additional information was needed related to work within the First2 Network, nine individuals responded, with several noting no additional information was needed. Similarly, eight individuals provided responses when asked what support was needed for them to

become more involved in the network, with half noting no additional support was needed. The final prompt asked for any other comments about the conference. Eight individuals responded, with several focusing on the conference format.

3.5.3 Conference Feedback Summary

In sum, participants provided positive feedback about the two conferences, with most of the rated items at 4.00 or higher on a five-point scale. For each conference, the lowest-rated item was that sufficient time was provided for general networking with other members. Student sessions were identified as high points for both conferences.

3. Systems Targeted by the First2 Network

3.1 Document Review

Latham's[35] 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).[36] Ultimately, systems change "is about changing the structures that shape our ability to improve pathways" (p. 13).[37]

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, or 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, indicates that working groups and members have sought to improve pathways in various ways in Years 2 and 3 (see Table 8 for examples).

Table 8: Evidence of First2 Network Pathway Improvement Efforts

Element of pathway improvement	Evidence of pathway improvement efforts
Improved quality	• 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 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 Aware, 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 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 HSTA teachers and 4-H extension agents to integrate activities that build STEM research skills into programming.
Improved cross-system coordination	• Year 3: The First2 Network continued to build integrative relationships with other state STEM collaboratives and industry including Solvay Corporation, 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, NASA West Virginia Space Grant Consortium, West Virginia Academy of Sciences, 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 9.

Table 9: Evidence of First2 Network Structural Improvement Efforts

Element of structural improvement	Evidence of structural improvement efforts
Reduction in barriers	• Year 3: The Faculty-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 website).
Development of enablers	• 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 one year of tuition at a state public college. This bill would enable students who need to stop of out college for any reason to secure funding for another academic year. SB 610 received a second reading in the 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.

Many of the efforts identified above to improve pathways and structures will require time and additional work to produce observable results. Nonetheless, they collectively represent concerted network attempts to render changes in the systems in which rural, first-generation, and other underrepresented STEM students pursue their educations and careers.

3.2 Backbone and Mentor Backbone Interviews

During June 2021, the ICF evaluation team conducted individual phone interviews with three staff members from the DSR at the West Virginia Higher Education Policy Commission (HEPC DSR) and two staff members from SRI International, all of whom have been involved with the First2 Network project over the past year (July 2020 – June 2021). The purpose of these conversations was to help evaluate the progress made toward achievement of the First2 Network goal of building capacity of the DSR to serve as a sustainable hub or backbone for the network, with SRI serving as a mentor backbone and providing capacity-building activities or supports.

Interview prompts were organized into four main 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.

3.2.1 Capacity-Building Activities

Describe the types of backbone capacity-building activities you have participated in, or the capacity-building supports that have been provided to you related to the First2 Network over the past year.[2] According to interviewees, SRI has provided less direct instruction this year and instead has served in a mentorship or coaching role. SRI staff are still involved, but no longer focused on teaching about collaborative infrastructure or networked improvement communities.

A backbone group comprised of two HEPC DSR staff, one SRI staff member, and one First2 leader meets weekly. As one interviewee noted, in those "incredibly valuable" meetings, "we're helping identify issues that need to go to the leadership team and making plans that reach out to these other partners." Meeting topics also include discussion of "network progress and upcoming things that might be of interest to First2 … we do some strategic planning—making sure that we are on track and making sure that we are capitalizing on opportunities to expand First2."

Capacity-building activities or supports include facilitation of weekly backbone meetings; thought partnership and feedback for institutional Memos of Understanding, grant proposals, and bylaw revisions; and guidance on the development of the network strategic plan, i.e., designing planning meetings, creating a process for plan development, and developing and implementing the plan.

Capacity-building support also focuses on shared metrics, which includes working with the Measurement Team on shared data metrics, working across the network to build members' improvement science and PDSA capacity through videos and workshops, and serving as a Measurement Team liaison and improvement science coach for the College Readiness Working Group. However, this support is not focused specifically on the DSR, since HEPC DSR is not taking lead on these network areas; this support is targeted instead to specific leaders and members across the network.

Which of the above activities or supports were most valuable in building your capacity, and why? "We learned that people need different levels of involvement depending on what their

[2] Questions asked of SRI staff focused on what types of support were provided rather than received, etc.

roles are," is how one respondent replied to this question. The Capacity Building working group originally included backbone members as well as industry representatives. Since much of the capacity-building work did not directly involve those industry members, a separate Industry Advisory Board was formed so they did not have to invest their time and resources on topics they didn't have "a stake in."

> *I think we learned a lot about how you might not have an ideal structure to begin with but if you can take the people who care, who want to be involved and then maybe reshuffle things a little bit … it's actually a really helpful thing because people can fit what they want to do with the roles that are available.*

One HEPC DSR staff member noted just having access to someone to provide feedback or ask reflective questions as well as the dependability, reliability, and expertise provided in giving "solid advice and feedback and it's well thought out, it just makes me feel very comfortable in doing whatever I have to do."

Based on SRI feedback, the brainstorming done around building institutional capacity was most valuable, noting that "as a result of our different conversations, [HEPC staff] have some ideas on how as a backbone they could support institutions and what would those roles as institutions [would] be."

> *[They] have really taken that [strategic] plan that we worked very hard to develop and are now focused on implementing it, so I think that has been critical. NSF said it was lacking, that we didn't have one. Now, HEPC has one, they are using it, they refer to it. So I think that is huge and it's going to be a great … the annual report to NSF is soon, and it's going to be a great success to be able to talk about how First2 is implementing it.*

3.2.2 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 commented that "when I accepted this role," the SRI staff member was already in place as well, "and it's just been a great experience working with her." Others noted the activities/supports "helped a lot in making the whole, making the backbone effective because we had those groups as resources or advising us." Typical comments included the following:

> *They are well on their way. They are in a completely different place than they were a year and a half ago, but that's not just because of [SRI], that's also because they hired [a First2 coordinator]. So for the first time a year and a half ago, they had a person that was 100% dedicated to First2 and they did not have that before. And then she's amazing.*
>
> *The progress that HEPC has made in the last 18 months in terms of understanding what it means to be a backbone and fulfilling that role is tremendous and I think everyone in First2 would agree with that.*

What remaining capacity-building needs does the Division have to be able to serve as an effective backbone for the First2 Network? Interviewees reported several remaining areas of need, most of which centered around the need for additional staffing and sustainability efforts.

Several interviewees suggested that additional staffing was needed for the HEPC DSR to effectively carry out the First2 backbone responsibilities; for example, an intern to provide support in particularly busy periods, a grant writer, a fundraiser, and a data person to lead the shared metrics focus. Even though shared metrics are typically viewed as backbone

responsibilities, the current funding for First2 staffing precludes the Division from taking on leadership of this area. One individual noted, "I would love for there to be money for HEPC DSR to have a person who worked on the shared metrics … related to improvement science PDSA cycles" so that when project funding ends, capacity would be maintained and sustained.

Interviewees also perceived a need to focus on sustainability. Specific comments related to topic are noted below.

> *How is the backbone going to be sustained once the grant terminates? And people are working on it but there is not a clear plan at this point yet and that would be really good if we could develop a specific plan for sustainability.*
>
> *How can we keep … the coordinator [position] in our office?*
>
> *How can people donate money to First2 as a 501(C)(3) because as corporations that's what people want … and since we're a state office that makes it a little bit awkward.*

How can the mentor backbone, HEPC DSR in general, and other relevant partners ensure that the Division has or gains the full capacity to serve as the First2 backbone after support from the mentor backbone ends? Several interviewees suggested a need for greater communication within and across the network:

> *Clearly communicating with the backbone so that we can share what's happening within our partner institutions … share it across the network and give these opportunities to students.*
>
> *I think in terms of building sustainability as it relates to our partners' responsibility, they have to share what's going on so we can share it more broadly.*

Others focused more on the need to recognize that as the backbone of the First2 Network, HEPC's DSR does not have sufficient resources to carry out all of the backbone-type responsibilities and functions. Given this resource constraint, decisions should be made about how to distribute ownership of some of the backbone-type functions across network members. There is a concern that taking on too much work will, as one person noted, "diffuse effectiveness." Pertinent comments included the following:

> *[It is] an ongoing issue in First2 in general. It's an ambitious project. And where do we focus our energy and how do we be strategic about that? It's just an ongoing question.*
>
> *It's unrealistic to think that HEPC can carry the weight of all backbone functions. And I think everyone knows that … but I think we could improve in distributing ownership a little bit more to more people so that those backbone functions are done well even if not 100 percent of them are done by HEPC staff.*

3.2.3 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 the Division as it fulfilled its backbone role over the past year, including securing institutional partners, fundraising, carrying out the strategic plan, organizing the network conferences, communications (including a monthly newsletter and social media), maintaining the network website, creating a First2 dashboard, building relationships and partnerships, and general overall coordination of the network. Specific quotes related to these tasks are listed below.

[Sustainability is] probably the biggest thing [as] we're about to be done with Year 3 and enter into Year 4 which is just a huge milestone. … Everything I do at this point is with the endpoint in mind of what is First2 going to look like after this money runs out.

Getting more institutions involved and excited about First2 … we want the institutions to say, "How can we as institutions pay for the work First2 started?"

Capacity building within institutions, supporting First2 within the institutions, because First2 can't work without people who are working it. … Creating what we call an institutional support team to be essentially a backbone within that institution who can keep in touch with us as the backbone, so we strengthen them and make sure that First2 works well.

…being transparent with where we are in terms of accomplishing what we said we would in the strategic plan.

What factors seem to be helping the Division's efforts to serve as a backbone organization?

Several constructive themes emerged. According to one interviewee, "The COVID-19 pandemic making everything be virtual has been a tremendous help to me in this role" because "First2 gets communicated to the network as a whole. It's so much easier to do that when people are already sensitive to emails and they're already getting on Zoom calls and they're already in that Zoom culture really." Further, with the network conferences being held virtually in fall 2020 and spring 2021, there "was a lot I didn't have to deal with in terms of rooms and with contracts and travel arrangements and food and things like that."

Another factor was the general sense that the right people were involved in the network and specifically in the First2 coordinator position:

Everybody in First2 works together really well and we understand each other, and everybody knows that people are doing things for the right reasons and there are no hidden agendas there. And if they bring a concern up, they really and truly are concerned. … They are very passionate and dedicated and honest in trying to solve this problem of having students stay in college during their first two years.

I think we're in a good place overall [and having] a fulltime First2 coordinator … was definitely a good decision. It made things a lot easier for our office in just … trying to help keep it all together. That's made it much easier for everybody.

… the right person [filled the First2 coordinator position.] They were just really lucky, she's able to do the detail work but she's also able to step back and see the big picture and remind us of what the big picture is. She's a great communicator. She's a connector.

[Prior to the First2 coordinator position being created and filled], the role of the backbone was unclear, leadership was confused, the backbone was confused. … [The backbone role] has become much clearer and they have the full leadership team support, … and leadership understands what they're doing.

Yet another facilitating factor was harnessing the broader resources of HEPC beyond the Division of Science and Research. Examples included having help with developing the First2 dashboard and "teaming up with the student success people here" to discuss potential opportunities for First2 to partner with other HEPC efforts, such as GEAR UP or working with high school counselors. Further, HEPC colleagues outside the Division of Science and Research are

now engaging in the network conferences "and that was encouraging to see," one individual noted.

What factors seem to be impeding the Division's efforts to serve as a backbone organization? One interviewee perceived that due to remote working, "communications in general is a bit of a struggle, especially virtually because it's just hard to interpret what somebody might want. Ten emails later you might have it figured out, but I think we've done well with it."

Another impeding factor is the potential lack of sustainability of the First2 coordinator position after the NSF funding ends. "Impeding us is that the state is not really giving us any contributions to support the First2 Network. It's all coming from the NSF or we get people to donate or something like that."

> *It would take a lot of interaction with the state government to get the First2 position made a part of state government. And the legislature this year was just not responsive to that kind of thing plus with the pandemic you couldn't even go talk to them in person. Maybe that will change or maybe we could make it into part of another program. But right now, there aren't any easy solutions for that.*

And, as noted earlier as a remaining area of need, the Division has insufficient resources and staff to take on all network backbone responsibilities. As one interviewee stated, they "are doing amazingly with what they have, but I sure wish they could have another position … to work on some of the data" or "someone that was more dedicated to the fundraising. … There is only so much a full-time person can do."

3.2.4 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 final comments about the First2 Network.

> *I think the rearrangement of how it was restructured was really beneficial and I actually think there are other parts of First2 that probably need to be restructured to make them more effective and to make us focus on what needs to be done in the next two years. The grant was very, very broad and involved all different levels from K-12 through college, workforce. … It would be really great if we could focus our efforts on the things that are going to help the network be sustained and then we can expand a little bit more. We need to focus in on the first two years of college and having something sustainable to support students through those first two years of college and then bring in the other parts.*
>
> *The network is really important to me and I'm grateful for the experience of being part of it. It's been really good, and I really think they can make a difference in West Virginia. It's such a difficult situation the state is in but I'm confident we're going to come out of this with having made an impact, so it's good.*
>
> *HEPC has just come a long way and they really are a legitimate backbone organization now.*

3.2.5 Backbone Interview Summary

In sum, both 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. The most frequently

mentioned area of need is for additional staffing, especially for someone to take on the data responsibilities and shared metrics.

3.3 Network Value Survey

The Network Value Survey, administered annually in June, asks members to use a four-point scale to rate the value of aspects of the network across 23 items across five sections: (1) activity, (2) output, (3) application, (4) outcome, and (5) impact. 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.[38] According to this research, networks tend to 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 46 responses were included in the analysis of Year 3 member respondents, compared to 49 in Year 2 and 39 in Year 1. Survey respondents indicated their level of agreement to twenty-three statements related to their experience with First2 membership. The items used a four-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.

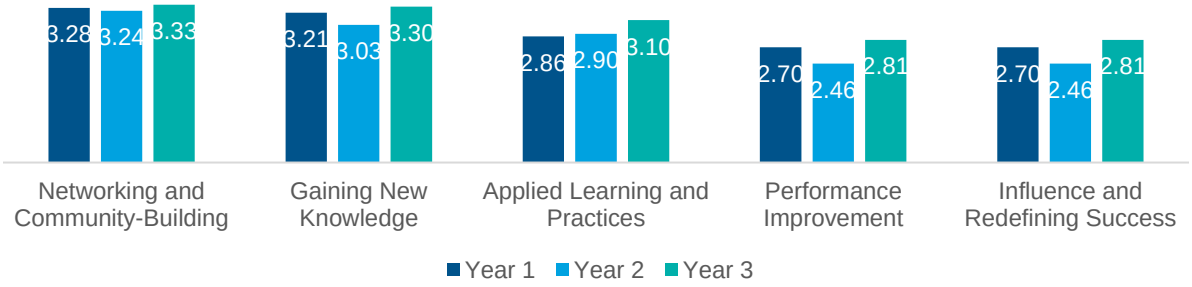
Year 3 surveys included questions prompting respondents to report on member status and working group participation. Of the total Year 3 respondents most were faculty members (37% of 46) followed by student members (30% of 46). Most respondents were affiliated with the Figure 18 shows a breakdown of respondents by working group affiliations, most were from the Faculty and Student Engagement working group (26%), followed by the Immersive Experiences

working group (16%). Almost one-quarter of the respondents reported no affiliation with a working group.

Figure 18. Working Group Affiliation of Respondents

Lifecycle mean responses ranged from 2.81 to 3.33, and the highest mean ratings among Year 3 members was in Networking and Community Building, followed by Gaining New Knowledge *(3.33 and 3.30*). The lowest means were Performance Improvement and Influence and Redefining Success (2.81 each). Mean ratings for the same lifecycle follow the same patterns in all three years. Expectedly, members find the greatest value in the Networking and Building Community (Activity) aspect 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. As network members undertook more core activities, such as participation in PDSA cycles and joint efforts on publications, we found that members cite network value as leading to applied value (changes in practice) and realized value (improved outcomes, including higher rates of STEM persistence). For example, for the first time in three years, Applied Learning and Practices shows a mean rating above a 3.0, indicating most members applied value of First2 involvement into their own personal and professional lives. Figure 19 below provides an overview of these ratings by year.

Figure 19. Overall Mean Scores by Lifecycle and Year



Overall mean scores from 2019, 2020 and 2021 are presented in Table 10 below, as well as mean scores for items associated within each lifecycle. Across all three years, ratings indicate that members most value the ways in which the network supports networking and community-building (Activity), with mean component ratings of 3.28 in 2019, 3.24 in 2020, and 3.33 in 2021, respectively. The largest gain from Year 2 to Year 3 was .35 associated with the Performance Improvement (Realized value lifecycle), meaning members believe there is increased understanding and evidence of First2's outcomes and network growth.

The largest mean item rating was associated with the Immediate and Potential value lifecycles, with mean ratings for all three of 3.41. All three items, 1. *made connections with colleagues around shared goals*, 2. *interacted with students as contributing members of the network*, and 3. *gained insight about a person or group I can turn to for information or support*, relate to the connections and shared information between members.

The least rated item, *observed data indicating that my organization's performance improved*, increased by 0.35 points from 2.17 in 2020 to 2.52 in 2021. This indicates that members valued the extent to which the network facilitated improved performance outcomes more in 2021 than they had in 2020. The only mean rating decline from Year 2 to Year 3 was associated with the item, *Engaged regularly with the network*. This slight decline, 3.26 to 3.09, may be attributed to the instability of scheduling due to the global pandemic.

Table 10. Network Value Survey Item and Subscale Mean Scores

Cycle	Response Option	Year 1	Year 2	Year 3	Difference Yr 2 – Yr 3
		(*n*=42)	(*n*=49)	(*n*=56)	
***Networking and Community Building* (Activity)**	Participated in network activities that were meaningful	3.31	3.21	3.39	0.18
	Made connections with colleagues around shared goals	3.38	3.38	3.41	0.03
	Gained access to professional relationships that change my perspective or understanding	3.29	3.10	3.33	0.23
	Engaged regularly with the network*	3.14	3.26	3.09	-0.17

Cycle	Response Option	Year 1	Year 2	Year 3	Difference Yr 2 – Yr 3
Building New Knowledge (Output)	Interacted with students as contributing members of the network	N/A	3.26	3.41	0.15
	Activity Mean	3.28	3.24	3.33	0.09
		(*n*=37)	(*n*=48)	(*n*=46)	
	Saw opportunities for learning that I did not see before	3.33	3.02	3.38	0.36
	Gained access to new tools, information, or processes I would not otherwise have access to	3.18	2.98	3.22	0.24
	Gained insight about a person or group I can turn to for information or support	3.28	3.17	3.41	0.24
	Acquired a new skill or new knowledge	3.05	2.94	3.20	0.26
	Output Mean	3.21	3.03	3.30	0.27
		(*n*=39)	(*n*=48)	(*n*=46)	
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	0.22
	Used knowledge or skills obtained through the network to contribute to understanding of problems or issues	N/A	3.10	3.33	0.23
	Made changes in my organization based on network work	2.64	2.63	2.89	0.26
	Used a document produced or made accessible by the network	2.95	3.00	3.14	0.14
	Leveraged a network connection to accomplish a task	2.92	2.92	3.11	0.19
	Application Mean	2.86	2.90	3.10	0.20
		(*n*=37)	(*n*=49)	(*n*=46)	
Performance Improvement (Outcome)	Observed practice/policy improvements at my organization resulting from network work	2.54	2.48	2.70	0.22
	Encountered evidence that the network has advanced its reputation	3.03	2.67	3.18	0.51
	Observed evidence of improvement in the key student outcomes we are pursuing	2.76	2.54	2.82	0.28

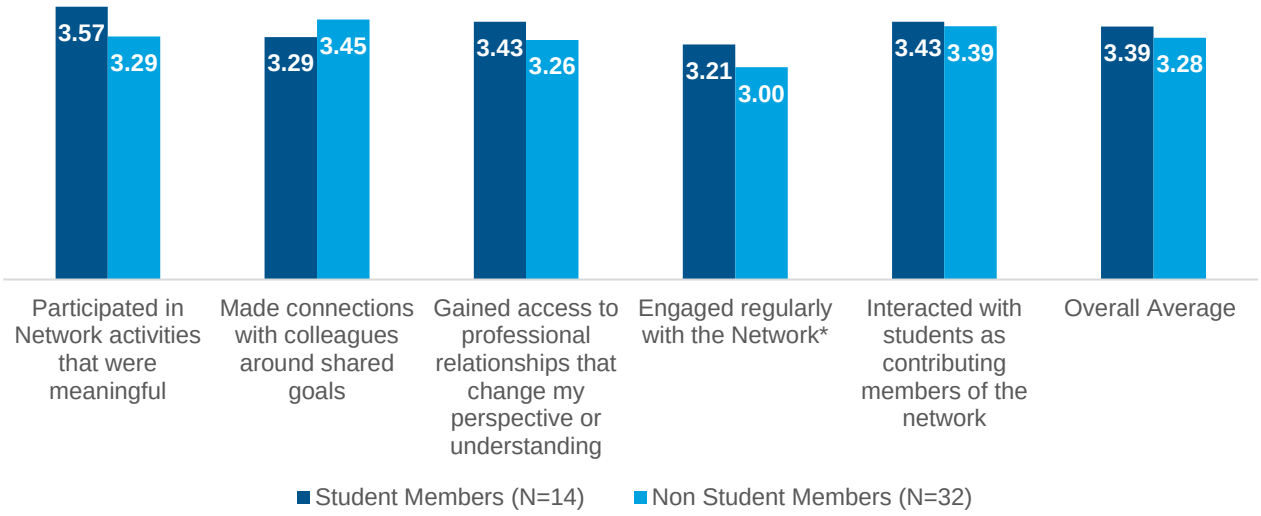
Cycle	Response Option	Year 1	Year 2	Year 3	Difference Yr 2 – Yr 3
Influence and Redefining Success	Observed data indicating that my organization's performance improved	2.46	2.17	2.52	0.35
	Outcome Mean	2.70	2.46	2.81	0.35
		(*n*=36)	(*n*=49)	(*n*=46)	
	Engaged previously uninvolved stakeholders in network efforts	2.94	2.70	2.83	0.13
	Contributed to a new framework or system for achieving network aims as a result of new understandings	2.89	2.79	2.80	0.01
	Used what I learned from network work to develop a new strategic direction at my institution	2.50	2.46	2.66	0.20
	Reflected anew on what it takes to achieve success	3.19	3.02	3.33	0.31
	Demonstrated an understanding of the complexity of elements important to rural students' pursuit of STEM careers	N/A	3.00	3.12	0.12
	Impact Mean	2.88	2.79	2.95	0.16

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.

2.5.1. Immediate Value: Networking and Community-Building (Activity)

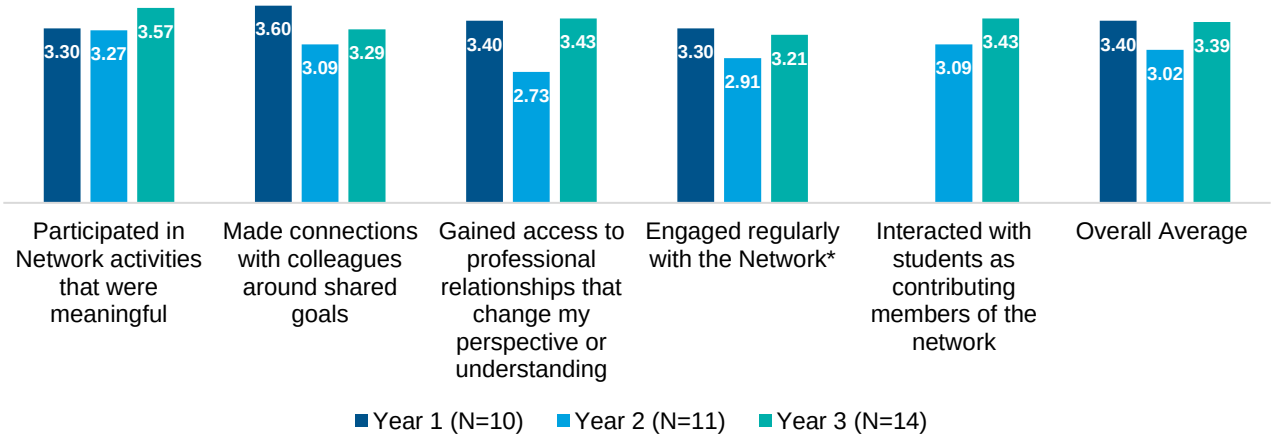
Among the respondents on the four-point response scale, most agreed that they found value from the networking and community building available as a participant in the First2 Network Community*. The mean average 3.33 increased from the previous year, and the first initial year. Figure 20 details how student members rated four out of the five items higher this year than the non-student members, with an overall mean rating of 3.39 compared to 3.28 among non-student members. This is a shift from the previous year when student members rated this component lower, on average, than non-student members (3.03 compared to 3.36 for non-student members). Non-student members agreed most with the item *made connections with colleagues around shared goals (Mean = 3.45)* and students agreed most *with Participated in network activities that were meaningful (Mean = 3.57).*

Figure 20: Immediate Value: Year 3 Mean Ratings by Member Type



As shown in Figure 21 above, student respondents showed an increase of 0.37 in their overall agreement rating from Year 2 to Year 3. Across both years, student members reported the greatest value from *participated in network activities that were meaningful (3.27 and 3.57, respectively).* Additionally, student members reported the greatest gain in immediate value for *Gaining access to professional relationships that change my perspective or understanding* (0.70 points). This may be attributed to First2 Student Club participation, internships, and mentorship – plus an overall increase in student group connectivity across and within institutions, as outlined later in the Social Network Analysis section 4.1.

Figure 21: Immediate Value: Mean Ratings for Student Members by Year



I really felt connected with the group at the 2021 Spring Conference.
– Student Member

The survey included an open-ended item asking respondents to describe how they applied something learned though the network and what it enabled that might not have happened otherwise. Nearly half of all 18 respondents believed they had forged connections with colleagues, faculty, students, or otherwise network members. Some identified conference sessions as where they connected with professionals, an important benefit to the First2 Network membership. A few mentioned their collaboration on a research article. One stated, "I worked on my first collaborative article with scientist associated with First2 network." Another respondent talked about the collaboration with the evaluation team on an article. Some respondents believed that the internship and student club experience had the most meaningful opportunity to connect with faculty and students. One student noted, "I was a part of the internship last year and through it I got to learn more about research and make connections to the faculty leaders." Another noted, "I bonded with our First 2 campus club hopefully recruiting more students to the club. "

A couple of comments centered around the advice or communication with a fellow member. One student member noted, "during the fall conference, I encountered a meaningful conversation with an evaluator that changed my perspective on how I interact with people my age." Another member shared, "I don't recall the exact details, but I remember some helpful advice I received during one of the sessions. I was able to incorporate that into my teaching. I really appreciate the opportunity to connect with other STEM instructors."

A few respondents described student-led workshops and conference program sessions among the most useful opportunities to gain perspectives from first-generation students about their work. In the conference sessions, students shared stories and examples of their first-hand experiences as students. One respondent stated, "The student sessions at the conference and in the meetings when they're led by the students have helped me gain new perspectives for my work." Another mentioned, "heard from first generation students in the program about things that are useful to consider for faculty in higher Ed." Some students also had success in conducting their own sessions on campus, partnering with faculty on student and faculty Trivia Night PDSA and March Mental Wellness Month.

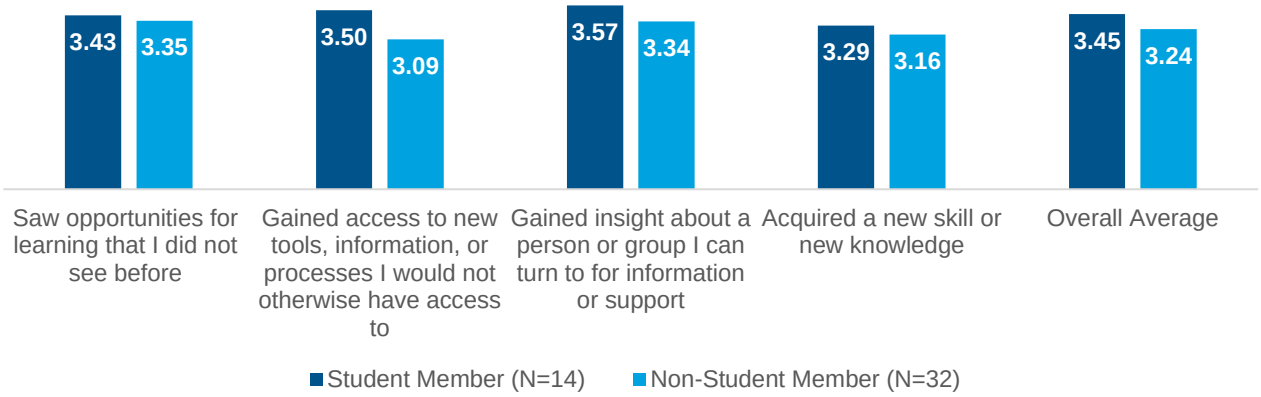
2.5.2. Potential Value: Gaining New Knowledge (Output)

Using the four-point response scale, respondents most agreed that they found value from the gaining new knowledge as a participant in the First2 Network Community. The mean average for all members, 3.30 increased from the previous year by 0.27 points. On average, Figure 22 shows students valued the new knowledge acquired via network participation more highly than did non-student members (Mean = 3.45 and Mean = 3.24).

Regarding individual subscale items, students were most likely to agree with the statement, *Gained insight about a person or group I can turn to for information or support (Mean = 3.57)* and non-student members were most likely to agree with*, Saw opportunities for learning that I*

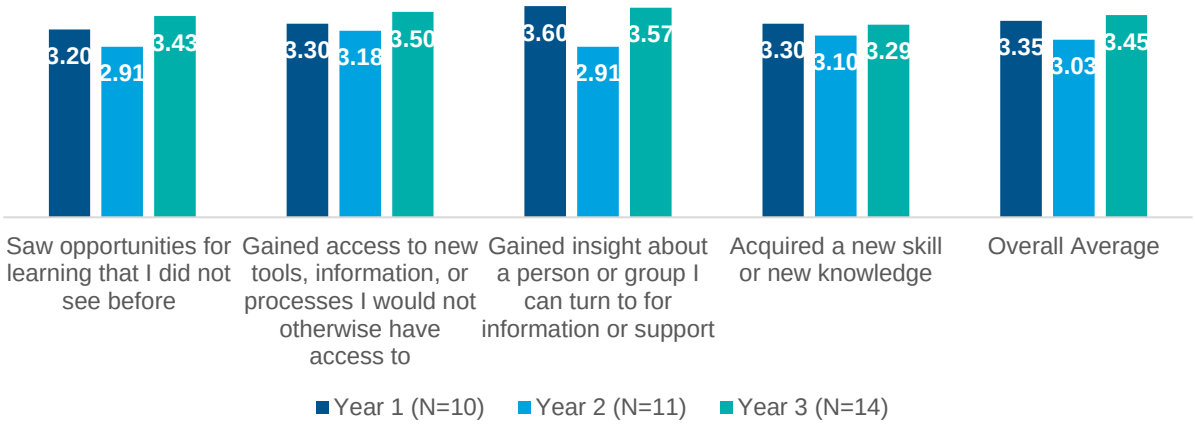
did not see before (Mean = 3.35). Both statements, individually were rated very high as a value of participation within the network.

Figure 22: Potential Value: Year 3 Mean Ratings by Member Type



Among student respondents, overall mean ratings increased by 0.42 points from Year 2 (Mean = 3.03) to Year 3 (Mean = 3.45) as shown in Figure 23. All three years show students reported gains in all Gaining New Knowledge subscale items from Year 2 to Year 3. The highest rated item is *gained insight about a person or group I can turn to for information or support* (Mean = 3.57), followed by *Gained access to new tools, information, or processes I would not otherwise have access to* (Mean = 3.50). The largest gain overall 0.52 was found in '*Saw opportunities for learning that I did not see before*' (Mean=3.43 and Mean = 2.91).

Figure 23: Potential Value: Student Member Mean Ratings by Year



Nineteen of the respondents (41%) mentioned several **resources useful within the network**, when asked to describe a specific network-developed resource and why they thought it might be useful. Some members elaborated on items tableau, Qualtrics, API, google platform tools, and PDSA knowledge, as the network developed or supported tools to help members in their practice. Some said the connection to many new people, while learning new tools, was also valuable. One person stated, "The WV STEM Hub/asset mapping has led to a lot of new

growth…we have connected to many people through that process." Another member had a similar sentiment, "I have been working with a group that has introduced me to several new Google tools that I will use in my zoom classes." Some noted that meeting people at conferences or through research was needed to build knowledge and connections. As three members stated,

> *Interacting with industry panels at the conference was really eye opening.*
>
> *Contact with other scholars to be able to see other research.*
>
> *Simply having the network to interact with and help guide first generations students and provide them opportunities is useful.*

Refreshing student perspectives on my own teaching practices was useful as I evaluate how I structure and introduce my courses, especially my large asynchronous online course which has a large number of HS and freshmen students. – Faculty Member

Some members also expressed their appreciation about the PDSA cycle activities. One member said s/he adapted the study cycle in class and teaches…about it. "I have adapted the study process for my classes and attempted to practice it with students." Another member also noted their use in professional settings. "I've applied the knowledge of PDSA cycles in activities from my job," one member shared. Another shared how the tools helped to support "how to use them in my own setting."

A few other members shared how they value in being an embedded student, providing an opportunity for them to give anonymous, written feedback to instructors about the class that they were taking. "Being an embedded student helped me to gain insight on how important it is to reflect back on the topics I covered in class that past week. This helps me to actively recall the information I received that past week." Another member agreed, "The embedded students project provided me with some ideas for my classroom." Student members from several schools discussed their participation in a book club, noting that it was useful in supporting study skills. "These skills will prepare me to tackle my classes effectively. I also learned how to work in the labs and use microscopes properly." Another member noted they gained new mentor skills during the summer immersion mentor training.

2.5.3. Applied Value: Applied Learning and Practices (Application)

All members valued the applied learning and practices afforded them by the network (Mean = 3.10), but students had a slightly higher overall average than non-student members (Mean=3.16 and Mean=3.08) on the four-point agreement scale. Figure 24 above details the individual items and their mean ratings by member type. Overall, students and non-student members have similar ratings for two of the four items, *Used a document produced or made accessible by the network* and *Leveraged a network connection to accomplish a task*. The highest rating for both member types was *Used knowledge or skills obtained through the network to contribute to understanding of problems or issues with mean ratings of 3.35 and 3.29, respectively*. Students and non-student members showed the largest difference in mean ratings (0.27 points) regarding *Made changes in my organization based on network work.*

Figure 24: Applied Value: Year 3 Mean Ratings by Member Type

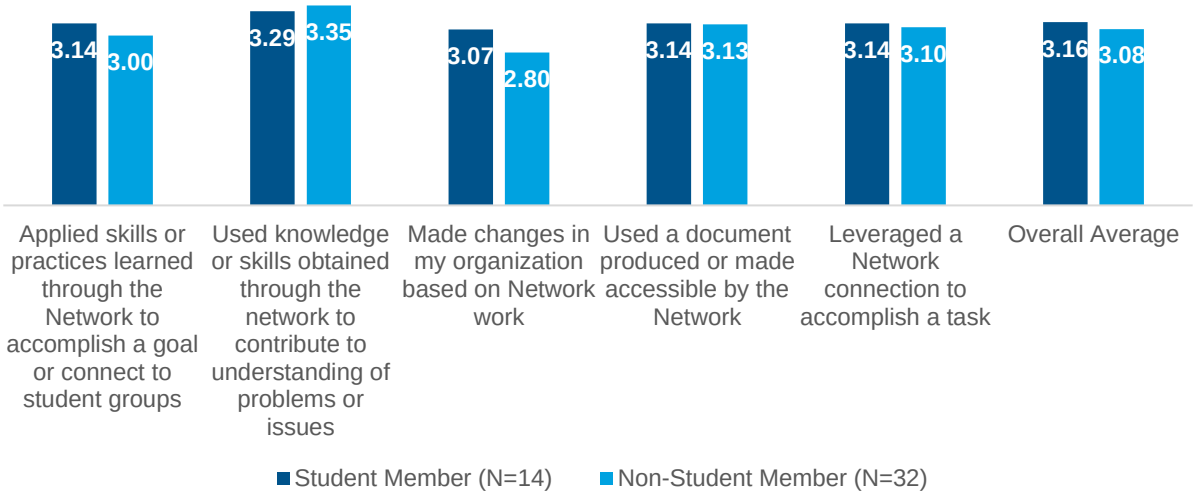
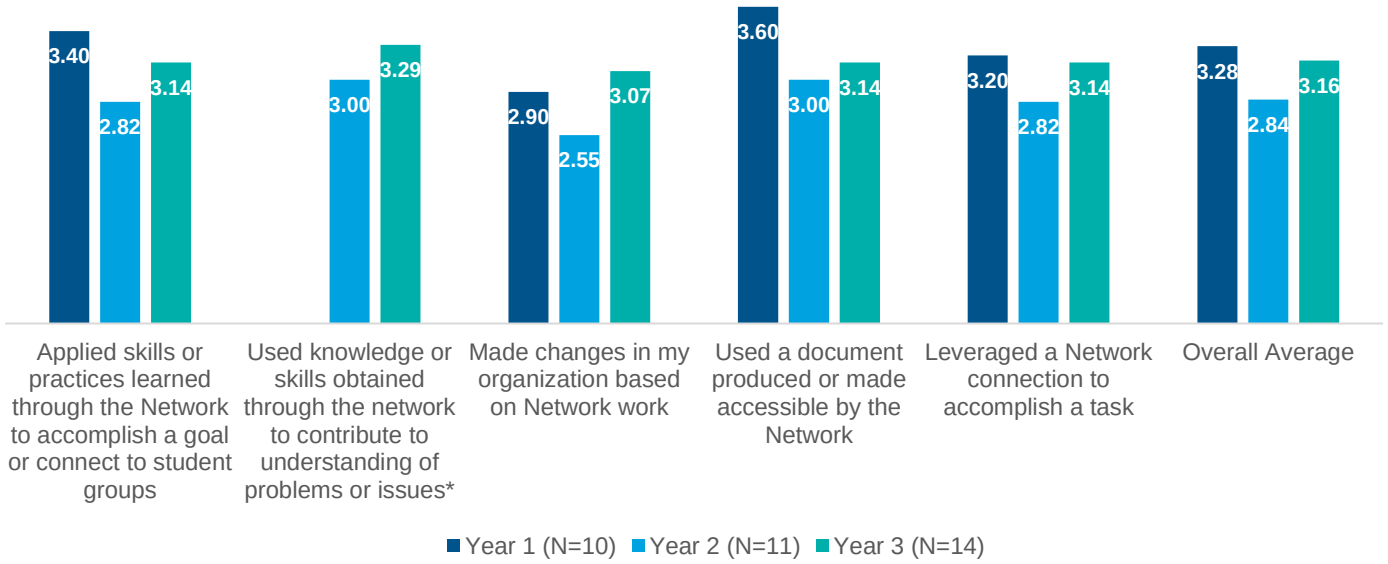


Figure 25 shows student respondents felt consistently stronger about the value of the application of tools and resources from the network to their lives. Respondent overall mean ratings increased by 0.32 points from Year 2 to Year 3. Students in Year 3 were most likely to agree they used knowledge or skills obtained through the network to contribute to understanding of problems or issues.

Figure 25: Applied Value: Student Member Mean Ratings by Year



I am more conscientious about diversity and inclusion in the workplace as well as community outreach initiatives. – Student Member

Approximately one-quarter of total respondents (12 out of the 46), provided comments when asked an open-ended question about **how they applied something they learned through the network to their practice and what it enables that might not have happened otherwise.** One respondent professed they are now "using PDSA cycles in my real job." Several respondents thought their participation in the network provided useful application to their current work. For example, one member had learned several google apps that assisted in an online classroom. "I learned how to use several Google apps that I was unaware of that I can use in my online courses" one member shared.

Nearly half of respondents reported they learned more about how to work with better with students, specifically those from first-generation backgrounds. Faculty respondents mentioned the ability to apply lessons learned about communication and course structure. According to these three respondents:

> *I used the Q&A document generated by first gen students and professors to reflect on and adjust how I present the opening information in my courses and how I structure my courses.*
>
> *Was able to provide more examples for students and clarify ideas where there might have been confusion*
>
> *Got to be part of a PDSA that allowed me to adapt my teaching practice based on student feedback throughout the spring semester.*

In general, most of the respondents spoke to applications about their use of skills or knowledge that could be used in their current studies or classroom directly. One respondent shared, "my

study habits improved due to the research project I was partaking in." Another reported, "through First2, I was able to instill the habit of communicating better in a group of adults." Other responses to the question included reporting community outreach and mentorship efforts. One respondent shared, "We started a mentoring program to help freshman get through really hard intro stem courses."

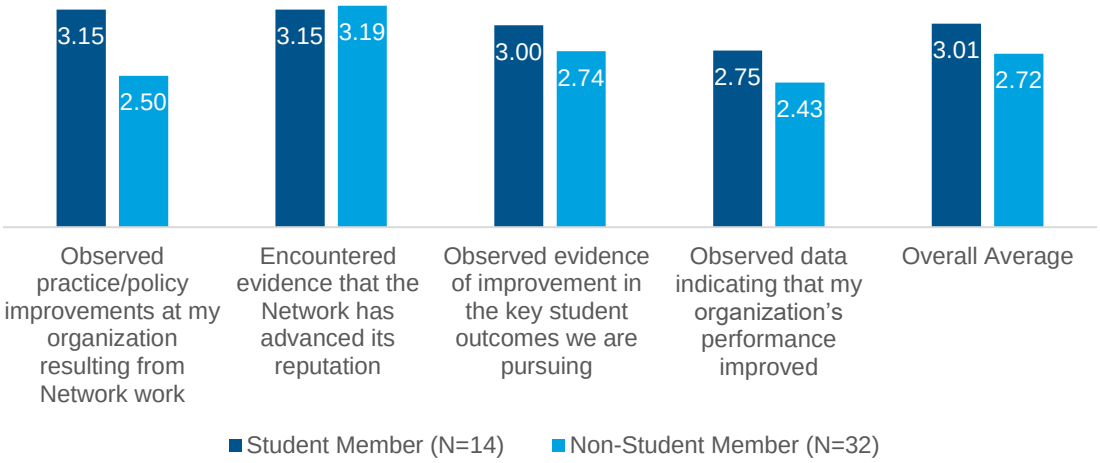
2.5.4. Realized Value: Performance Improvement (Outcome)

Both student and non-student members rated the value of performance improvement higher than previous years. Figure 26 shows student members agreed with the realized value provided to them as members of the network, as this group ranked 0.29 points higher than non-student members (Mean = 3.01 compared to Mean = 2.72).

Regarding individual subscale items, students rated these areas of observation much higher than non-student members, *Observed practice/policy improvements at their organization resulting from the network, Observed data indicating that my organization's performance improved* and *Observed evidence of improvement in the key student outcomes the network is pursuing*.

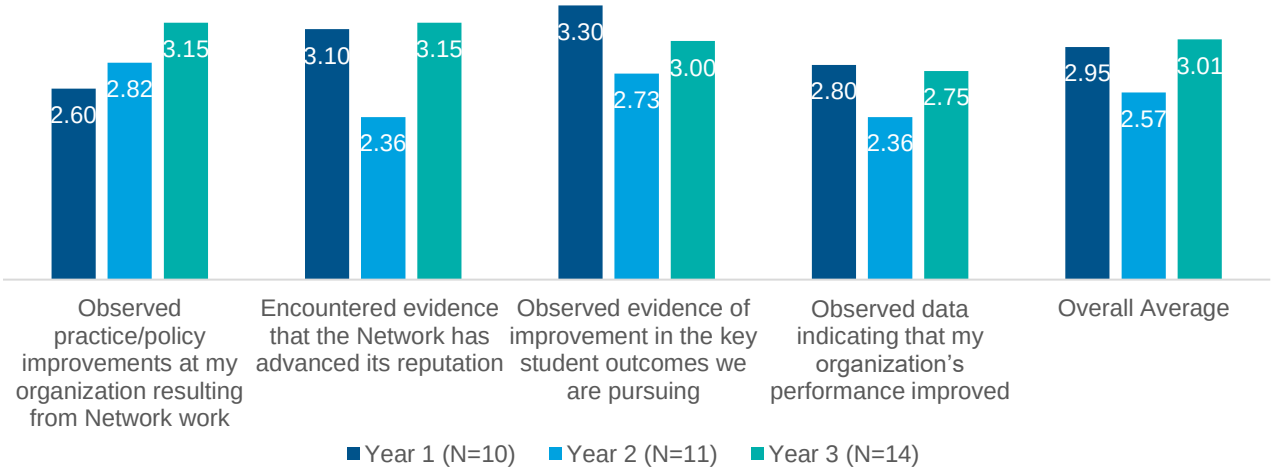
For non-student members, mean ratings fell below 2.75 for all three of these items, indicating there were some non-student members who disagreed with the statements about observations of realized value (See Figure 26). Among both student and non-student members, the highest rated item concerned encountering evidence that the network has advanced its reputation, with mean ratings of 3.15 and 3.19.

Figure 26: Realized Value: Year 3 Mean Ratings 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 0.44 points from Year 2 to Year 3. Students were more likely to agree on all four subscales associated with realized value (Figure 27). This means most students agreed they observed outcomes related to their direct involvement in First2, including encountering evidence that the network has advanced its reputation.

Figure 27: Realized Value: Student Member Mean Ratings by Year



When asked to expand upon this area, most respondents held an optimistic view about the outcomes of their work in the network: One respondent noted, "it has opened up my network vastly across different campuses in WV." Two other respondents expressed appreciation for the professional growth opportunities. "*I have been able to apply concepts that were otherwise unthought of to my efforts to connect with the community and promote STEM. Professionally, I've been able to build my resume through making connections and performing tasks with several working groups. We had information and citations from First2 to use on grant proposals submitted through my institution.*"

In terms of student value, some respondents were both hopeful about students' future with First2 and outcomes so far. One respondent indicated, "Students were performing better in their intro courses after seeking help." Another reported enthusiasm with the student involvement overall. "Student involvement is exemplary!" One respondent shared, "Allowed for insight into struggles and successes of first gen students. With continued participation trends and more knowledge about this group of students can be obtained which may help with recruitment and retention of such individuals in the future."

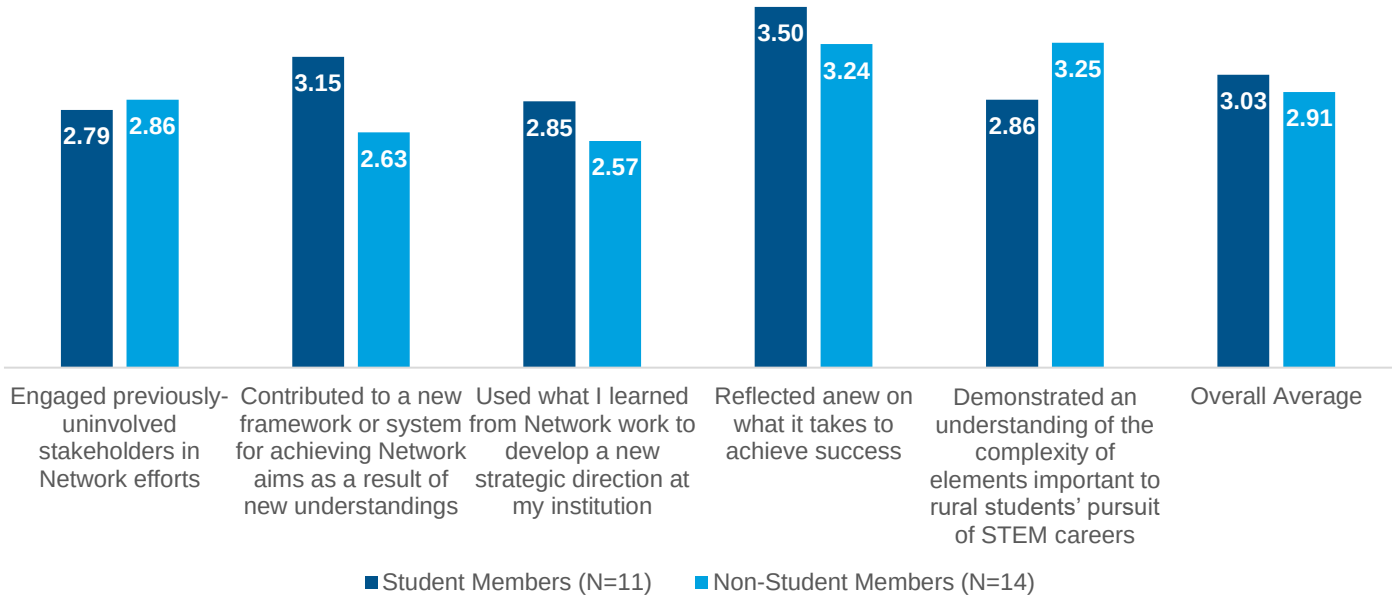
Overall, many respondents indicated better professional attributes working with students, gained through lessons learned or connections made as a result of their network participation. One respondent noted, "Seeing the network operate gives me hope for the future--great minds working together to encourage persistence in getting a four-year education is a positive move that should continue!"

2.5.5. Reframing Value: Influence and Redefining Success (Impact)

Students rated the Reframing value component slightly higher than non-student members, meaning most students agreed about the influence of redefining success brought on by their participation as First2 student members. With two items, student members had lower ratings: *Engaged previously uninvolved stakeholders in network efforts (difference of .07 points)* and *Demonstrated an understanding of the complexity of elements important to rural students'*

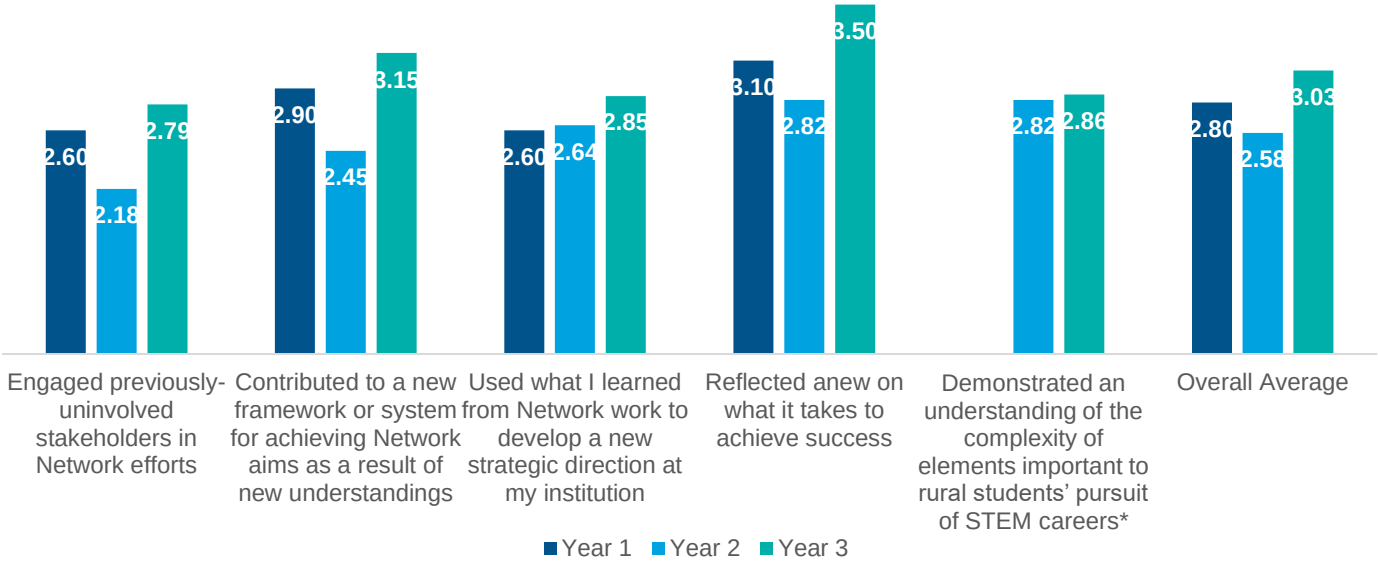
pursuit of STEM careers (0.39). Both students and non-student members found great value in, *Reflected anew on what it takes to achieve success* (Mean = 3.50 and Mean = 3.24).

Figure 28: Reframing Value: Year 3 Mean Ratings by Member Type



Overall, student member ratings were higher in Year 3 than in prior years (see Figure 29 above). With a mean of 3.03, Year 3 students valued the impact First2 Network is having on their personal and professional lives and on campus. The highest rated item, They *reflected anew on what it takes to achieve success (Mean=3.50)* was followed by *Contributed to a new framework or system for achieving network aims as a result of new understandings (Mean=3.15).*

Figure 29: Reframing Value: Student Member Mean Ratings by Year



My perception of success changed. As a student, I viewed it as getting all A's, but I have learned that it is okay to get worse grades as long as you understand the material. Success is understanding rather than memorizing.

– Student Member

Ten 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. Nearly half of those respondents mentioned a change in their beliefs about success. A few comments are shared below:

> *To me, success changed from being a high-paying individual with a powerful position to just being a successful person with using a growth mindset.*
>
> *This just strengthened my personal belief that success is achieved through teamwork.*
>
> *More and more, I am seeing success as ability to sustain progress through personnel transitions.*

Some respondents discussed a new understanding about how students in a culturally relevant way, particularly from rural backgrounds. "Sometimes rural students learn in a different way. Making things relevant and moving away from the way 'it's always done' and giving relevant examples helps them learn."

Other members expressed feelings of satisfaction that their outreach is helping to spread the word to students around campus. One member stated, "at an admissions event after our meeting, the student success staff member who attended came up to me and said how much he enjoyed the meeting and was enthusiastic about getting F2N more involved on our campus." One shared how while the effort is being made, it is still challenging to create buy in and stated,

"trying to get more people on my campus involved in F2N, but it's been an uphill struggle on my end."

2.5.6. Network Value Survey Summary

This year has shown moderate to large gains in all five components on the Network Value Survey, particularly for students. A few students indicated the network provided them with a better sense of understanding related to their own studies and purpose, suggesting a reframing of student success. These students cite high levels of involvement in First2 student clubs, internships, and working group PDSA activities. Other members indicated a positive impact in understanding tools and resources that support better teaching and course structure to better benefit 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 a consistent positive gain in value from Year 2 to Year 3 in participant ratings of the applied, achieved, 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. Forty-four network members completed the annual social network survey in December 2020/January 2021 (compared to 32 and 25 respondents, respectively, in the previous two years), based on their network activity over the past year. The composition of network members' organizations is provided below in Table 11. Of the 42 respondents, 75% were female, 43% had achieved a doctoral degree, 34% were between 55-64 years of age (followed closely by 30% between 18-24). About one-third (32%) were at their organization between 1-2 years, and another 32% had served at their organization for 6 or more years. In addition, 41% had a primary role of faculty member/lecturer/teacher, and 27% were undergraduate students.

Table 11. SNA Survey Respondent Organizational Affiliation

	Organization Name	Number of Respondents	Percent of Respondents
Lead First2 Network organizations	West Virginia University	16	36%
	Fairmont State University	3	7%
	Higher Education Policy Commission	2	5%
	Green Bank Observatory	2	5%
	High Rocks	1	2%
Other organizations	Marshall University	5	11%
	University of Charleston	3	7%

	West Virginia State University	2	5%
	Davis & Elkins College	1	2%
	West Virginia Department of Education	1	2%
	West Liberty University	1	2%
	Pocahontas County Schools	1	2%
	TechConnect West Virginia	1	2%
	WVU Institute of Technology	1	2%
	SRI	1	2%
	Chemours/Dupont	1	2%
	National Energy Technology Laboratory	1	2%
	Not provided	1	2%
Total		**44**	**100%**

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

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[39] 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 12 and Figure 30. All 44 respondents identified at least one individual with whom they collaborated; 24 respondents collaborated with five individuals, and 13 collaborated with 10 individuals. As anticipated, the collaboration score is higher for the first two individuals 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 3.56, which falls closest to the Coalition level. This year's results indicate a slightly higher level of engagement, moving from the overall score of 3.34 for Year 2 and 3.11 for Year 1, both of which were at the Coordination level. Figure 31 depicts the overall strengthening of the engagements from Year 1 to Year 3, in general, for the members identified as collaborators.

Table 12. Network Members Identified as Collaborators in the First2 Network

Individuals Identified	Number Identified	Average Collaboration Score
One member	44	4.21, Coalition
Two members	39	3.97, Coalition
Three members	35	3.76, Coalition
Four members	28	3.96, Coalition
Five members	24	3.74, Coalition
Six members	21	3.35, Coordination
Seven members	19	3.83, Coalition
Eight members	17	2.75, Coordination
Nine members	17	3.00, Coordination
Ten members	13	3.00, Coordination
Overall Score		3.56, Coalition

Figure 30. Levels of Collaboration by Individuals Identified

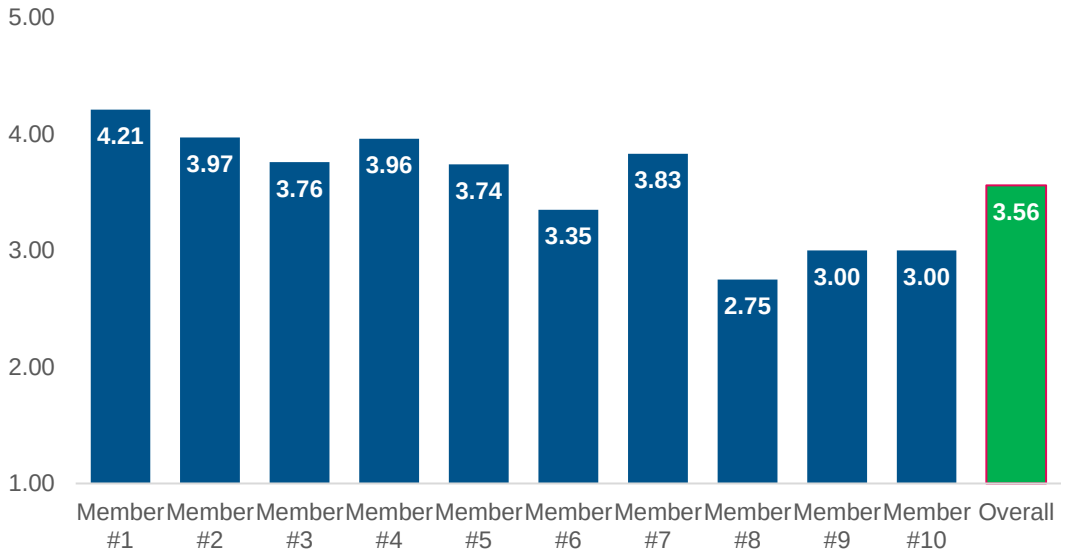
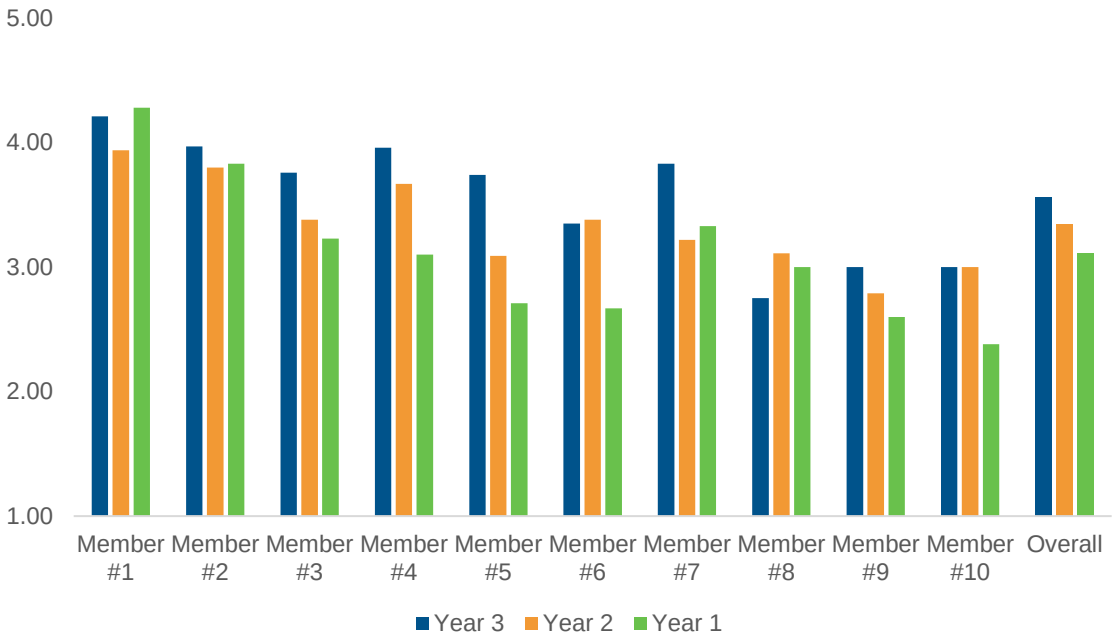


Figure 31. Levels of Collaboration by Individuals Identified by Year

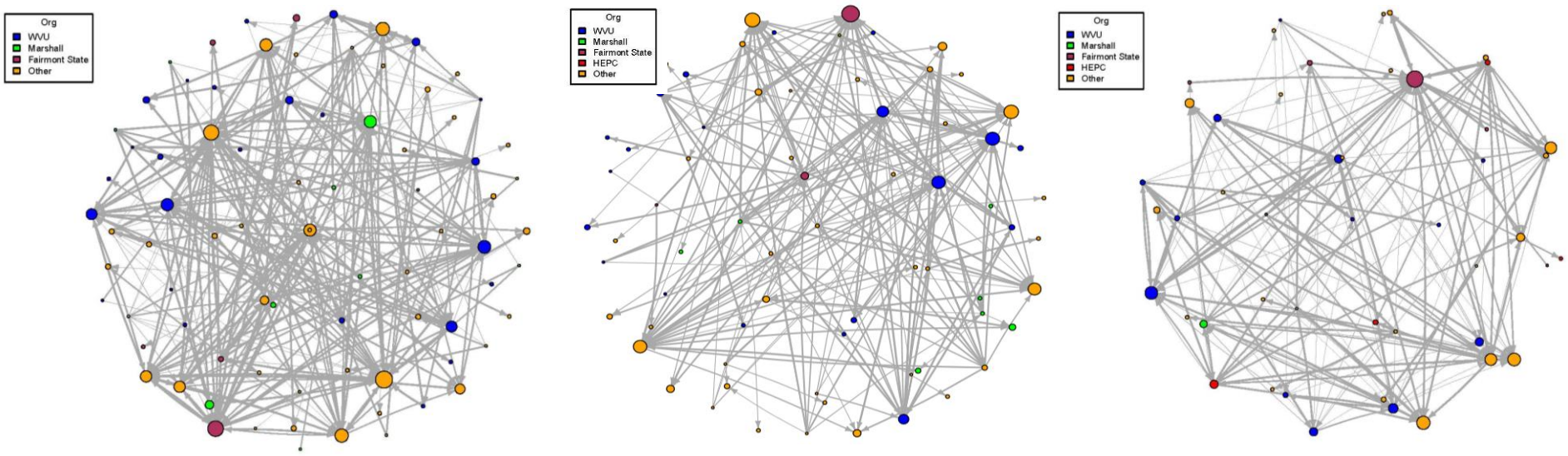


The survey asked respondents to select one person out of those individuals identified whom they considered to be of exceptional importance (in terms of resources, information, or guidance provided) to their role in the First2 Network. As anticipated, the first few individuals identified were most frequently identified as the key contact (especially the first person identified, at 73%). 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, 50% were prior acquaintances; for the second member identified, 30% were prior acquaintances.

Based on the 44 respondents, the graph shown in Figure 32 depicts the connections among those individuals identified as collaborators within the network for Year 3 as well as for the previous two 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 five key organizations involved with the First2 Network are identified with different colors, and all other organizations are depicted as white circles.

The overall shape of the Year 3 network map is star-shaped, with most frequent collaborators coming from WVU, MU, and FSU, along with individuals from other organizations. One FSU individual is currently the person most linked to others within the network, with multiple individuals from WVU, Marshall, and other organizations interspersed throughout the network. As anticipated, this map differs from the previous two maps, showing not only more collaborators, but also more collaboration among members and at higher levels.

Figure 32. SNA Map of Connections in the First2 Network by Year



Year 3 (2020/2021) **Year 2 (2019/2020)** **Year 1 (2018/2019)**

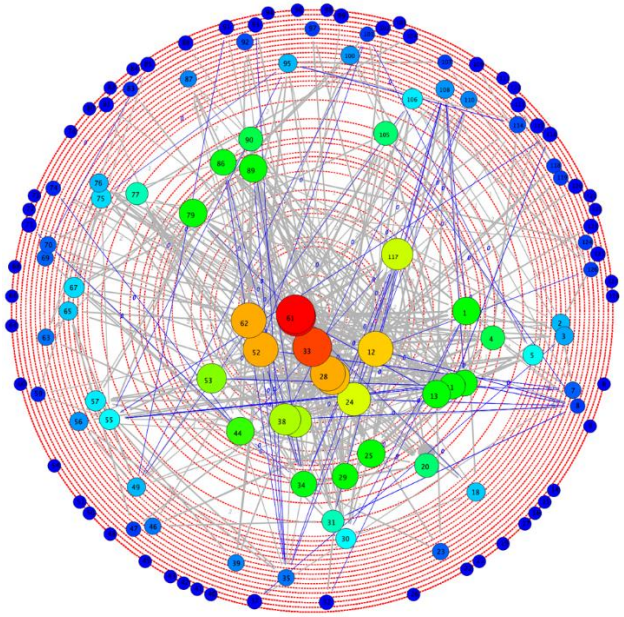
Another way to envision the network is through a radial representation, again where the size of the node indicates the number and strength of the connections. Those individuals with more connections are central to the figure and those with fewer connections are on the outer ring. To compare the results from Year 3 (2020/2021) with the previous two years, the three radial graphs are depicted in Figure 33. These graphs also reveal a growing network, with both more collaborators overall and more collaborators moving to the center, depicting increased connections.

The number of nodes (individuals) increased annually from Year 1 to Year 3 (from 48 in Year 1 to 128 in Year 3), as did the number of edges (connections) (from 210 in Year 1 to 479 in Year 3). The graph density decreased from 0.19 in Year 1 to 0.06 in Year 3, indicating that approximately 6% of all possible ties or connections are present in the Year 3 results. The social conductivity score (measuring conductivity from direct paths) decreased slightly from 2.78 in Year 1 to 2.51 in Year 3, indicating the average strength of the connections between individuals remained fairly constant (between cooperation and coordination) even though the network has more than doubled in size. The robustness score (measuring conductivity from indirect paths) also decreased from 2.55 in Year 1 to 2.35 in Year 3, 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.

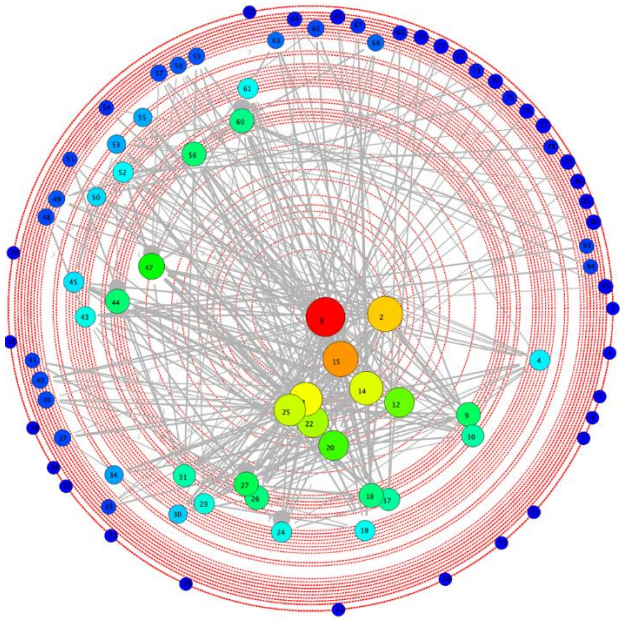
4.1.1 SNA Summary

In sum, the trend from Year 1 to Year 2 continues from Year 2 to Year 3, as the First2 Network has become even more collaborative this year with an increase in the number of collaborators and more collaboration at higher levels. Members are even more connected this year, based on respondent feedback.

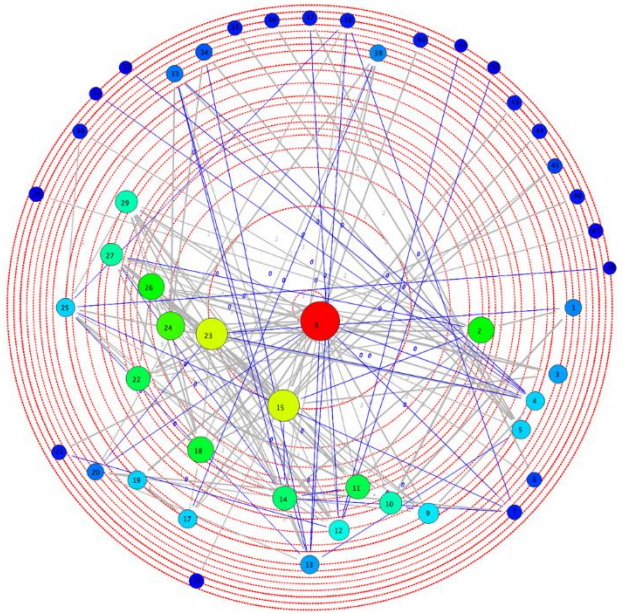
Figure 33. First2 Network Radial Representations by Year



Year 3 (2020/2021)



Year 2 (2019/2020)



Year 1 (2018/2019)

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 two-week research internship experiences in Summer 2021, which included 54 students, as listed below.

- Green Bank Observatory (August 1-14, 5 students): Interns contributed to development of an innovative receiver by characterizing radio frequency interference for future machine learning algorithms.
- High Rocks (July 15-30, 5 students): Students conducted research on dendrochronology forest pathology, entomology, and microbiology, and contributed to an active forest management plan to support stewardship of the ecosystem surrounding High Rocks.
- Marshall University (July 18-30, 6 students): Students conducted research activities in chemistry (nanotechnology applications of DNA), biology (neuroscience), and physics (physical processes in water filtration).
- University of Charleston (June 28-July 11, 5 students): Students conducted research on the effects of long-term acid mine drainage input in riparian areas on biological indicators (zooplankton or microbial community function).
- West Virginia School of Osteopathic Medicine (July 18-30, 6 students): Students conducted environmental science research by creating original research questions and then collecting and analyzing soil samples at locations that were determined based on their hypotheses.
- West Virginia State University (July 18-30, 8 students): Students conducted research in one of six areas: ligand synthesis used in water monitoring to detect pollutants, recovery of critical elements from passive acid mine drainage systems, research on a new generation of neural networks based on biological science, how hormones affect brain tumors, evaluating the selectivity of insecticides against beneficial insects, and investigating how capsaicin can affect gene expression in fruit flies.
- West Virginia University (July 18-30, 14 students): Students conducted research determining the modulation transfer function of smartphone cameras, land use impacts on water quality, fish in a dish, mapping Appalachia, and exploring metal-catalyzed coupling reactions.
- West Virginia University Institute of Technology (July 18-30, 5 students): Students conducted research in one of two areas: data analysis using machine learning and investigating the effects of tilt angle and shading on solar panels.

Students who were 18 years or older completed an online survey at the beginning and end of the internship. At pretest, three respondents were not yet 18 and were exited from the survey; 50 of the remaining 51 students completed a pretest survey (98% response rate). At posttest, 47 students who were 18 or older completed a posttest survey (92% response rate). Results were aggregated across all eight sites for this analysis.

Sixty-six percent of the respondents identified as female and 28% as male (6% selected *non-binary* or *preferred not to respond*). Eighty-four percent described themselves as White and 16% as Black or African American; less than 5% each selected other ethnicity options. Forty-two percent qualified for a federal Pell grant, 32% did not qualify, and 26% did not know if they qualified. Fifty-six percent considered themselves as first-generation college students; 31%

reported their parents/guardians attended some college, and 31% reported at least one of their aunts/uncles/cousins attended or completed college. Forty percent described the place where they grew up as rural (42% selected *town,* 16% *suburb,* and 2% *city*). Seventy-three percent graduated from high schools within West Virginia.

Students identified a variety of majors or intended majors, as shown in Table 13. Forty percent selected *Biology,* followed by *Engineering* at 18%.

Table 13. 2021 Intern College Majors

Major	Number	Percent
Biology	20	40%
Chemistry	5	10%
Computer/Information Science	5	10%
Engineering	9	18%
Environmental Science	3	6%
Exercise Physiology	1	2%
Forensics	2	4%
Immunology and Medical Microbiology	1	2%
Neuroscience	2	4%
Physics	1	2%
Political Science	1	2%

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

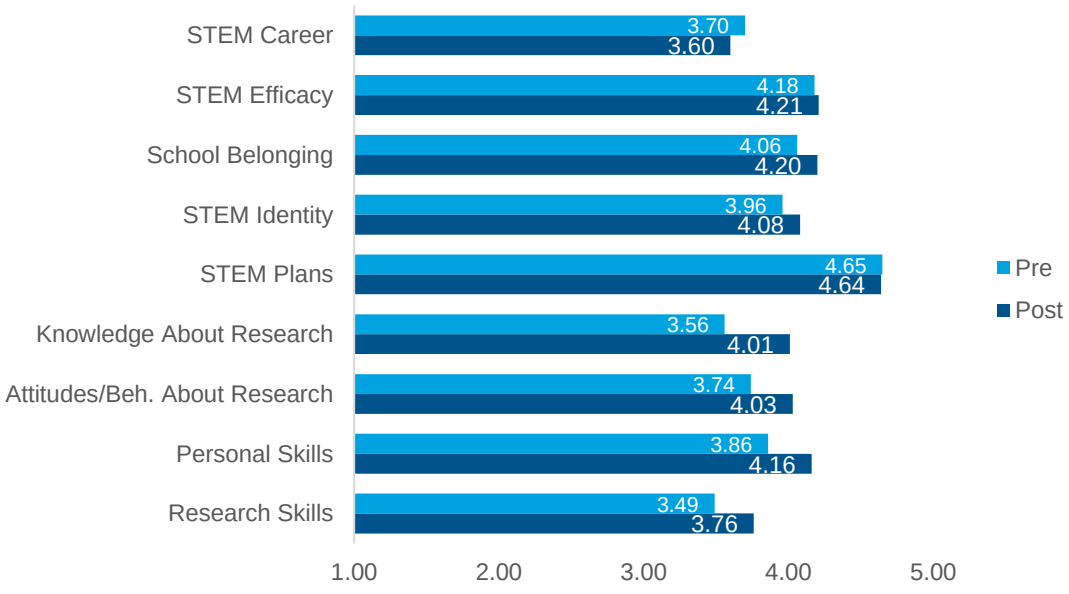
Table 14 shows results for the five subscales of STEM Career, STEM Efficacy, School Belonging, STEM Identity, and STEM Plans (on a five-point scale of *Strongly Disagree* to *Strongly Agree*), as well as the four subscales of Knowledge About Research, Attitudes and Behaviors About Research, Personal Skills, and Research Skills (on a five-point scale of None to A great deal).[40] At pretest, the highest-rated subscale was for STEM Plans at 4.65 (SD 0.55); the lowest-rated subscale was Research Skills at 3.49 (SD 0.71). At posttest, STEM Plans was again the highest-rated subscale at 4.64 (SD 0.50) and STEM Career was lowest at 3.60 (SD 0.62). The Knowledge About Research subscale showed the greatest amount of change from pre to post (0.45). Figure 34 depicts the pre/post mean scores for all nine subscales.[3]

[3] Cronbach alpha reliability estimates were computed for each subscale and for the overall set of rated items. At pretest, subscale values ranged from 0.39 (for the two-item STEM Plans subscale) to 0.93 (STEM Identity), with an overall value of 0.95. At posttest, subscale values ranged from 0.49 (STEM Plans) to 0.92 (Knowledge About Research), with an overall value of 0.95.

Table 14. 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	50	3.70	0.72	47	3.60	0.62	-0.10
STEM Efficacy	50	4.18	0.47	47	4.21	0.57	0.03
School Belonging	50	4.06	0.62	47	4.20	0.63	0.14
STEM Identity	50	3.96	0.84	47	4.08	0.69	0.12
STEM Plans	50	4.65	0.55	47	4.64	0.50	-0.01
Knowledge About Research	49	3.56	0.68	47	4.01	0.72	0.45
Attitudes/ Beh. About Research	49	3.74	0.93	47	4.03	0.71	0.29
Personal Skills	49	3.86	0.64	47	4.16	0.59	0.30
Research Skills	49	3.49	0.71	47	3.76	0.68	0.27

Figure 34. Pre/Post Mean Subscales Scores for 2021 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 46 matched pairs (linking each individual's pre/post scores) was identified for five of the subscales; 45 matched pairs were identified for the remaining four subscales. This analysis revealed statistically significant results for four subscales, as shown in Table 15, in which students' posttest scores were significantly higher than their pretest scores for Knowledge About Research, Attitudes/Behaviors About Research, Personal Skills, and Research Skills.

Table 15. 2021 Intern Pre/Post Matched Pairs Survey Results

Subscales	N	Post Mean	Pre Mean	Mean Diff. (post – pre)	*t*	df	Sig.
STEM Career	46	3.61	3.66	-0.05	-0.71	45	0.48
STEM Efficacy	46	4.24	4.21	0.03	0.27	45	0.79
School Belonging	46	4.20	4.08	0.12	1.71	45	0.09
STEM Identity	46	4.09	3.92	0.17	1.91	45	0.06
STEM Plans	46	4.65	4.65	0.00	0.00	45	1.00
Knowledge About Research	45	4.07	3.55	0.52	4.78	44	0.00*
Attitudes/ Beh. About Research	45	4.07	3.73	0.34	2.76	44	0.01**
Personal Skills	45	4.19	3.84	0.35	3.30	44	0.01**
Research Skills	45	3.80	3.49	0.31	2.92	44	0.01**

*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 noted their excitement about the internship, described the internship as an opportunity to help prepare them for college and career, noted that they would be conducting research, or just said they were 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 have an internship this summer, it is going to help prepare me and challenge me and get ready for college in the fall. I am super excited and can't wait to learn!*

I talk about the experiences this internship will bring to me and how much it will further me in my educational career.

That the experience is important to me, not only because it will give me a head start in school, but also because it will help me create connections with students who share my interest in science.

I tell my friends and family that I have been accepted into a wonderful program that will allow me to expand my knowledge on topics I'm interested in at a very early point in my career.

It is an internship for underrepresented minorities in STEM and will open doors for many opportunities in the future.

It's an opportunity to learn about science. It is also an amazing way to learn in a slight amount [of time] what college will be like and develop a friendship with my peers in this to start college with a support group.

I tell them that it is a chance for me to get immersed in science surrounded by people of similar interests which will help further me in my goal to become a scientist.

At posttest, responses were similar in nature, but students were more descriptive about what they had experienced. Positive illustrative quotes are provided below.

I would say it is a great experience for anyone interested in science, lab work, and research.

It was a great experience. I would recommend to any incoming STEM major.

It was a learning experience that gave me a chance to explore what major I want to be in college. Additionally, it taught me that communication and networking is important for my career success.

I told them that I was getting hands on research in a real lab.

It is First2Network internship where I can be immersed in a research lab and help me know other people that also have STEM majors.

I had a good experience with the first2 network and feel inspired to pursue a STEM career.

It was a fantastic experience worth every second of it.

I would say that it was just the right amount of fun and work. The activities made us all closer as a group (I now have 8 amazing friends) and the research gave me so much experience with what things may be like in college. I am more confident now in myself that I can go through college and succeed.

I loved it and it was super fun, cool, and useful for my career.

However, a few interns provided more critical comments; a few illustrative quotes are provided below.

I originally told them it was a research-oriented internship, however after the internship I would tell them it was a summer camp first with research secondary.

I would say it is a useful experience, but it is incredibly unorganized, and we weren't prepared for all of the extra activities they made us do.

I told them that we did nothing the entire time I was here. … This experience had no support or structure and I questioned whether or not STEM is for me based on how confusing this whole experience was.

Students were also asked at pretest and posttest what job or career they expected to have in 10 years. As shown in Table 16, careers in the medical or research/science fields were the highest at both time points.

Table 16. 2021 Intern Job/Career Expectations in Ten Years

Career	Pretest (n=51)		Posttest (n=47)	
	Number	Percent	Number	Percent
Aerospace	3	6%	3	6%
Biology	0	0%	2	4%
Computer science	4	8%	2	4%
Engineering	4	8%	2	4%
Environmental Science	1	2%	2	4%
Marine Biology/ Oceanography	2	4%	1	2%
Medical	12	24%	12	26%
Research/Science	15	29%	15	32%
Wildlife Biology	5	10%	2	4%
Miscellaneous	2	4%	3	6%
Don't Know	3	6%	3	6%

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 five-point scale of *Strongly Disagree* (1) to *Strongly Agree* (5), 7 items about the usefulness of the internship components rated on a five-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 five-point usefulness scale. Table 17 depicts the results of those rated items.

Overall, respondents rated the internship experiences favorably, with 15 of the 16 mean scores above 4.00 on the five-point scale. Nearly all (98%) agreed or strongly agreed the experience helped them to increase their knowledge of research within a STEM field (mean 4.70, SD 0.59). Other highest-rated items (96% agreement) were that the experience helped them learn how STEM research is conducted (mean 4.62, SD 0.64) and helped improve their research skills (mean 4.57, SD 0.74). The lowest-rated item (68% agreement) was that the recruitment information adequately prepared them for what to expect from the experience (mean 3.83, SD 1.13). Other lowest-rated items (at 81% and 75% agreement, respectively) were that interns were more likely to pursue a STEM degree as a result of the experience (mean 4.20, SD 0.98) and the format of the immersion experience worked well for them (mean 4.11, SD 1.05).

Table 17. Response Option Frequencies and Descriptive Statistics for Rated Items: 2021 Intern Posttest Survey

	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=47)	4%	4%	6%	36%	49%	4.21	1.04
This experience helped to improve my research skills. (n=47)	2%	0%	2%	30%	66%	4.57	0.74
This experience helped me to increase my knowledge of research within a STEM field. (n=47)	0%	2%	0%	23%	75%	4.70	0.59
This experience helped me to increase my general scientific knowledge. (n=46)	0%	2%	4%	30%	63%	4.54	0.69
This experience helped me learn how STEM research is conducted. (n=47)	0%	2%	2%	28%	68%	4.62	0.64
This experience helped me see myself as someone who can do STEM. (n=47)	2%	0%	6%	30%	62%	4.49	0.80
I am more likely to pursue a career in research as a result of this experience. (n=47)	2%	2%	13%	21%	62%	4.38	0.95
The things I learned during this experience will help me stay in my STEM major when my coursework is challenging. (n=47)	2%	0%	9%	26%	64%	4.49	0.83
I am more likely to pursue a STEM degree as a result of this experience. (n=46)	2%	4%	13%	33%	48%	4.20	0.98
This experience will help me succeed in college. (n=47)	2%	0%	4%	30%	64%	4.53	0.78
I would recommend this immersion experience to others. (n=46)	2%	2%	4%	26%	65%	4.50	0.86
The recruitment process made it easy for me to apply to this experience. (n=47)	0%	2%	4%	38%	55%	4.47	0.69
The recruitment information adequately prepared me for what to expect for this experience. (n=47)	2%	15%	15%	34%	34%	3.83	1.13
The format of the immersion experience worked well for me. (n=47)	2%	6%	17%	28%	47%	4.11	1.05
This experience positively influenced how I feel about my chosen college. (n=47)	2%	0%	9%	23%	66%	4.51	0.83
I am more certain my STEM major is the right choice for me as a result of this experience. (n=47)	2%	2%	9%	23%	64%	4.45	0.90

	(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=47)	4%	6%	15%	15%	60%	4.19	1.17
Community-building mentoring provided by undergraduate mentors (n=47)	4%	2%	6%	28%	60%	4.36	1.01
Meeting/conversing with faculty members (n=47)	0%	2%	4%	26%	68%	4.60	0.68
Research oversight/training provided by faculty members (n=47)	2%	0%	11%	23%	64%	4.47	0.86
Team-building activities (at your internship site) (n=47)	2%	4%	11%	36%	47%	4.21	0.95
College readiness activities (n=47)	0%	9%	11%	30%	51%	4.23	0.96
Community-building activities (across the First2 Network) (n=47)	2%	6%	21%	34%	36%	3.96	1.02
For your favorite/assigned research project worked on during the internship:							
The activities you carried out for that project, (n=47)	2%	0%	2%	36%	60%	4.51	0.75
The data analysis required for that project, (n=47)	0%	4%	0%	40%	55%	4.47	0.72
The presentation of your project findings, (n=47)	2%	0%	13%	32%	53%	4.34	0.87

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.

When looking at the items focusing on the specific research internship components, seven items were rated very favorably, with six mean scores above 4.00 and the seventh score at 3.96 (community-building activities across the First2 Network). Respondents rated meeting/conversing with faculty members the highest, with a mean of 4.60 (SD 0.68).

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

- Green Bank Observatory: cyclostationary plot research to detect radio frequency interference with Green Bank's telescope
- High Rocks: insects, trees, and streams
- Marshall University: DNA nanostructures and cerebral organoids
- University of Charleston: macro and micro invertebrates, microbial communities, and labwork/equipment
- West Virginia School of Osteopathic Medicine: soil samples
- West Virginia State University: pest management, water monitoring, pollen counts, and cancer research
- West Virginia University: metal catalyzed coupling reactions, face recognition/detection, land use impacts on water quality, fish in a dish, and Jetson nano with coding
- West Virginia University Institute of Technology: machine learning for perinatal depression, rock/paper/scissors, and TeNeBot research proposal

After identifying their favorite/assigned research project, respondents were asked to rate three items based on that particular project. Respondents rated activities carried out as the highest, with a mean of 4.51 (SD 0.75), followed by data analysis (mean 4.47, SD 0.72) and presentation of project findings (mean 4.34, SD 0.87).

When asked which research project was least enjoyable, nearly half (42%) indicated they enjoyed all the research. In looking at specific projects, no particular project or component was mentioned more than once or twice. There were a handful of miscellaneous comments; an illustrative sampling follows.

> *Not having any knowledge about what we were doing.*
>
> *I just didn't understand what to do.*
>
> *I'm not exactly sure but Thursday was extremely exhausting for some reason and our brains just crashed.*

The posttest survey also included six 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 theme by far was the networking aspect—getting to meet their peers, mentors, faculty members, and like-minded people. This was followed by the actual research/lab experiences they experienced. Other emergent themes were college preparation and recreational activities. Illustrative quotes for the networking and research aspects follow.

> *I liked meeting people with the same major and feelings about the scientific community.*
>
> *I enjoyed working with faculty one on one. I also enjoyed meeting people that I will be having classes with in the fall.*
>
> *I really enjoyed getting to network with the professors and getting to meet students and work with them.*
>
> *I really enjoyed hearing from so many guest speakers and being exposed to all that there is in STEM.*
>
> *I liked the closeness that we had with our mentors. They were everything and more.*
>
> *I liked getting to gain lab experience that I would not have otherwise.*
>
> *Getting to work with a real scientist and getting to experience real work.*
>
> *My favorite part was gaining experience researching and learning about the process.*
>
> *Doing the hands-on data collections and making the presentation at the end.*

Forty-five 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, followed by improved communications or that nothing should be improved. Less frequently mentioned themes included logistical issues (such as food, housing, and transportation) or suggestions for specific activities. Illustrative comments related to schedule modifications and communications are provided below.

> *I think that it would be better to have a shorter experience option and a longer one. Then people can learn without staying too long or they can do in-depth research.*
>
> *I think that, if possible, this program should start in the same week as the other camps so we can work on a project right from the beginning and not just be thrown into the middle of something.*

Less full schedule!!! There is wayyyyy too much pack[ed] into the 12 days that most of us were not aware of until we came here. In some ways it felt like a summer camp not an internship, which is not what I wanted.

I think that it should be longer so that we could use the first week for learning background information and the rest of the time to focus on our research.

I think we should have more time here as interns. Being here is not only good for learning but the isolation makes it to where we have to become close and develop real life friendships and professional relationships.

The clarity on the application page.

The organization and transparency about what we will actually be doing/itinerary.

Make clear earlier what we will end up doing.

When asked how they learned about the First2 Network program, all 47 respondents provided a response. The three most common methods were by First2 Network faculty members, through email messages from higher education institutions, and by high school counselors or teachers.

Forty-four respondents provided feedback about what worked best and what didn't work in First2 Network recruitment. On what worked well, respondents most frequently noted email messaging and talking with network faculty members. On what did not work so well, respondents noted items such as limited details in early communications, insufficient advertisement of the internship opportunity, and a long lag time between application and notification of acceptance.

All but one of the 47 respondents 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. The most common challenges included having limited research/lab experience, limited background/content knowledge, and presenting findings.

4.2.1 Intern Survey Summary

In sum, 2021 summer research interns viewed their internships as very successful. Fifty-four students participated in these experiences across the eight sites, and 51 provided survey responses. Two-thirds were female, more than three-fourths were White, almost half qualified for a federal Pell grant, more than half were first-generation college students, less than half were from rural locales, and about three-fourths graduated from high schools within West Virginia.

Four subscales showed statistically significant increases in mean scores from pre to post, including Knowledge About Research, Attitudes and Behaviors About Research, Personal Skills, and Research Skills. The largest increase was for Knowledge About Research and the highest rated subscale at both pre and post was STEM Plans.

Participants rated the internship experience favorably, with high ratings (above 4.00) for most items. Nearly all respondents agreed the experience helped them increase their knowledge of research within a STEM field, learn how to conduct STEM research, and improve their research skills. Specific internship components were also rated highly, especially meeting/conversing with faculty members.

Respondents reported the best part of the internship program was the networking aspect and the most common suggestion for improvement was schedule adjustments. The most common ways of learning about the First2 Network and subsequent successful recruitment were through network faculty members, email messages, and high school counselors or teachers.

4.3 Intern Focus Groups

During the May 2021 virtual spring conference of the First2 Network, the evaluation team conducted three virtual group interview sessions with college students who had participated in one of the nine summer 2020 research internships (one session each was held on May 10, May 11, and May 12). A total of 13 students participated, including one who was involved in the First2 Network but had not been able to participate in a 2020 summer internship.

As an icebreaker activity, students were asked to provide a one-word description of their First2 Network experience. Figure 35 below depicts their responses—all terms were unique, except for "helpful," which was voiced by two students (and one student did not provide a description).

Figure 35. One-Word Description of First2 Network Experience

Students were also asked three descriptive questions to identify whether they were first-generation collegegoers, whether they had a STEM major, and whether they came from a rural background. All 13 had a STEM major; six were first-generation college students, and eight were from rural areas.

The remaining questions were organized into four categories: students' early experience with the First2 Network, their experiences during the summer 2020 research internships, their involvement in First2 Network more broadly, and a wrap up. Responses are organized by question within these categories.

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 emails (some of which were from First2 staff), from flyers posted at high schools, and from friends who either knew about the First2 Network or were already in the network. A few other methods included a text message from the College Foundation of West Virginia, a Schoology posting, and a First2 student presentation at a high school biology class.

What was the main reason you wanted to become a member of the network? The most frequently mentioned reason to become part of the First2 Network was the opportunity to get involved in research early in their college experience. One student noted the research internship was "a really good opportunity for me to kind of get a head start on research, because one of the things they really push as a STEM major is to get involved in research as much as you can. So, being able to go into college already with my feet wet, so to speak, seemed like a really good opportunity." Other reasons were for the opportunities in general the network could provide and that the internships were being held at colleges students would be attending. One student commented "I knew that I wanted a career that was in STEM and so I knew it would be a good fit for me."

What suggestions do you have for sharing this network opportunity with other students? There was a common consensus among participants that more awareness of the First2 Network was needed throughout West Virginia high schools, and students suggested that both teachers and guidance counselors could help advertise the opportunity by talking about it and distributing flyers. As one student commented, "If I hadn't of seen that paper [a flyer], I would have never known about it. But if my science teacher had announced in class, 'Hey, there's a really good opportunity for you all, here it is,' it would have been really helpful."

One participant suggested increasing social media about the First2 Network and another suggested improving the overview video that had been created about First2. One way to improve it would be to involve more First2 students in making the video and encouraging First2 staff to use students' suggestions about the video. According to this student, the current video was "this weird Frankenstein-esque type video with all the other videos smashed together from other campuses."

What do you recall about the application process? Reactions were mixed, with some participants recalling that the process was simple and easy to do or that they didn't remember the process, yet others recalled specific issues they encountered. These issues included unclear questions (what qualifies as a STEM major, what is a rural area, what constitutes first-generation status), no confirmation that the application had been accepted or was under review, and glitches such as the inability to correct an item if answered incorrectly. Illustrative quotes include:

> *I remember the portal that we did the application through was, for lack of a better term, kind of like janky. I remember there were things that didn't work, and there were glitches, and I remember thinking 'there's no way this is real.' … And I don't think we got a confirmation when we sent it in.*
>
> *I remember that it took me about two months to hear anything back. I didn't get a confirmation email. I was never told my application was being processed or got through a first wave or anything. I had to reach out to them and ask if anything was happening and if they even got my application at first and they replied and said they did, and I should have a response in a week or so.*
>
> *For me it was surprising because I was looking at the application and the definition for a first-generation college student was that neither of your parents had attended a four-year university, and for me I didn't feel like I was eligible going into it because my dad has a two-year degree. And then my grandfather went to college. So, at a surface level, I didn't think I would be eligible. But then I got into the application process and saw that I was eligible for this opportunity and to join the network and that kind of caught me off guard and I was pleasantly surprised.*
>
> *I do remember that on the section where it asks like what level of college your parents, siblings, and grandparents have been in, I accidentally clicked that my grandparents have been in a four-year college or something and that is not true, but I couldn't unclick it. So, I just put it in the notes that my grandparents have not been to college.*

What suggestions do you have for making the application process better for future applicants? Participants offered several suggestions for improvements, which focused primarily on communications and application modifications. For communications, participants suggested a message confirming that an application had been received, and then subsequent messages to provide updates on the status of the review process. For modifications, suggestions included adding the option of being able to exit and return to the application prior to submission, revising

the survey so that applicants could access prior items and make corrections as needed, and clarifying special terms and related eligibility criteria for those terms (such as what constitutes an eligible STEM major, a rural area, and first-generation status).

4.3.2 Summer 2020 Research Internship Experience

To what extent did the research internship meet your expectations? Four of the participants specifically noted they had expected that the internships would be held in person. They recognized the necessity to switch to a virtual platform, and in general believed the change was handled successfully, although one student was "pretty disappointed" to have to go to a virtual setting after expecting it to be in person. Several illustrative quotes follow.

> *I didn't know really what to expect going in, so I didn't really have any expectations to be met but having to do it all online I feel like they did a really good job like communicating online and switching it that fast.*
>
> *My original expectations were pre-COVID, so obviously it didn't meet the experience of actually going to Green Bank Observatory, but I would [say] my expectations after COVID developed further, they were exceeded. I didn't really expect it to be as pleasant as it was. I expected the whole thing to be flushed down the toilet and when they sent us these packages and were like 'these are some tools we're providing you…we want to do be able to do this with you guys' and creating ways for all of us to communicate with each other and still have a lot of interaction and experience, that was really nice. … I was really happy.*
>
> *Personally, I at first was fully expecting in-person lab experiences and was super-excited for it. When I was told that it would be online, I was like, 'Oh, do I even want to do this anymore?' because I was like 'what can we research online and still have a good time doing it or really learn about the research process?' But I decided to stick with it, and we did the project, and it was actually a lot better than I expected. It exceeded my expectations … we did like water collection and micro-biology research and that, I mean, it blew me away that they sent us just a ton of equipment to use and stuff and it was a lot better than I was expecting.*

Other participants were aware of the virtual nature of the internships from the beginning and reported that their expectations were met as well.

> *I didn't have many expectations for a virtual internship because that was what I had signed up for and what I was expecting, but we did actually do research. I was sort of worried that it was just going to be like a learning experience, and we were just going to study something, but we actually got to go out and do an experiment from a sample that we took ourselves.*
>
> *I thought they did a pretty good job communicating [the switch to virtual] as well.*

One participant described how the internship experience:

> *Definitely helped me decide on whether I wanted to be a STEM major or not because … research in general, being a scientist, is not one of those things that is fully understood by high school students. Usually if you're told, 'Hey, this person is a scientist,' you think long days in the lab, you know, writing hours and hours of reports and all that and … it was honestly like really good to be able to participate in something that definitely seemed easy but also was a little bit difficult. I definitely found it was a confidence boost especially since I was … spending time with my father and I actually got him a little bit excited about it … which was really exciting for me as well.*

Two other participants provided explanations of how the research internships had not met their expectations, for varying reasons.

> *So, overall, I had a really good experience … but the one thing that was kind of frustrating was we needed soil samples and water samples for my internship site, and they didn't let us know that until I think a week before the camp started. And I was going on vacation that week and I was going to be back right before the internship started, but they needed us to drive the soil samples and water samples up to one of the professors, so it was really hard for me to fit that into my schedule, and they weren't being that flexible with it. I understand they needed it by a certain date, but I wish they would have told us sooner—given us more notice.*

> *I got put in a site that on my application I put that I wasn't interested in at all, which I'm still very thankful to have that opportunity. But, yeah, we were doing radio astronomy and I'm a chemistry major—like that's my passion in life—and I just so wasn't interested at all. It so wasn't fun for me to the point where I was like I don't even think I even want to do research in my field because this is just so not fun. It's not interesting to me at all.*

When asked if an explanation was given for why that student was put in a different internship:

> *I didn't really ask. But I'm assuming that by the time they got to my application, they were scraping at the bottom of the barrel and just had to fill up that site. So, yeah. I mean, again, I am thankful for the opportunity, but it was just so not anything what I was interested in. I don't know. It was pretty disappointing.*

What provided the most value to your college experience? Most participants provided examples of what they perceived as the most valuable aspect of the internship to their college experience. These topics included meeting people and forming friendships, learning what others were interested in, talking with mentors and getting their advice, meeting and talking with faculty members, conducting research, and learning more about what research involves. Illustrative quotes are provided below.

> *What was most valuable to me was getting to meet people that were going to the same school as me. I didn't really know anybody going in so getting to meet people was really useful so that I would know people when I got there.*

> *I would say what was really helpful to me is we had one session where we broke out into breakout rooms with people from our campus that we were going to be with in college, and I met … a few interns that were going to UC and so I already had that kind of background going into UC. … and then we all were in our First2 Network club together. We formed a pretty close relationship through the immersion.*

> *I think for me it was nice to get to talk to some college students, … our college mentors who had already been through at least like half a semester of COVID and virtual learning, so that kind of helped me like prep for it and get an idea of how to schedule my time and make the best use of it.*

> *I'd also say that the actual conducting research part was really helpful because I know, at WVU at least, all of our [fall] labs were made online, and it went from actually getting your hands on something to essentially filling out worksheets. So, being able to experience, you know, working with STEM experiments and getting some actual insight into that was very valuable because I didn't get to do any of that*

> *my freshman year, so I feel like I won't be as dead in the water as things open back up. I'll know how to go about things.*
>
> *[While] the actual immersion itself was not super useful for me and my major and what I was interested in, it did provide me with resources whether it be other students, mentors, or faculty members who could help me pursue research and additional research opportunities. And so, … I am grateful for that.*

When participants were asked to identify any internship activities that stood out as either best or least favorite parts, several provided feedback. Several commented that all activities were "pretty good," and another noted "something I really enjoyed about my site was that they actually sent us chemicals and stuff to do our experiment with. I thought that was so cool." Others liked the smaller group meetings within each internship or the one-on-one time with research; illustrative quotes follow.

> *I actually like more meeting with the group … I thought it was more beneficial because we were a smaller group, and we were actually like able to talk to each other better.*
>
> *For me, I had a really good time actually getting one-on-one time with the individual that we were primarily with … getting to talk with him was most valuable.*

Comments focusing on least-favorite activities included the daily First2-wide meetings or time not spent on research. Illustrative quotes are provided below.

> *I didn't really care that much for the like every day there was a new First2-wide meeting. … because when you have a Zoom call with like it felt like 50 or 60 people, it's not very fun and no one's going to talk except for the people that are in charge and that's it.*
>
> *I remember that I always kind of dreaded the afternoon sessions a little bit because they were never like focused on my research and a lot of times it was just sort of like a seminar because it just wasn't really interactive.*
>
> *I think for me the least pleasant was whenever we weren't with the researchers. … whenever we had to pull it back and do less research-oriented things, it made me a little sad.*

How, if at all, did participating in the research internship affect your decision to declare or not declare a STEM major? One participant noted how the water pollution research "helped me decide that I wanted to do something research-wise in undergrad in water pollution" and another said participation "definitely helped me decide on whether I wanted to be a STEM major or not." A third participant stated, "I was sort of flip-flopping a little bit," and the internship research helped inform the decision for a broader STEM major than public health specifically. A fourth participant recalled how the internship had affected the decision for a STEM minor:

> *Something that came to mind that was rather specific: In talking to one of the researchers that we were working with, he was saying one of the things he'd had to learn after he had gotten to college was programming and that reinforced the idea that I should continue learning programming through college and so now me in my physics major, I'm also minoring in computer science because a lot of physicists out in the field are having to learn that in order to continue their work, so I'd say that's something that influenced my STEM major is looking more at minoring in things that will help me in my field.*

The remaining participants were more ambivalent about whether the research internship experience affected their decisions about their STEM majors. Illustrative quotes follow.

> *For me, I don't really feel like it had much of a change at all. I was pretty dead set on physics before I had entered the internship. It just kind of reaffirmed that it was something that I was interested in, and I was okay to feel that way.*
>
> *Not really but I think with hearing everyone's point of view on what they were choosing to major in was helpful just because like I realized how much more STEM majors there actually were rather than just mine—or just like the main two everyone thinks of.*
>
> *I went into the internship 100 percent confident on doing chemistry—like that's what I want to do, and I already felt pretty confident about my ability to do coursework.*

How, if at all, did participating in the research internship influence your confidence in your ability to do STEM coursework? Several participants perceived the internship experience had influenced their confidence in their ability to do STEM coursework, noting the research component helped them be more prepared for coursework.

> *Doing the internship did help boost my confidence of my performance in the major. And I think the biggest thing I took out of the research internship was this past semester me and actually the mentors from my immersion experience continued the research we were doing. So, I think that helped me during the internship and I got to do more research this past semester.*
>
> *I'd say it probably increased my confidence. I felt that the research I was doing was successful in how we carried it out and I think that put a good bit of confidence in my brain going forward since that's what I wanted to do.*
>
> *Before our experiment, we did have a few PowerPoints and stuff that we went over that taught us just sort of general plant biology and I picked up on that pretty okay, and it also prepped me for when we talked about plant biology in our Bio 115 and 117.*

A few participants were more ambivalent about whether the internship had influenced their confidence in doing STEM coursework:

> *If I'm going to be for real, if you mean the coursework in general, I'm going to say that especially it was a research immersive, so it was more about research. I don't feel like it kind of did anything about my STEM coursework in general. It didn't really affect my opinion on it.*
>
> *I think it was more of a confidence…I wouldn't say booster, but I think it was more like assuring just because like I understood what it was we were looking at based off of what I did in high school. So that was helpful.*
>
> *It didn't really influence my confidence. Like, I mean, it was there as a safety net in case I needed any help. The coursework was pretty fun.*

How, if at all, did participating in the research internship influence your sense of yourself as a future scientist or mathematician? Three participants reported the internships did not influence their views of themselves as future scientists or mathematicians. Another was neutral, noting that "going through college and just doing more stuff that scientists and mathematicians do is what is building my idea of me being an engineer more specifically."

Two participants perceived the internships had positively influenced their perceptions of themselves as future scientists or mathematicians:

> *Yes, I one hundred percent agree that it made it feel real, like actually putting on the latex gloves and the goggles and stuff. Like that experience it makes it feel like [I'm] a scientist.*

> *I'd say it made it feel a little bit more real as opposed to being in high school and just kind of being a student getting to get, again, kind of get your feet wet. It made it feel real and like okay, I'm entering college and I'm actually contributing and conducting research as opposed to just reading about it. So, I'd say it helped positively influence that sense of being a future scientist.*

How, if at all, did participating in the research internship continue to influence your progress through your STEM major? About half of the participants provided examples of how the research internship was continuing to influence their progress through their STEM majors. Benefits cited by students include improved time management and opportunities for in-depth interaction with faculty. Specific illustrative quotes follow.

> *It kind of made me focus on like the whole research side of things in college, like at State they offer a lot of research opportunities for students and it's pretty helpful and I think after doing the First2 immersion last summer it kind of made me focus on I need to do that and get involved as soon as possible and so I did.*
>
> *I think it also gave us more opportunities to get to know the professors and stuff and like who to talk to and who not to talk to if you have certain questions.*
>
> *So, one of my big struggles I guess through high school was time management and I was worried that in college I wouldn't be able to keep up with everything, so the internship allowed me to figure out how I want to do time management with writing all the documents and making the presentation for the research project we did. So, that kind of just taught me or let me figure out how to do my own time management and helped calm my nerves I guess for that. And that's carried through my first couple of semesters so far.*
>
> *I think the biggest influence from the research internship was not the research but from the relationships that you got from the internship with your peers and your staff/adults. From the internship you were able to build relationships with people that you wouldn't have normally met, and those relationships gave you opportunities to do different research—research that you actually liked, or you were able to do research … I don't know. I feel like the biggest influence in that was the people that you met and how that carried on through your freshman year.*

What changes should be made to improve future research internships? Five participants provided suggestions for improving future research internships. One suggested the obvious—that the internships be held in person, if possible. The other four suggestions are noted below. Several participants noted they did not have any suggestions.

> *I don't know if this would qualify as research, but something I did in high school was like doing a lot of interning with engineering firms from the area and that was pretty beneficial to me, I think. I think job shadowing and stuff like that is always cool.*
>
> *I'm not sure what all they could change. Just like I said before, they kind of exceeded my expectations with what they were able to do with the online format and not experiencing what it was like before, I'm not sure how much they could change there. For me, we got hands-on time with the telescopes and things like that. I mean, that was great, and I would just continue doing those kinds of things.*
>
> *For State we had to do fireflies, bees, and water pollution. And it was like so much work to do in a matter of two weeks that you kind of were kind of stressed because you didn't know which one to do first and how to get one done and start the other.*

So, I would probably say either choose one huge topic and do that or give us more time in between so it's actually doable.

This might already be a thing, I'm not sure. Maybe have some of the professional development topics covered the same way or cover the same information across all the sites so that some kids aren't getting stressed out because they think they have to do research the whole time through college or maybe some kids just aren't really getting much information.

4.3.3 Experience with the First2 Network

Other than participating in the summer research internship, in what ways are you involved in the First2 Network? Participants noted a variety of ways in which they had participated in First2, including monthly campus club meetings, serving as a mentor for the upcoming 2021 research internships, participating in general First2 Network meetings, serving as a hometown ambassador, serving as a campus lead, serving on the student leadership working group, and forming a social media team with other First2 students. When describing the campus club activities, respondents recalled getting together to "talk about what's going on," "hang out," "paint just to kind of relax before finals," host mental health activities, and "do check-ins with each other." When describing the social media team, one said, "I like to have the power to outreach to First2 in general and students and parents and let them know about what's going on and what it's about and I think it was a really good experience for me as a person."

How are you balancing participation in the network with your college responsibilities? Only a few participants provided comments about balancing participation. One noted how participating in the campus club helped balance work and network involvement. Other comments are noted below.

Yeah, so for me I know the fall semester I was a bit more involved in First2 and then when spring started, I got into the research apprenticeship program and I started working in a lab, which could go up to like 10 hours a week, … but I had to step back a little bit and stop attending the network meetings. I also was on the embedded student project and some weekends I just could not do it.

Yeah, I kind of … the network for me personally kind of got put back, especially being locked in the dorms, a lot more time was spent on classes and kind of keeping my mental sanity in check with everything going on.

In the beginning of my first semester, I was attending every meeting I could, or just every meeting period, and I was really enjoying it. But then towards the end of that semester my work began to build up a little bit, so I was attending less and when we were doing finals and a week or two before that I wasn't attending any meeting at all and I was barely keeping up with First2. Then over break I decided I need to put a little bit more attention back into First2 … so this second semester I've been trying to get back to where I was at the beginning of my first semester.

I definitely balance my club at UC with my classes and everything pretty easily because we just meet just once a week for an hour or so. So, I would say that is pretty easy for me, but as far as the statewide meetings, I feel like I never really have time for them because I also have a job that I have to work around, and I have a few other clubs that I have to work around, and I feel like I can never really fit that in.

For me, at WVU, I joined the First2 group chat and looked at joining a club but I kind of had to go back to focusing on schoolwork because math took up a lot of my time the past two semesters, being in multi-variable calculus, … making sure that I really

hammered home learning that since it's a base and a foundation for what I'm doing going forward. I wanted to get involved [in First2 activities] and I got to a little bit, but then chose not to participate as much so I could focus more on my studies.

How much of a voice do you have in the network? Students in general? Responses were mixed as to the degree of voice individual students had in the First2 Network, as well as students in general. One theme was that students in general have a prominent voice in the network. Illustrative quotes follow:

People are always asking for our opinions.

Most of the network as a whole is student-led, and then especially like the clubs on campuses, those are pretty much student-led. It's just like the faculty member or something is just there to just advise, I guess.

I think students in general are also listened to a lot because that's the whole point—they want to listen to the first gen. Sometimes I think maybe the communication is not the best but there is that like trying. I just feel like sometimes things are confusing and they don't feel accessible. Something I know that we talked about in one of the network-wide meetings was the term 'student leaders.' Usually, you hear that, and you think it's like a leadership position, like somebody who is elected to be a student leader but that's just their term for everybody. We've talked about that. I haven't been in any meetings since then and I don't know if there are any plans to change it, but they did sound like they were receptive to changing that.

Other students were more ambivalent, indicating the degree to which they have a prominent voice depends on them, or that the experience depends on the campus affiliation with the network. Illustrative quotes follow.

I don't know that I have a huge voice right now, but I think the important thing is that I know I could. There are lots of avenues for me to voice my opinion. You know, if I wanted to go to a meeting and bring up something I could.

For me personally, I feel like I have a very small voice but just because of my situation. I know that students in general do have, at least from my perspective, they have a large voice and I know who to contact if I wanted to have a bigger voice. I know the avenues I could go through and the people I could talk to [in order] to have my voice heard should I want it to be. But right now, it's small and that's more on me than anyone else.

I think as one person I have an equal say as just about any other student, or equal voice, which isn't super big, but if I talk to other students and then they agree with me and we all bring up a point, then we can really make change. But one student doesn't have too much of a voice, but if a large amount of students agree with that student and we all speak about it, then yeah.

I think how much of a voice you have in the network really depends on you. You get out of it what you put into it. I would say that like I don't quite make use of that that much, but I feel like if I wanted a change to be made or I wanted to pursue an opportunity, I do feel like I could make that happen because I do feel like the network is pretty student-led. We hear about them making a social media team with students or a podcast or like separate working groups because students wanted that to happen and so they made it happen, and things like this where we're allowed to give feedback to make the network better. I do feel like

> *it's very student-led and that we do have a lot of feedback that we can offer and that we do have a voice in what happens in the network.*
>
> *I think it's also dependent on how your campus is affiliated with the network, so like how much work are you doing statewide related or are you doing most of your stuff just like on your campus. Like, with Tech, where we're so small, everybody gets a voice on our campus and we all have a chance to kind of talk about things and kind of provide our opinions on our campus whereas some of us who are more involved with the state, we choose to speak up more in the statewide network. I guess it kind of depends on where you are.*

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

> *I think through getting to know the other students that are in the same STEM program that you are [in] gives you help to like work on the same paper together if one of you guys are struggling and they can help you out or you help them out and I think that's pretty important.*
>
> *I think it's very helpful, … just having other students there to discuss topics with that you don't fully understand—getting their viewpoint and maybe they can help explain something to you.*
>
> *I've only talked to maybe two or three of the people that were in my [internship] group like on a day-to-day basis in the first semester and one of them was a chemistry major and we worked on stuff all the time together because we were in the same Bio 120 class.*
>
> *My First2 group last summer I wasn't with State and so going to State I was kind of like going and not knowing everyone, except for like teachers and stuff, so I just learned to basically build connections with like everyone in my class and also within our little club, too.*
>
> *Some of the connections I made were through First2 and then others were just people I met on campus. Both were very helpful though.*

The second theme focused on the benefit of getting involved with research.

> *For me, my involvement in the internship definitely helped progress through my STEM experience because it is very, very pressured on physics students to get involved in research as fast as possible, so it provided a good avenue to get a head start, … you have to get in research as fast as possible, and it's stressful and knowing that I'd already taken a good first step was comforting.*
>
> *I asked a couple of people if they would let me join their lab and it wasn't until I got to a professor that was also first gen that they were accepting and willing to take me on during COVID. So, I think like maybe being in the First2 Network might have influenced a little bit and yeah, getting started in research early is important.*
>
> *I think it's definitely helped me a lot because UC is very small, and our club is pretty small. … I also got involved in research through my club because that was something I wanted to pursue. … I pretty much just asked my advisor, "I'm interested in research. What should I do?" and she pointed me in the right direction and to the right person and I've had that opportunity, which at UC … that's a pretty big deal and*

> *I feel like that has really helped me a lot and I don't think I would be able to do that if I wasn't involved in First2.*

Finally, one participant said the First2 Network hadn't helped much, other than the professional development, noting "it's more my fault because I haven't been participating in my club."

4.3.4 What's Working Well and Student Suggestions

How can the First2 Network provide you with better support as you continue in your STEM program? Several participants provided feedback confirming the network should continue providing its current support, i.e., "just keep doing what it's doing," "I think it's doing a pretty good job," and "I feel supported." Two participants mentioned that First2 should continue offering stipends because they allow "students to be able to focus on research instead of having to go find a job." Another participant also mentioned that the First2 Network should continue offering a flexible level of support so that students have "the opportunity to back away when they need to but still tell them 'whenever you want to come back, whenever you're free, you're welcome back'—and I think they do a really good job of that."

What is one thing that the First2 Network is doing especially well for students? Six participants provided unique comments about what they perceived the First2 Network is doing especially well for students. Items cited by students included job postings, the ability to make connections, and opportunities for students to make their voices heard.

> *In that one group on the website, I think it's like the student leadership group, they always post job opportunities, like internships and scholarships and things like that. That's something that I'm always really interested in, but I don't quite know where to find them. So, they always post those opportunities and that is really helpful to me.*
>
> *I think letting like students have a voice is also something that the First2 Network does that lots of organizations don't necessarily do very well. Like these direct meetings with leaders on the network—I've never really experienced that before.*
>
> *Connectivity is definitely something that I think they do well. The First2 at WVU, all the people that you can meet, all the people that you meet in the internships, letting you know that they're there and that you have more opportunities that are available to you. They're definitely helping with networking especially with everything that's going on.*
>
> *Exposing a lot of high schoolers and also college students to the idea … there are STEM jobs out there, especially in our state. To be honest, the high school that I went to, … if you weren't going to college for a liberal arts degree, you probably weren't going to college. So, I think it's done and is continuing to do a good job of exposing the STEM opportunities in the state of West Virginia.*
>
> *I think there's a stigma around people getting a STEM degree, that it's super-hard and almost unattainable but I think they're doing a good job of making people realize that it's not as difficult as it seems, and it is possible for people to do, and you don't have to be like some genius to be able to do it.*
>
> *I think keeping us up to date on what's going on in the whole organization on the First2 Network website. They do a pretty good job on keeping us up-to-date and stuff on that.*

Any final comments to make anonymously via a survey link? None of the participants provided additional comments through the optional survey link, which was provided to give

students a safe space to share feedback anonymously that they didn't want to share verbally amongst their peers.

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, even with the virtual setting, with students finding value in the experience and in the networking aspect of the network. Most students believed their participation in the internship influenced their STEM major decisions, positively influenced their confidence in doing STEM coursework, and was positively influencing their progression in their STEM major. Further, most perceived that students in general have a prominent voice in the First2 Network. Overall, these interns saw value in the First2 Network in building networks with students and faculty and in gaining early research experience. To here

4.4 Student Outcomes

4.4.1 2020 First2 Network Intern Early Persistence Rate

During the First2 Network's third year, Network team members collected data from 2019 and 2020 interns about their college persistence and STEM major status.

2019 interns. Retention status could not be secured for four of the 31 interns from 2019. Of the remaining 27, 18 (67%) persisted in a STEM major between Fall 2019 and Fall 2020 semesters. Eight (30%) did not re-enroll in a STEM major in Fall 2020, and one student (4%) dropped out of college. (Fall-to-3rd Fall data for these students will be available in the next annual evaluation report.) Of the 31 interns, 8 (26%) served as mentors for the 2020 internships and 4 (13%) were selected to serve as mentors for the 2021 internships.

2020 interns. Because Fall-to-Fall STEM reenrollment data are not yet available for the 2020 interns, we report Fall 2020-to-Spring 2021 reenrollment instead (Fall-to-Fall data for these students will be available in the next annual evaluation report). Limited data was available for the 2020 interns; retention status could only be obtained for 27 of the 74 interns (36%). Of those, 21 (78%) persisted in a STEM major between Spring 2019 and Fall 2020. Five (19%) did not re-enroll in a STEM major in Spring 2021, and one student (4%) dropped out of college. Of the 74 interns, 8 (11%) were selected to serve as mentors for the 2021 internships.

The evaluation team will provide an addendum to this report when Fall 2020 to Fall 2021 STEM persistence data become available.

Comparison to West Virginia rates. Semester-to-semester STEM persistence rates against which to compare this early finding for 2020 interns are difficult to locate. One proxy comparison is to the West Virginia rate of Fall-to-Fall reenrollment in a STEM major among rural STEM students eligible for a Pell grant (a proxy for first-generation status, as HEPC DSR does not collect a measure of first-generation status). These data show rates of 78% for 2016 freshmen, 70% for 2017 freshmen, 74% for 2018 freshmen, and 75% for 2019 freshmen (see Appendix C).

In sum, the Fall-to-Fall STEM persistence rate of 67% for 2019 interns is slightly lower than the Fall-to-Fall STEM persistence rate of similar West Virginia students who were freshmen in 2016-2019. The Fall-to-Spring STEM persistence rate of 78% for the 2020 interns was comparable to the state rates, albeit based on a shorter time duration.

4.4.2 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 evaluation also reports 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 C2 provides more complete details by College Readiness (Tables 1a-1d for readiness data for 2016-2019 freshmen), College Participation (Table 2 for Fall-to-Fall and Fall-to-3rd Fall retention rates for 2016-2019 freshmen), and College Persistence (Table 3 for graduation rates for 2012-2015 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.
- Similarly, minority youth have significantly lower rates of readiness, persistence, and completion than non-minority youth.
- STEM students have higher readiness and persistence rates than non-STEM students.
- Female students have lower readiness rates than males, but they also have higher persistence and 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 36-41 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 36-37), Figure 36 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; scores remain fairly constant from 2017 to 2019. 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, but rates for the 2019 cohort are either slightly lower than 2018 (Rural) or remain the same (Non-Rural).

Figure 37 shows that for STEM students, Pell recipients have lower STEM readiness rates than their non-Pell counterparts, regardless of rurality, for all four cohorts. All four groups show varying patterns of increases, decreases, or nonchanging rates across the four cohorts; the largest change is the 19-percentage point increase from 2016 to 2017 for Non-Rural STEM Non-Pell youth.

Figure 36. STEM Readiness Rate (Percentage): Rurality by Major

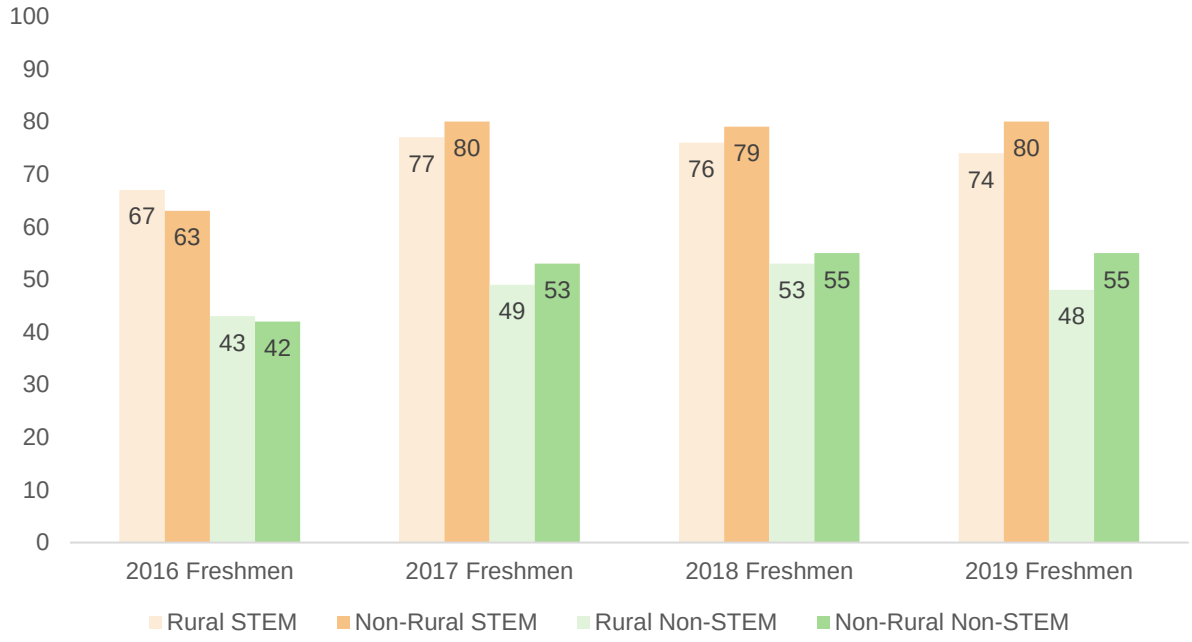
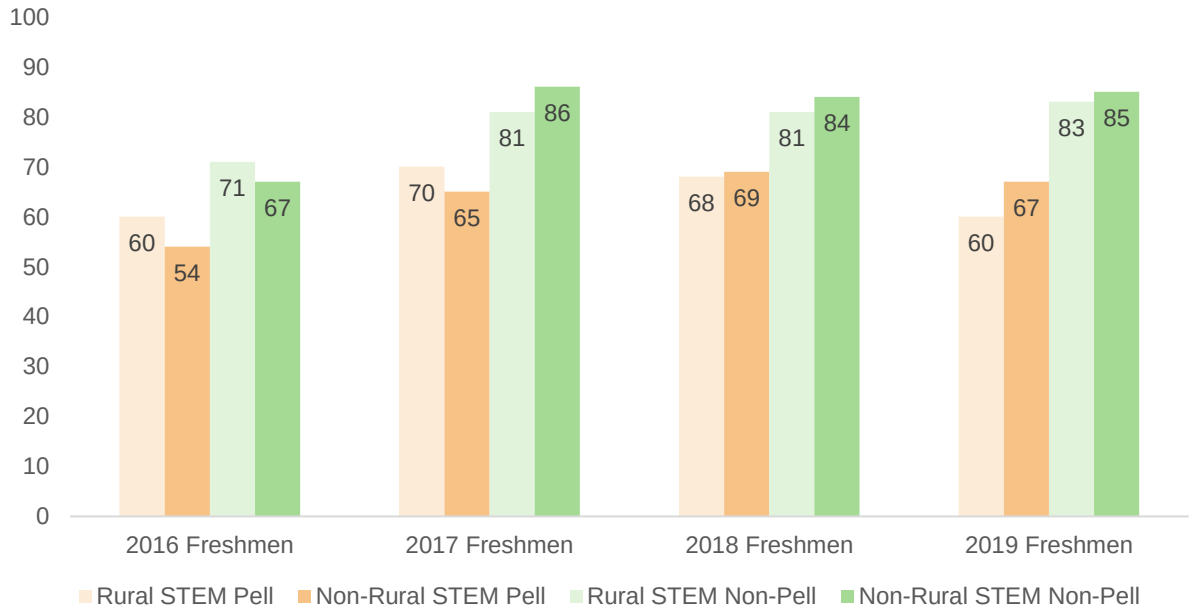


Figure 37. STEM Readiness Rate (Percentage): Rurality by STEM Major by Pell



For College Persistence (Figures 38-39), Figure 38 shows that STEM students have slightly higher retention rates than Non-STEM students, 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. Figure 39 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.

Figure 38. Fall-to-Fall Retention Rate (Percentage): Rurality by Major

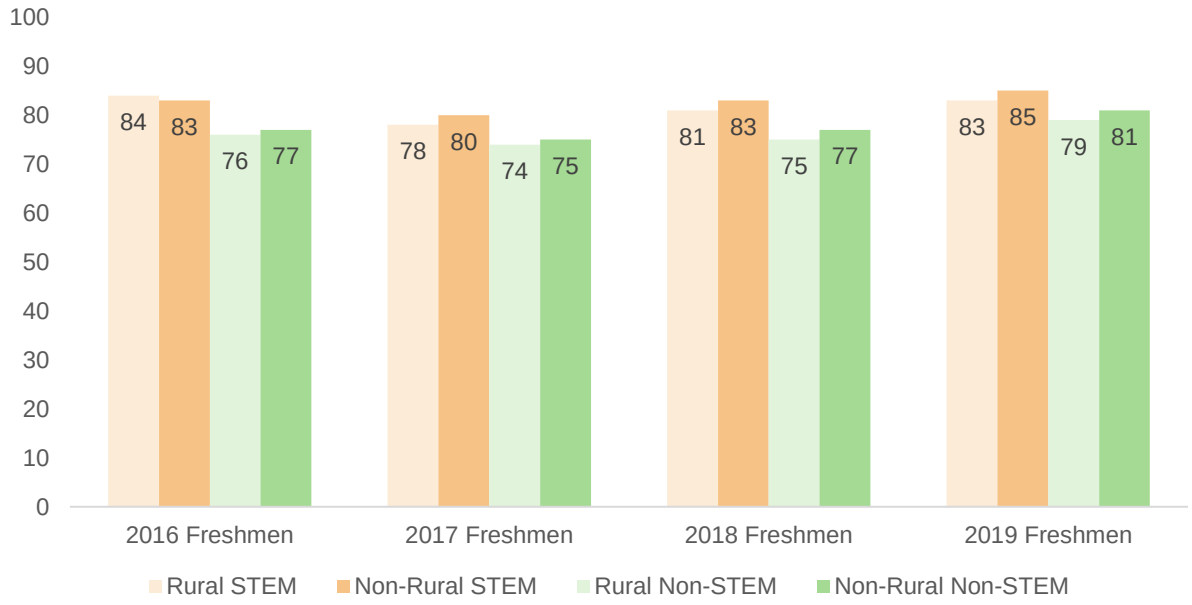
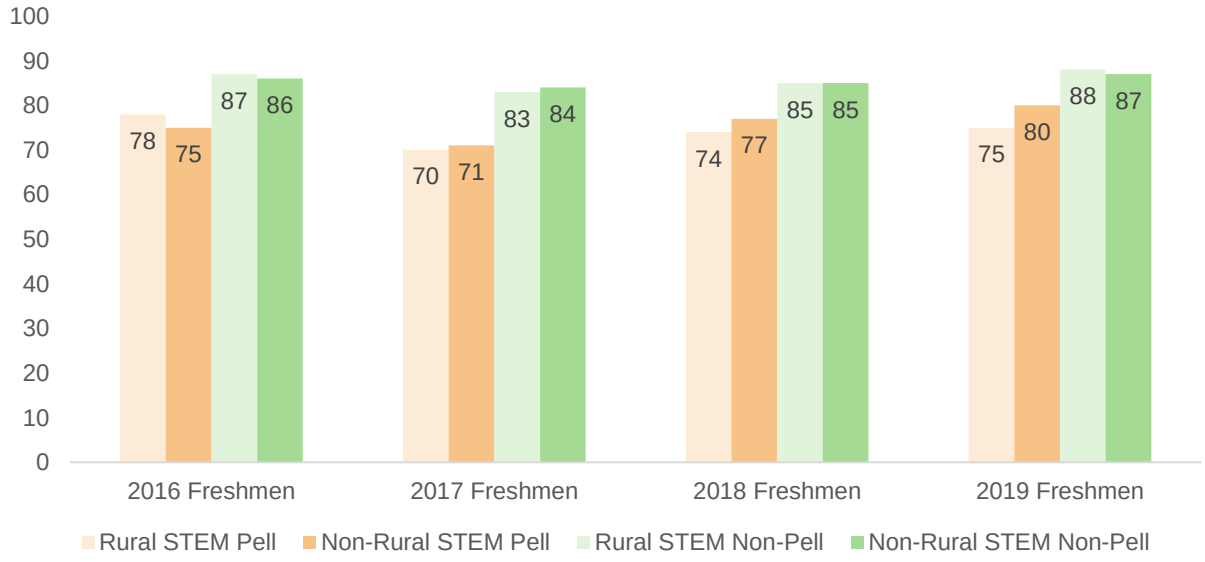


Figure 39. Fall-to-Fall Retention Rate (Percentage): Rurality by STEM Major by Pell



For College Completion Figures 40-41), Figure 40 shows that STEM students have lower graduation rates than Non-STEM students, regardless of rurality, for three of the four cohorts (2013-2015); the 2012 freshmen cohort had slightly higher graduation rates for STEM youth compared to Non-STEM. Three groups show varying patterns of increases, decreases, or nonchanging rates across the four cohorts; the Non-Rural Non-STEM group shows an increase for each successive cohort. Figure 41 shows that for STEM students, Pell recipients have lower graduation rates than their Non-Pell counterparts, regardless of rurality, for all four cohorts. All four groups show a variety of increases or decreases across the four cohorts.

Figure 40. 4-Year Graduation Rate (Percentage): Rurality by Major

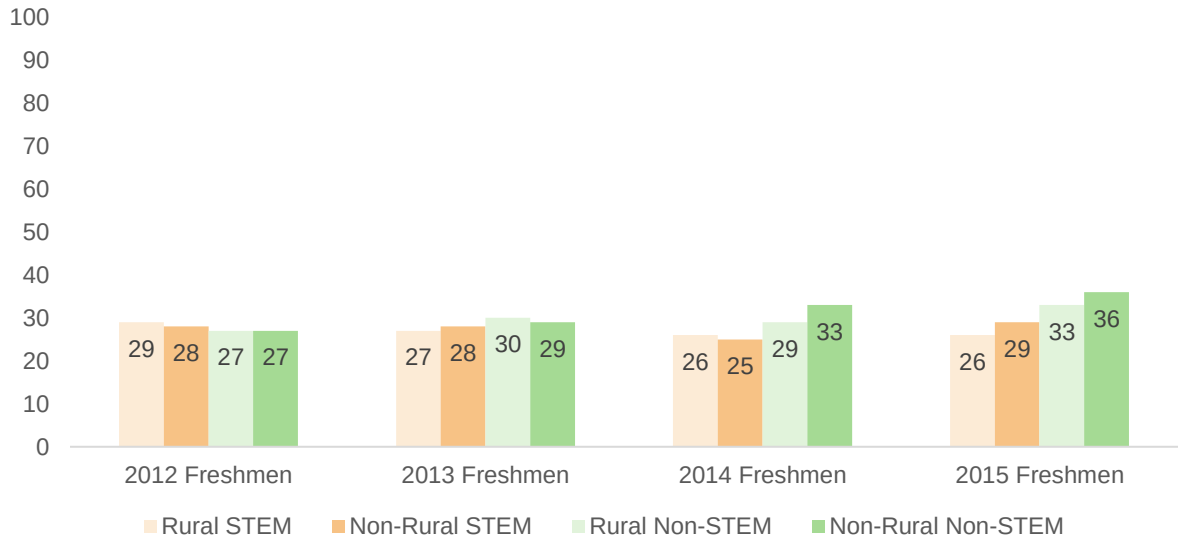
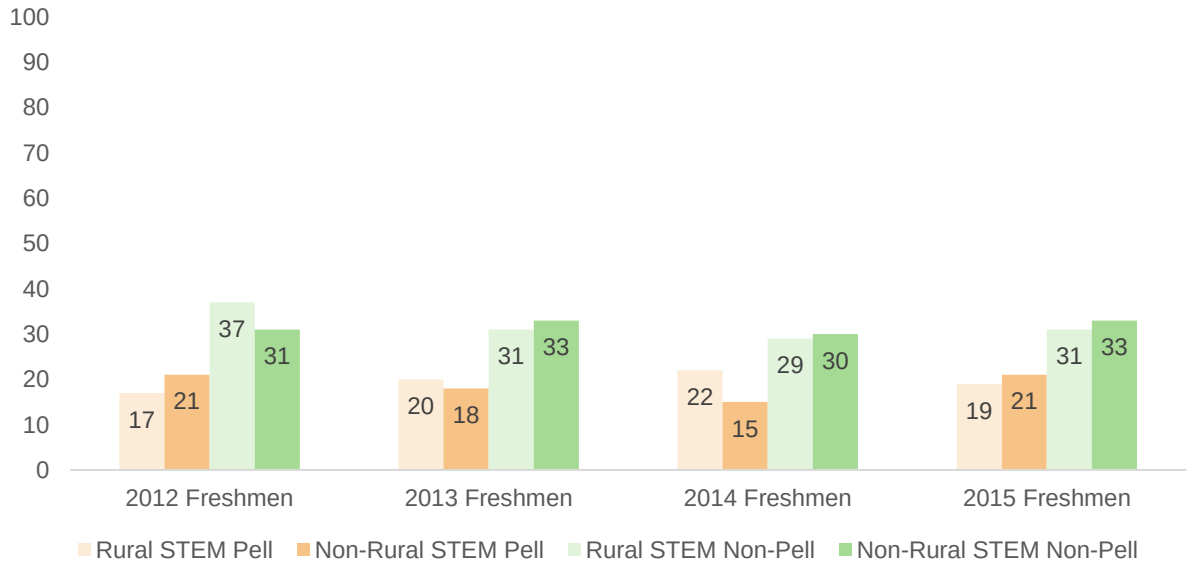


Figure 41. 4-Year Graduation Rate (Percentage): Rurality by STEM Major by Pell



4.4.3 Student Outcomes Summary

In sum, the First2 interns have fairly comparable persistence rates when compared to West Virginia rural STEM Pell-eligible students. The 2019 interns had slightly lower fall-to-fall rates, but the 2020 interns had slightly higher fall-to-spring rates, as compared to the 2016-2019 statewide freshmen cohorts. Further, in looking at West Virginia students in general, Pell-eligible, minority, and rural youth had lower rates of readiness, persistence, and completion than their counterparts. STEM students had higher readiness and persistence rates than non-STEM students. In addition, female students had lower readiness rates than males, but higher persistence and completion rates.

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

The COVID-19 pandemic continues to be a significant contextual factor in the life of the First2 Network. A few summer research experiences were facilitated online as they had been in Year 2, but most were held in person, and both conferences were likewise held virtually. Students reported facing the sorts of educational access challenges that have become widespread nationwide—unstable broadband, coursework that did not transition to virtual formats successfully, lack of connection to other students and to campus life. On the other hand, some network members reported that the use of virtual meetings and conferences improved their access to network activities since participation did not require travel.

COVID-19 aside, much about the context in which the First2 Network operates remains consistent. West Virginia remains poorer, less diverse, and less educated than the nation in general. West Virginia remains an EPSCOR state, one indicator of limited STEM capacity. During the 2021 state legislative session, policymakers introduced several STEM education bills, but none were passed.

1.2. First2 Network Structures and Processes

The First2 Network included 487 members, an increase of 72% from 283 in Year 2 and of 238% from 144 in Year 1. More than two-fifths (43.1%) of members were students, and over a third (34.9%) were university faculty or staff.

The number of summer research interns declined between Year 2 and 3. A total of 159 interns have participated in First2 Network summer experiences since 2019. Thirty-one participated in Year 1, 74 in Year 2, and 54 in Year 3.

The representation of conventionally underrepresented racial/ethnic students in the Y3 First2 Network summer research internships is higher than their representation in the state at large. A total of 16.0% identified as Black/African American, 4.0% as Hispanic or Latinx, and 4.0% as American Indian/Alaska Native.

More than half (56.0%) of interns self-identified as a first-generation college student. Two-fifths (40.0%) of interns hail from rural places and a similar percent (42.0%) report coming from towns. Two thirds (67.0%) of Year 3 interns were women.

The First2 Network made substantial progress toward full implementation of all five elements of collaborative infrastructure. Network documents and member feedback indicate that members embraced a shared vision, which they promoted via an array of communication and outreach activities. The network continued to expand its partnerships, signing MOUs formalizing institutional partnerships and engaging with national STEM education and first-generation collaboratives. In addition, the network made progress toward establishing processes for obtaining and reporting shared metrics via a data dashboard and toward improving communication about metrics from project research and evaluation. Adults and students alike were offered leadership development opportunities and leadership roles in the network. To

support expansion, sustainability, and scale, the First2 Network established an EPSCoR workshop planning team for outreach to other EPSCoR jurisdictions, developed and began implementation of a strategic plan, and facilitated advisory committee and industry advisory board meetings.

In terms of the functioning of working groups, mean subscale scores on the Working Group Self-Assessment have consistently improved since Year 1. The extent to which working groups engage in collaboration continues to be the most highly rated subscale. On the other hand, the Measurement Team identified several issues that the network might address to improve the use of improvement science across the network, including strengthening oversight of improvement science activities, alignment of change ideas to the driver diagram, quality control of change ideas and PDSAs, and capacity building across the backbone organization to support improvement science.

Steering Committee members have observed important progress in the committee's work over the course of Year 3. Although some governance and communication issues remain to be resolved (e.g., maintaining clear focus on network goals, ensuring active participant engagement, ensuring everyone has an equal voice, reducing burnout), respondents tended to think that governance and communication had improved since the network's first year. Steering Committee members also reported that they had nearly or fully achieved their roles in leading work groups, understanding the responsibilities of Steering Committee membership, and championing the First2 Network by communicating with others in the state and elsewhere about its work. They also cited progress toward achieving goals associated with other Steering Committee roles.

First2 Network conferences continue to be well-received by participants, offering opportunities to interact with colleagues and learn about broadening STEM participation. Attendees in both October 2020 and May 2021 rated the events highly regarding format and content. Interestingly, a larger percentage of participants in the May 2021 than the October 2020 conference indicated that they were new to the network (20% compared to 6%).

1.3. Systems Targeted by the First2 Network

Members of the First2 Network undertook an array 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 3, these included attempts to improve the pathways, and the linkages among such pathways, along which students travel across their academic experiences. Notable efforts were jointly developing a grant proposal with the WVU Physics Frontier Center and five community colleges to partner in a STEM engagement effort; creating a West Virginia STEM assets map to document STEM pathways available to students and identify service gaps; helping students to facilitate peer support and campus clubs to help first-generation students acclimate to STEM majors; establishing an Industry Advisory Board to facilitate co-creation of clearer pathways from STEM education to STEM careers; planning to establish "institutional implementation teams" to coordinate student support for first-generation students on partner campuses; and building relationships with other state STEM collaboratives and industry including to jointly plan and coordinate STEM education efforts.

In terms of structural change, the First2 Network strove to create structural enablers to support improvements to STEM persistence. Such activities included contributing to a state legislative bill that would provide students completing one year of AmeriCorps service with one year of tuition to a state public college, supporting students who need to stop out of school to work, care for family members, and/or earn money to attend school, limit their postsecondary

absence, and afford another year. This is particularly enabling for first-generation college students, who are more likely to need to work or care for families than students who are not first generation.

One systems change sought by the First2 Network is the establishment of a fully functional, sustainable backbone organization housed at HEPC DSR. Both the mentor backbone and backbone organizations achieved considerable progress toward this goal during Year 3, with the mentor organization providing substantial coaching, counsel, assistance, and training. Cross-network communication was also viewed as improved. On the other hand, representatives of both entities reported a need for additional HEPC DSR backbone staffing to accomplish the many tasks at hand, with a particular need for a staff member to coordinate data and shared metrics responsibilities.

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 Network members in Year 3 continued to value the networking and community building afforded by their participation, followed by the ability to gain new knowledge. But for the first time in the network's three years of operation, the mean rating for valuing the applied learning and practices afforded by network involvement was above 3.0 on the 4-point scale. This suggests that what members value about the network is evolving.

1.4. Impact of the First2 Network

An important impact of the First2 Network is the development of stronger STEM social capital across West Virginia. STEM social capital includes the social connections between STEM stakeholders—relationships, reciprocities, networks—that facilitate potential access to tangible resources, such as STEM educational opportunities, scholarships, internships, research projects, jobs, and funding. Compared to the project's first and second years of operation, the First2 Network has more members, more multidirectional relationships among members, and stronger collaboration, all indicating growth in the STEM social capital of members.

Students participating in the eight 2021 summer internships demonstrated statistically significant growth between pre- and posttest on four measures. By the end of the research experience, students rated their knowledge about research, attitudes toward research, personal skills, and research skills at statistically significantly higher levels. In addition, interns rated their internship experiences favorably, with 15 of 16 items about these experiences earning mean ratings above 4.0 of the 5-point rating scale. (The lowest-rated item—*The recruitment information adequately prepared me for what to expect for this experience*—earned a mean of 3.83.) Valued most highly by interns were community building and networking opportunities that enabled them to build relationships with similar students, mentors, and STEM faculty—that is, the opportunity to build their STEM social capital.

According to focus group feedback from students who participated in the 2020 internships, student experiences tended to be very positive, even with the transition to virtual formats. Interns were pleased to have built their STEM social capital and to have engaged in real research. Most students also reported that their participation in the internship influenced their decision to major in a STEM field, bolstered their confidence in doing STEM coursework, and continued to influence their progress through their STEM major.

The Fall-to-Spring STEM persistence rate for 2020 interns about whom the evaluation team could obtain data was 78%, a rate comparable to statewide Fall-to-Fall STEM persistence rates. The evaluation team will provide an addendum to this report when data about Fall 2020-to-Fall 2021 STEM persistence are available.

Because state institutions do not consistently collect or report data about students' first-generation status, the evaluation team employs a proxy group to create a rough estimate of STEM outcomes for rural, first-generation STEM students—rural, Pell-eligible students. This is, as are all proxies, imperfect, given that not all Pell-eligible students are first-generation college students and not all first-generation students qualify for Pell grants.

According to statewide data, rural, Pell-eligible STEM freshmen in the 2016 and 2017 cohorts in WV institutions met the ACT STEM readiness benchmark at higher rates than non-rural, Pell-eligible STEM freshmen. But this pattern was reversed among rural, Pell-eligible STEM freshmen in the 2018 and 2019 cohorts, when the rates of STEM readiness among non-rural, Pell-eligible freshman surpassed them. The STEM Fall-to-Fall retention rate among rural, Pell-eligible STEM freshmen in the 2016 cohort was higher than non-rural Pell-eligible STEM freshmen. But in the 2017, 2018, and 2019 freshmen cohorts, non-rural Pell-eligible students had higher STEM retention rates. Finally, there is no consistent pattern in terms of STEM completion rates, which vary among rural and non-rural Pell-eligible students who were freshmen in the 2012 through 2015 cohorts. However, the data clearly suggest that Pell-eligibility is associated with lower STEM readiness and persistence, regardless of whether students are rural or non-rural. In addition, rural STEM students tended to have lower STEM readiness and persistence rates than non-rural STEM students, with the exception of students in the 2016 cohort. In sum, rurality and Pell-eligibility appear to be associated with lower levels of readiness to undertake college-level STEM coursework and with lower levels of persistence in STEM majors.

1.5 Emergent Challenges

Several interrelated themes from across the Year 3 evaluation indicate challenges that the First2 Network may want to examine during the next year of operation.

- **Network growth versus core activities.** The need to balance network growth and sustainability activities with the core work of the network (namely, iteratively testing and scaling change ideas to improve the early STEM persistence of rural, first-generation students) appears to be an important tension within the network. The energy and resources necessary for ongoing outreach, recruitment, and engagement for the purpose of expansion are different from those required for careful facilitation of improvement science. In the context of limited resources, it may be useful for network leaders to review and renew this balance at regular intervals.
- **Systems thinking versus improvement science.** Systems thinking directs members toward considering the large systems and contexts in which rural, first-generation students experience challenges to their STEM persistence. Thus, members reflect on and deliberate the implications of state policies and politics, the ways in which resources are distributed across the state, and how systemic forces limit the participation of underrepresented students in STEM, for example. Improvement science, on the other hand, directs its users to focus on small, repeatable practices that—while they may contribute to larger systems and contexts—are more amenable to change. This tension seems endemic to projects that seek to ameliorate the conditions associated with

entrenched and complex social issues ("wicked problems") that are at once systemic and embedded in the details of individuals' lived experience. It also risks a common project phenomenon—scope creep—whereby a project's purview expands beyond its original scope. Such a project comes to include goals, targets, activities, requirements, and/or deliverables that were not included in its initial conceptualization. These new project features jeopardize the project's ability to achieve its original goals, deliver services or products on time, manage its budget, and help its staff remain energized and focused.

- **Collaborative leadership versus decision making imperatives.** The tension between the commitment to collaborative, distributed leadership and the need to make quick decisions is one with which the Leadership Team appears to struggle. Agenda items may go unaddressed, and decisions may be delayed, because the relevant issues are complex, members have different perspectives, and there is rarely sufficient time to ensure all interested parties can communicate fully and come to consensus. This can frustrate participants, contribute to burnout and attrition, and create competition for airtime during meetings.
- **Wide recruitment versus targeted recruitment.** First2 Network members confront a challenge between recruiting as many students as the First2 Network can support with the need to prioritize the difficult-to-identify rural, first-generation students given that WV public institutions of higher education do not collect information on first-generation status in a consistent manner. As a result, the percentage of interns who are first-generation college students has declined since Year 1. On the other hand, the network elected to expand its focus to include other underrepresented student groups, and seems to have succeeded in its effort, with large percentages of women and students in racial/ethnic minority groups among its interns.
  One implication of these demographics for the First2 Network is that it increases the complexity of network efforts to improve STEM persistence; the challenges to early STEM persistence faced by various student subgroups can be quite different. For example, white first-generation students will not experience systemic racism (e.g., in the form of de facto tracking into lower-level math classes or paucity of STEM role models) or become the target of interpersonal racial prejudice. On the other hand, this also represents an opportunity for network clarity about the problems it seeks to address, sharpening analysis and activity to those challenges that may be common to student subgroups. Inadequate high school math preparation, whether due to lack of access to higher-level courses or to qualified teachers, is a risk factor hampering the success of all student subgroups served by the First2 Network. Alternatively, the network might use this opportunity to sharpen its recruitment efforts to increase the percent of first-generation students receiving support.
- **Student voice versus the "adultier adult" (non-student) world.** First2 Network members face a tension between their commitment to elevating student voice in the network and the logistical, organizational, and cultural barriers to operationalizing that commitment. Recognizing these barriers, the Student Leadership working group conducted a PDSA to test an effort to engage adult members through a pre-conference trivia game. Few adultier adults participated, so students pivoted to another change idea—an "asynchronous conversation" with Leadership Team members to ask each other questions about the network. These student led PDSAs suggest that students appreciate the opportunity to be involved meaningfully in the life of the network and seek to help the adultier adults bring their student voice commitments to fruition.

2. Recommendations

In the spirit of helping the First2 Network focus on its core purpose and avoid extraneous effort, only a few recommendations are offered here for its members to consider.

- **Re-focus effort on the First2 Network aim and core activities.** The First2 Network may want to consider re-centering attention on its primary aim—learning how to improve the early persistence of rural, first-generation STEM students in their majors. This might require the curtailing of activities that are more distally related to the network's aim, re-allocating resources to support activities that are clearly aligned with the aim, and communicating regularly with members about the aim and activities intended to achieve it. Members may also elect to review and refine the driver diagram that informs the network's improvement science cycles, ensuring that it accurately reflects new understandings of the problem of early STEM attrition and appropriately guides members' attention to drivers and change ideas that they hypothesize can improve persistence.
- **Strengthen organizational capacity and support for high-quality improvement science activity.** Given the centrality of improvement science to the First2 Network's strategy for learning about how to improve the early STEM persistence of rural, first-generation students, network leaders might consider re-allocating resources to support a staff member to "own" improvement science. The individual in such a role could provide an array of services depending on network needs—PDSA oversight and quality control, assistance with measurement, coaching and consultation, and ensuring alignment and coordination across working groups, among other activities deemed appropriate. Network leaders might consider supporting this role within the backbone organization to facilitate the sustainability of improvement science expertise after grant completion.
- **Devote more time and resources to synthesizing and reporting improvement science and research findings across the network.** In Year 4, the First2 Network should consider establishing standard procedures and timelines for synthesizing and reporting what is learned from PDSAs and research. This might include both informal and formal reports, including website blog posts, newsletter articles, research briefs, podcast episodes, and webinars. Steering Committee members reported that they value the Deep Dives during which working groups provide 15-minute briefings about their activities and learnings every quarter; network leaders may want to explore how to leverage these updates into communications with the larger network membership. The value of improvement science and research can only be realized when findings are shared widely, clearly, and in actionable language.
- **Consolidate and finalize the student tracking system.** The First2 Network made some progress during Year 3 toward establishing a system for student tracking. In Year 4, the network PIs should continue their effort to coordinate and streamline a network system for collecting, maintaining, and accessing basic and STEM persistence information about participating students. The system is currently not centralized, exists in the form of multiple data sets, is managed by different organizations, and is not easily accessed for reporting purposes. A centralized database should permit easy data entry via one platform, the ability to enter data over time as students progress, a variety of access levels so not all users can obtain sensitive personal information, and sufficient reporting functionalities to meet network needs. A consolidated system will moreover position the

network to track and support students and to report evidence of its effectiveness to funders present and future.

- **Acknowledge and celebrate strides the First2 Network has made since Year 1.** The challenges of establishing a statewide network in a largely rural EPSCoR state have been considerable, even with INCLUDES funding and the dedication of network personnel. Nonetheless, network leaders have built and nurtured a steadily growing collective impact community, taught members how to use improvement science, engaged students in a wide range of experiences and activities, and raised the awareness of state educators and policymakers about the importance of broadening STEM participation. Since March 2020, network leaders and members have made this progress during the uncertainty and stress of a worldwide pandemic. Acknowledging and celebrating these achievements seems worthwhile given the substantial energy members have devoted to helping each other learn how to ensure the success of rural, first-generation STEM students.

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[1] Appalachian Regional Commission. (n.d.). *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. (n.d.). *Quickfacts.* United States. https://www.census.gov/quickfacts/fact/table/US/PST045219

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

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

[5] Southern Regional Education Board. (2019). *West Virginia featured facts: From the SREB book on higher education*. https://www.sreb.org/sites/main/files/file-attachments/westvirginia19_finalweb.pdf?1563376170

[6] U.S. Department of Education, National Center for Education Statistics. (2020). *Number and percentage of public school students eligible for free or reduced-price lunch, by state: Selected years, 2000-01 through 2018-19.* Number and percentage of public school students eligible for free or reduced-price lunch, by state: Selected years, 2000-01 through 2018-19.

[7] Douglas, S., & Walker, A. (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

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

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

[10] U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey", 2018-19 v.1a; "State Nonfiscal Public Elementary/Secondary Education Survey", 2018-19 v.1a.

[11] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. Digest of Education Statistics (2020). https://nces.ed.gov/programs/digest/d20/tables/dt20_204.20.asp

[12] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. Digest of Education Statistics (2019.). https://nces.ed.gov/programs/digest/d19/tables/dt19_204.70.asp

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

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

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

[16] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2017, December). *Numbers and types of public elementary and secondary schools from the common core of data: School year 2015-2016.* https://nces.ed.gov/pubs2018/2018052.pdf

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

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

[19] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. (2017, December). *Numbers and types of public elementary and secondary schools from the common core of data: School year 2015-2016.* https://nces.ed.gov/pubs2018/2018052.pdf

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

[21] U.S. Department of Education, Institute for Education Sciences, National Center for Education Statistics. *State profiles*. http://nces.ed.gov/nationsreportcard/states/

[22] West Virginia Department of Education. (2020). *Zoom WV*. Charleston, WV: Author. https://zoomwv.k12.wv.us/Dashboard/dashboard/2111

[23] 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.

[24] National Center for Education Statistics, U.S. Department of Education. (2019). https://nces.ed.gov/programs/digest/d19/tables/dt19_219.85a.asp

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

[26] http://www.wvhepc.edu/institutions/

[27] https://www.wvctcs.org/colleges

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

[29] Southern Regional Education Board. (2018). *West Virginia state progress report: Looking closer*. Atlanta, GA: Author. https://www.sreb.org/sites/main/files/file-attachments/2018progress_wv.pdf

[30] West Virginia Higher Education Policy Commission. (2019). *Academic readiness report.* Charleston, WV: Author. http://www.wvhepc.edu/wp-content/uploads/2019/06/AcademicReadinessReport_2018_AMENDED_15Jan2019.pdf

[31] West Virginia Higher Education Policy Commission and West Virginia Community and Technical College System. (2018). *West Virginia higher education report card.* http://www.wvhepc.edu/wp-content/uploads/2019/01/ReportCard_FINAL_8Jan2019.pdf?

[32] ACT. (2018). The condition of college & career readiness 2018: West Virginia key findings. https://www.act.org/content/dam/act/unsecured/documents/cccr2018/West-Virginia-CCCR-2018.pdf

[33] National Science Foundation. (2018). NSF INCLUDES: Report to the nation. Alexandria, VA: Author. https://www.nsf.gov/news/special_reports/nsfincludes/pdfs/INCLUDES_report_to_the_Nation.pdf

[34] Ibid.

[35] Latham, N. (2014). a practical guide to evaluating systems change in a human services system context. Washington, DC: Center for Evaluation Innovation. https://www.evaluationinnovation.org/publication/a-practical-guide-to-evaluating-systems-change-in-a-human-services-system-context/

[36] Kania, J., Kramer, M., & Senge, P. (2018). The water of systems change. Boston, Massachusetts: FSG.

[37] Latham, N. (2014). A practical guide to evaluating systems change in a human services system context. Washington, DC: Center for Evaluation Innovation.

[38] Wenger, E., Trayner, B., and 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. http://www.knowledge-architecture.com/downloads/Wenger_Trayner_DeLaat_Value_creation.pdf

[39] City of Palo Alto, Project Safety Net. (2011. *Project Safety Net: Levels of collaboration scale.* http://www.psnpaloalto.com/wp/wp-content/uploads/2011/04/PSN_Levels-of-Collaboration-Scale_survey.pdf

[40] The student research internship survey contained 27 items that were rated on a five-point scale of *Strongly Disagree* (1) to *Strongly Agree* (5). These items were grouped into five subscales of Career, Efficacy, Belonging, Identity, and STEM Plan. The survey also included 37 items grouped into four scales of Knowledge About Research, Attitudes and Behaviors About Research, Personal Gains Related to Research, and Skill Gains Related to Research, all rated on a five-point scale of None (1) to A Great Deal (5). Paired sample t-tests were conducted to compare the pre and posttest responses.