



Evaluation of the First2 Network

Year 1

August 2019

Submitted to:
The West Virginia Higher Education
Policy Commission

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I. Introduction

First funded in 2016, the First2 Network is a National Science Foundation (NSF)-sponsored 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 science, technology, engineering, and mathematics (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.

As an alliance the First2 Network facilitates collaboration among community college and university STEM faculty, rural first-generation STEM undergraduates, National Laboratory STEM professionals, state department of education staff, informal STEM educators, industry representatives, among others, to study and address the problem of undergraduate attrition in STEM majors that occurs during the first two 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.

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

- Facilitating improvement-science 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 readiness)
- Facilitating a capacity-building working group to plan for First2 Network growth and long-term sustainability and other ad hoc working groups to address specific issues (e.g., governance, marketing, student leadership)
- Integrating students into First2 Network leadership and into developing and testing change strategies

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

- Conducting early STEM experiences for rural, first-generation STEM students via summer research internships
- Operating a support network for students
- Providing instruction in STEM skills development through a discovery-based seminar on the principles of research and development for first-year 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

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, Fairmont State University, West Virginia University, High Rocks Educational Corporation [High Rocks], and the West Virginia Higher Education Policy Commission [HEPC]), 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.¹ HEPC serves as the First2 Network backbone organization. Because HEPC has not previously undertaken such a role, however, SRI is subcontracted to Fairmont State University to provide capacity-building and mentorship support to HEPC.

ICF serves as the external evaluator for the First2 Network. This report summarizes evaluation findings, conclusions, and recommendations from project launch in September 2018 through July, 2019. To understand the various levels at which the network functions, findings in the next section are organized by four analytic levels: 1) context, 2) project activities and processes, 3) the systems the project seeks to change, and 4) impact. Details about the evaluation design and methods are included in Appendix A.

II. Findings

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).

1.1 Socioeconomic, Historical, and Political 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 15 of the state's 55 counties are considered *distressed*, with high unemployment, low per-capita income, and high poverty rates; 15 are *at risk* of economic distress; and 24 are *transitioning* between strong and weak economies.² Average per-capita income in 2017 was \$24,774, below the national average of \$31,177, with 19.1% of the state population falling below the federal poverty line.³ At the same time, while 85.9% of West Virginia residents 25 years of age and older are high school graduates,⁴ in 2016, 74% of adults did not have a post-secondary credential.⁵ Almost half (46.1%) of public school students qualify 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 93.6% white population,⁹ only 3.6% of the population is black, and 1.6% is Hispanic (and the overall population in the state has decreased by 2.5% from 2010 to 2018). Of its 277,452 K-12 public school students, 94.7% are white, 4.3% black, 0.4% Hispanic, 1% are English-language learners (ELLs); and 16.3% are students with disabilities.¹⁰

More than half (51.3%) of the state population lives in rural areas,¹¹ and 42.4% of West Virginia students attend public K-12 schools in rural places,¹² with more than half (51.2%) of the state's schools located in rural communities.¹³ Only roughly one quarter (21.6%) of West Virginia students attend schools in towns.¹⁴ 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.¹⁵

1.2 Educational 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. Reading performance for grade 11 remained relatively stable, 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, fewer than a third of 8th graders, and about half of 11th graders are proficient or higher in math.¹⁶ West Virginia National

Assessment of Educational Progress (NAEP) results from 2009 to 2017 reveal a slight increase in grade 4 reading and grade 8 math performance over time; however, in 2017 more than two-thirds of 4th graders scored below proficiency in reading, and three quarters of 8th graders did so in math. 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.¹⁷

The state shows some growth in its efforts to ensure college and career readiness, however. Graduation rates have appeared to improve over time (84.5% in 2013–2014 to 89.4% in 2016–2017), while the rate of white and black high school students not graduating on time decreased over time (15% and 21%, respectively, in 2013–2014, and 10% and 12%, respectively, in 2015–2016).¹⁸ The average ACT scores of 2017 West Virginia high school graduates was 21.5, similar to the 2016 average of 21.6.¹⁹ Nearly three-quarters (74%) of state high school graduates achieved the ACT English Benchmark, down from 76.3% in 2016. Only 38.5% of West Virginia high school graduates scored at or above the ACT Math Benchmark, however, down from 40.2 % the prior year. A total of 43.3% of state high school graduates who enrolled in a 2-year or a 4-year postsecondary institution scored at or above the ACT Science Benchmark, a decline from 44.3% in 2016.

The 2016 high school dropout rate for West Virginia was above the national average, however (6.6% and 5.8%, respectively),²⁰ and, although the college-going rate for state public and private high school graduates increased from 54% in 2002 to 59.2% by 2010, this rate steadily decreased in 2012, 2014, and 2017 (56.5%, 54.7%, and 54.5% by year, respectively).²¹ Of these 2017 graduates, 42.5% enrolled in one of the state's public colleges or universities, 3.9% in independent colleges and universities, and 1% in degree-granting proprietary colleges or universities. These numbers generate an in-state college-going rate of 47.4%, which represents an increase over the previous year's figure (47.2%).

West Virginia's postsecondary students are served by 13 public 4-year institutions,²² 9 public community and technical colleges,²³ and 8 independent 4-year colleges.²⁴ In terms of persistence and degree completion, the state falls below national and regional averages. In the 16-state Southern Regional Education Board (SREB) region, the 1-year persistence rate for the 2015 cohort of full-time, first-time bachelor's degree-seeking freshmen at public 4-year institutions was 85%.²⁵ 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 reports a 31.2% on-time graduation rate for first-time freshmen pursuing bachelor's degrees, compared to 40.6% nationally.²⁶ In West Virginia, low-income students, many of whom are also first-generation college students, graduate at a rate of just 22.4%.

1.3 STEM Educational Context

West Virginia high school students indicate higher levels of interest in STEM than nationally, according to a 2016 report by ACT—58% versus 48%.²⁷ Among those ACT-takers indicating interest in pursuing STEM studies, however, only 37% achieved the Mathematics Benchmark and 37% the Science Benchmark. Even more concerning, only 16% 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).

Policy-makers, education leaders, and advocates have taken up the call to improve STEM education across the state. The West Virginia Department of Education, for instance, is planning a comprehensive statewide approach to improving STEM education, and advocacy organizations such as WV Forward and the Education Alliance are implementing 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 the Green Bank Observatory.

On the other hand, West Virginia has not been involved in collective impact STEM education and equity networks, such as STEM Ecosystems or GlobalMindED. In fact, West Virginia is designated as eligible for the Established Program to Stimulate Competitive Research (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.

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.²⁸ 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.²⁹ 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.³⁰ 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

The First2 Network seeks to identify and test practices that improve the persistence of rural, first-generation STEM college students in their programs of study. To accomplish this overarching aim, the First2 Network facilitates several structures (a leadership team, steering committee, backbone institution, and working groups) and activities (e.g., improvement science processes). The First2 Network's governance plan articulates the role of these structures and processes along with the role of the grant PIs in overseeing operations, such as reporting and budget management.

This section discusses results from evaluation surveys administered, interviews conducted, and documents reviewed during 2018 and 2019 (refer to Appendix A for more information about evaluation methods and analytic techniques). Findings are organized by broad themes—network structures, development, implementation, and sustainability.

2.1 Structures

2.1.1 Roles and Responsibilities

Much of the work accomplished during the First2 Network's first year focused on establishing governance systems, building backbone capacity, and developing resources for student involvement. The core organizational structure consisted of a steering committee, a leadership team, and working groups to carry out this effort. In addition, as noted in the introduction to this report, SRI provided training and support to HEPC staff to build internal capacity and position HEPC to assume full responsibility as the Network's backbone organization. Following is a brief overview of key structures, according to project documents:

- **Leadership Team.** Composed of PIs and selected chairs, the leadership team provides oversight and holds final decision-making authority related to all network efforts.
- **Steering Committee.** Committee members are responsible for the governance of systematic processes and procedures related to the First2 Network efforts. To execute the action items related to the network, this group, composed of the PIs and working group chairs, undertake a collaborative approach to decision-making, meaning that committee members agree to include collaborating individuals and organizations in developing standardized processes, purchases, and procedures by which network activities are organized, communicated, and conducted across the project.
- **Working Groups.** A critical component of the project structure has been the development of working groups and the application of learning practices. For each of the three types of working groups developed—improvement science (e.g., immersive experiences, faculty and student engagement, and college readiness), capacity building, and backbone—creating and testing strategies to extend opportunities to institutions, students, businesses, and community groups throughout the state is the priority.
- **Informal Working Groups.** In addition to the official working groups, the network committee members organized some informal working groups as well. These groups consist of members with specific expertise or interest to advance the efforts in that area. Some of the groups include marketing and branding, conference planning, governance, and measurement.

2.1.2 Project Management

According to First2 Network leaders interviewed, while by-laws address the role of the steering committee in coordinating efforts and providing oversight, many steering committee members have concerns regarding the relative lack of consistent project management. One member noted that more project management would be beneficial and would address “at a broad level, a bunch of the things that I feel worried about.” Another member shared, “I think project management is something that we generally would benefit from doing more of.” Other members reported the same challenge but considered the positive impact that overcoming these challenges should produce. For example, as one member phrased it, “...having that variety of

viewpoints, I think, while it makes the initial management a little bit rocky, will hopefully help us achieve something that works across institutions and experience.”

2.1.3 Leadership Role Clarity

Across multiple data collection activities, First2 Network members suggested that the project would be improved by clearer delineation of member roles. For instance, early in the project, one member suggested that a leadership team was necessary to support the decision-making and direction of the network implementation. As s/he explained, “The formation of a leadership committee that directs the project will help.” [A leadership team was established in March 2019.] Another stated, “I think maybe the leadership team should run the project, and steering committee is a group of trusted advisors...” Still another member noted that perhaps more explicit guidance should have been provided for working group co-chairs in terms of their roles and responsibilities. This individual reflected that in leadership team meetings, at times neither co-chair is present when “really critical decisions are supposed to be made.” Other members also reported a need for more clarity in terms of leadership roles and responsibilities, as well as for structures and processes for moving forward in carrying out those roles.

2.1.4 Shared Measures

Members seemed unsure how to measure the First2 Network’s various goals. One member described a specific meeting that was “illuminating” during which milestones were discussed, the first time this particular member understood First2 Network commitments in terms of milestones. Other members noted the First2 Network is beginning to make progress in building the statewide network, but that it was too soon to see progress in improving students’ STEM persistence. Others were unsure of what types of goals would be determined for the working groups and how such goals would be measured.

Several members expressed urgency about the need to identify shared metrics for the First2 Network. One such individual suggested that measurement was “perhaps lagging a little bit” but noted a measurement working group was being formed. Another admitted to being “concerned” that members developed measurement questions for the summer immersion experiences prior to considering what type of change was sought, “so I worry that we aren’t going to be able to find out what we want to find out.” According to this individual, the measurement piece “is a huge hole in ownership of management.” Other members reported confusion around the development of shared measures and research; for example, whose responsibility is it to oversee the capture and tracking of baseline data and institutional review boards (IRBs)? Another member voiced concern that if common data were not collected about students currently in their first semester, the opportunity to collect such information might be lost. Yet another person noted this was a challenge because of the need “to hit the ground running.”

Finally, other members focused measurement comments more broadly, asking how to ensure that there are common metrics (shared or similar measures) across the various collective impact efforts, “So that when we talk about moving the needle, we could have things that everybody understood that we could be looking at.” Specifically, members expressed frustration with the identification and use of shared metrics because it was unclear whose responsibility it is to develop common measures and track indicators. For some members, shared metrics should

be the purview of the backbone organization; others opined that a research-based institution might be a better fit.

2.1.5 Networked Improvement Community (NIC) Support

Members raised concerns that the proposal promised NIC expertise on staff to support improvement science methods, but that consistent expertise and support have yet to materialize. One member reported that only a few members are actively working in groups to advance the goals of the network, and there is a need to develop "more buy-in from more people and institutions" to expand the existing resources. Members agree with the importance of an NIC model to fostering a culture of continuous improvement to improve the quality of programming, but most are still unclear about how implementation will occur. One working group member noted that there was "lack of clear process to achieve goals." Specifically, most members still struggle with understanding the framework and supporting its use within the working groups. As one interview put it, "I mean, I think the intention is that those working group chairs have a lot of responsibility, and I think there's constantly the kind of ongoing battle from leadership about how much responsibility is too much responsibility because they're really not very well resourced."

SRI has supported HEPC through trainings on both backbone organization roles and responsibilities and on improvement science. However, several network participants expressed concern that it was unclear who

in the network was responsible for ensuring that working group members had access to improvement science training, coaching, or other supports. As one First2 Network member put

it, "I don't feel like I'm empowered with that role in the project, so I am worried." While working group co-chairs are responsible for coordinating their group's PDSA efforts, instructional supports and practices in this area have been limited. One member stated, "I still struggle a little bit with the NIC...That's very new to me and just wrapping my head around all of that [is challenging]."

“And so there’s a deep need for the work to be connected, and I think that there’s a lot of excitement around putting students at the center of the work.” –Network member

2.1.6 Shared Vision

Members were generally in agreement on the shared vision of the First2 Network. One person indicated that "to an incredibly high degree, this network has a shared vision and common agenda for the work." According to this individual, while there is a common understanding of the problems facing first-generation students, people [members] have not been "making a lot of progress on their own." Another member voiced a similar perception, noting "I think when we're in the same room and we're together in person we have the same vision and a common agenda." But when in separate meetings and separate groups, "we start to go in some different directions." Another member concurred, noting that while everyone "gets the big picture," as people get deeper in the First2 Network goals, there is less agreement. Another member shared a similar sentiment, saying "I feel a little lost sometimes as to what we're currently working on. I understand the larger goals but don't completely understand how we're getting there." Or, similarly, that each working group is defining their own "goals and vision," and each group has

its “own piece of the puzzle” [referring to the driver diagram]. The national convenings were an effective means to communicate the First2 Network goals, however, and overall, leadership reported that membership understands and agrees with the shared aims and role of the First2 Network.

While some progress has been made across the network to operationalize those shared aims into working group objectives, some members do not believe there is shared understanding and agreement in the process. One member stated, “I think to an incredibly high degree, this network has a shared vision and common agenda for the work – for the outputs of the work that needs to get done, and I don't think we have had a shared vision of the methodology of that work.”

2.2 Development

2.2.1 Backbone Capacity

According to network members, there is a common understanding regarding the role of SRI as the provider of backbone capacity mentorship and improvement science content. However, several members expressed concern that insufficient information is available about the specifics of the backbone mentor role. One member noted the relationship between the backbone organization (HEPC) and backbone mentor (SRI) “was extremely different than what is actually happening, and that’s bad because we have not been able to see the details of what the mentor backbone is actually contracted to do.” Another commented that perhaps since HEPC staff had not been involved in the DDLP, they may be “having trouble finding their voice in order to lead.” Some members focused on the need to further clarify First2 Network backbone responsibilities between HEPC and SRI. One referenced the materials that had been shared to date by SRI and suggested “I think that’s just going to take time to cultivate and develop and learn from them as well as perhaps from other additional outside resources.”

Another identified challenge was getting the First2 Network underway at the same time that the infrastructure was being created to support it. Regarding the timing of the presentation about details of a backbone organization from SRI last fall, several members felt the focus to define a backbone early on did not resonate. Members of the HEPC team shared that much of their current effort has been participating in and establishing working groups, both formal and informal. One member explained, “I feel like I have my hands in so many things that aren't necessary... like, maybe functions that a backbone would do, but at this point I think we're working to try to establish things. So maybe we're not taking on those traditional roles that we're expected to, but at least as we progress.” It is still unclear how, if at all, members' role in the working groups will support the role as a backbone. One member said, “I don't necessarily see us functioning in a true backbone role, as I understand what a backbone is, right now.”

Varying levels of understanding seemed evident among individuals during the first year, such as on developing the backbone. For example, one new member perceived that it's sometimes hard for pilot members “to understand what people who weren't part of the pilot do or do not know . . . I think sometimes there is the assumption that we all know a little more than we do.” In the previous year and grant, the student program was developed as a pilot and according to HEPC members, it still seems led by the pilot team.

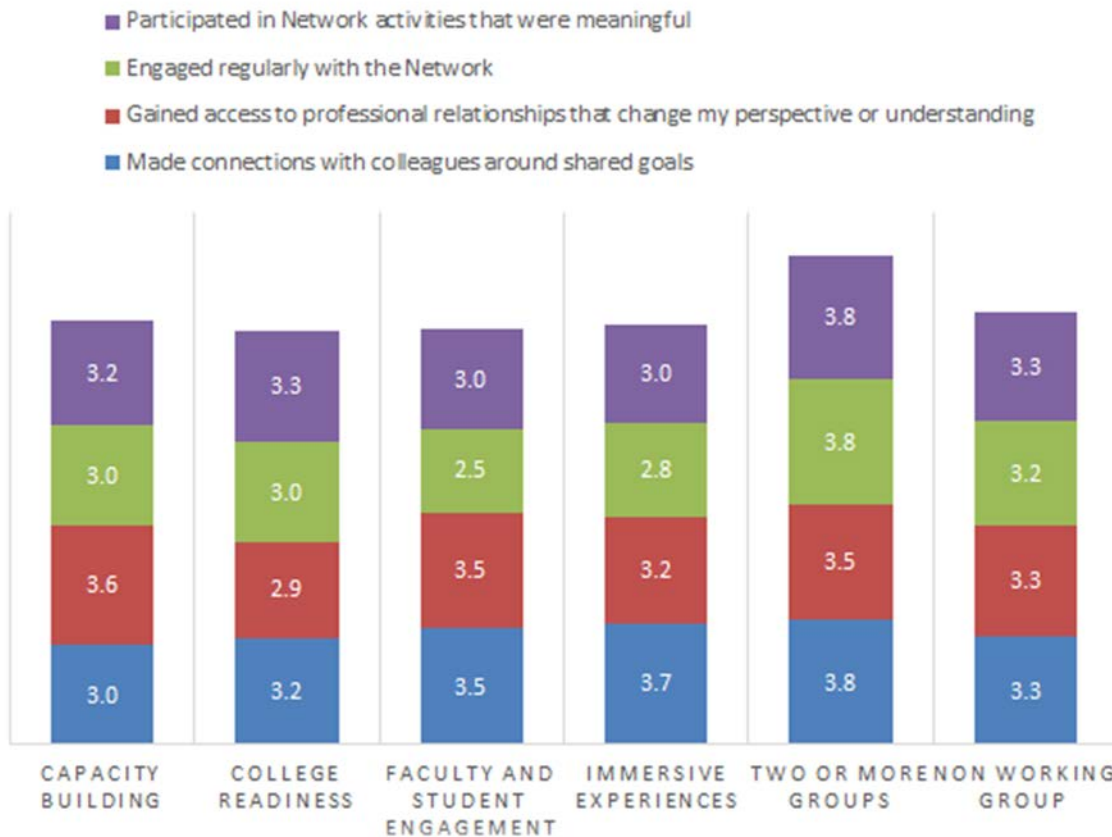
Conversely, for those who served on the pilot, there is the issue of repetition; for example, one member noted “I personally feel really exhausted with the basics of NIC . . . that’s maybe the result of me being in the pilot project . . . [but] how many years are we going to say ‘let’s step back and look at the fishbone [diagram] again?’ I understand new members need that, though.” Another expressed a similar sentiment, noting that newer members might not yet have the “whole vision” that initial members have, so “it’s an ongoing effort to onboard new members.” Others expressed some doubt that everyone currently signed up on the First2 Network portal as a member could actually “articulate the shared vision.”

“The NIC process in general is meant to empower people to do the work that they feel is important and they feel like they can do,” but the catch is that “it’s just hard to explain that to any new member, because they [ask] ‘What do I do?’ and I’m like, ‘It’s up to you.’” –Network member

2.2.2 Improvement Science Working Groups

An expectation for the working groups is to develop ideas that are tested across the network, run by working group members and supported by industry and institutional partners. In Year 1, working groups focused on establishing operations, recruiting membership, involving students, and fostering collaboration. Members did not believe change activity was occurring but are hopeful that it will soon. Several members focused on how the First2 Network has increased to several hundred members who are now talking about what changes they want to make, and that the “next round of communication can be around actually making those changes and then people see themselves as integral members of the Network who are creating these changes and not just implementing somebody else’s thing.” Several members noted that expansion of the First2 Network so quickly during the first year was one of its biggest achievements— “Bringing so many people together who have similar interests and really want to do things to benefit the state and first-generation students and persistence of STEM students.”

Exhibit 1. Networking and Community-Building Activity Items by Working Group

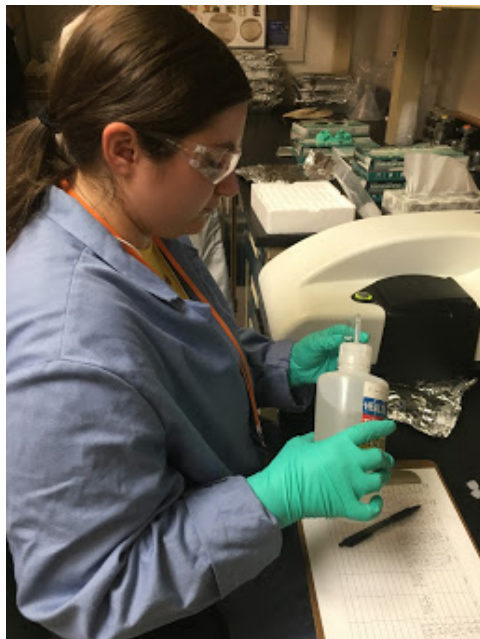


Operations. HEPC and leadership interviewees pointed to the establishment and subsequent operation of the working groups as one of the main goals or outcomes achieved to date. For example, as one respondent commented, "Work is actually being done within those groups," and another noted the working groups have "finally reached their critical mass for being able to operate." Another network member noted, "they've brought in a lot more organizations, so that seems impressive. And they've added some more Internships and more students involved and that's what the whole goal is." Nearly all member respondents said they participated in a networking event this past year and indicated they serve as a member of at least one working group. Most working groups now hold weekly meetings of at least 60 minutes in length with their group of active members via Zoom. Exhibit 1 presents data from the network value survey; bar values depict the average scores for survey items (on a 4-point scale). As shown in this exhibit, most members also agreed that they made connections with colleagues around shared goals (range between 3.0 and 3.8 out of 4), and aside from multi-group members, immersive experience and faculty and student engagement groups are more likely to indicate agreement on making connections with colleagues (3.7 and 3.5 out of 4) and conversely the least likely to agree in the value of regular engagement with the First2 Network (2.8 and 2.5).

Member Involvement. One interviewee described how "the working groups overlap a lot," making it difficult to determine which group is working on which tasks to reach the network's goal. This individual added that tasks "bleed from one team in to the other, I can't tell them

apart. It can't be compartmentalized to one team. So, it's a little bit confusing . . . it's confusing who's going to do what, and when." To address this challenge, one member expressed the need to delineate roles and responsibilities across and within groups to build more active and effective participation. As this member phrased it, "to divide tasks and announce subsets of working groups might be a better approach. I recommend more frequent meetings with specialized tasks to be completed prior to the meetings to allow for most efficient use of the meeting as a review and feedback." The same member also shared that while "there are many participants, the attendance is not as high as expected. It would be recommended to reach out to non-active members and reflect back on the level of involvement they hope to provide to the network."

Several members also expressed a concern about the small number of active participants. One member shared, "We also need more buy-in from more people and institutions. Maybe it's just the summer, but we only have a small core group who is active." Another member stated that "low attendance at meetings [is] due to so many commitments." Other members raised the fact that they were overcommitted with project responsibilities as a challenge where additional support was needed. For example, one person mentioned finding enough time to attend the various meetings and to prepare requested reports as a particular challenge. Another commented that "I am in way too many working groups, some of which I don't know how I was booked into." According to another member, "Yes, the time commitment has been somewhat more than I had expected, so it's kind of hard to try to find time to fit everything in. I should have guessed." For some members, then, it appears the time commitment of serving on both working groups and acting on the steering committee causes some network fatigue. As one member noted, over the last several months we've been calling everything a working group even though they're not formal working groups, and I was having for a while there nine meetings a week for the First2 Network."



**Fairmont State University, 2019
Summer Internship**

Members expressed the need for increased organizational resources and buy-in, training, and understanding on how to effectively act in their working group role within the network. One member said, "I guess that's a form of leadership training, just understanding what is the expectation of you." One committee member shared that the leads need to understand their roles as addressed in the governance document, but "that level of detail has not been provided." While working groups are now actively meeting and continue to grow their members, complications of scheduling and time and resource management can still act as barriers to project development by the working groups. Members reported that more focused time during meetings about roles and resources should assist in clarifying some of the shared aims and member responsibilities related to the project. One member stated, "We don't have clear decision-making policies or assigned roles. It hasn't been a problem so far, but it could be later."

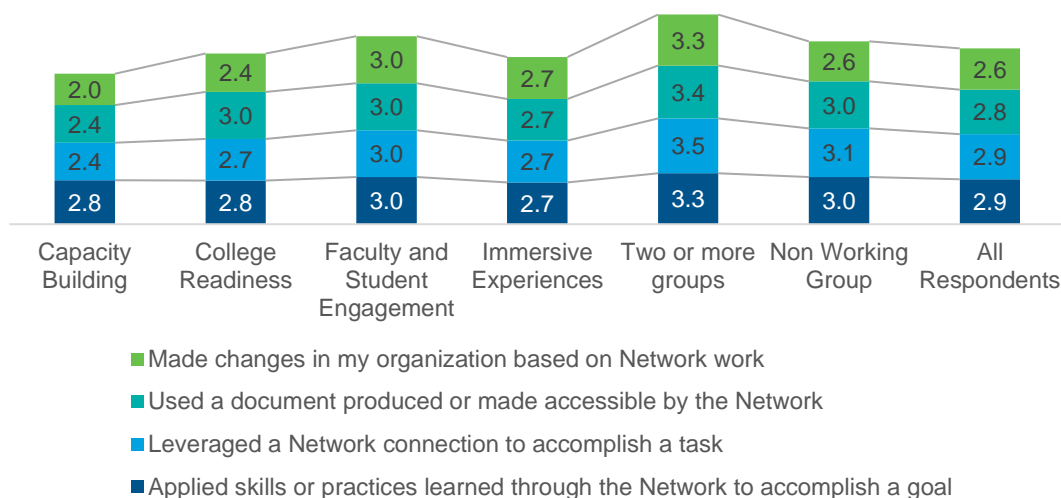
Members in general were pleased with the progress made in establishing the working groups and seeing them get underway. In general, members believe that the summer immersion experiences working group made the most headway, in part because it had a more solid goal or focus, whereas the other working groups were more “open-ended” with a less clear vision, at least at start-up. In fact, several members identified the summer internships as the First2 Network’s biggest achievement to date. According to one member, filling all the internship slots was “an amazing achievement . . . I think it’s the most important thing that we’re doing.” The immersive experiences working group also indicated its greatest strength is including student perspectives. One member stated, “We always make sure voices are heard. Nothing is written in a policy strictly as an immersive experience activity.”

2.2.3 Capacity-Building Working Group

The First2 Network prioritizes the inclusion and capture of new membership and partner groups—both industry and technology—in the capacity-building working group. Much of the mission and work has been identifying structural elements to make information across the network more accessible to increase active membership and expand student and industry partnerships.

Operations. Several capacity-building working group meetings have occurred as weekly sessions, and an in-person meeting is scheduled for August 2019. Since its first documented meeting on March 2019, the number of active members, as determined by meeting minutes, has noticeably increased and student involvement has grown as well. In the quarterly assessment, working group members were asked about their inclusion of rural, first-generation students as a strength or a weakness. Capacity members reported mixed beliefs about the inclusion of students in the group’s work. A few members reported limited awareness of the student involvement in this working group. Additionally, capacity-building members reported slightly higher disagreement levels when compared to counterparts (as identified in the value survey) about the application of practices learned through the First2 Network to their practice and what it enabled that might not have happened otherwise.

Exhibit 2. Applied Learning Practice Items by Working Group



The capacity-building working group meets weekly with a clear focus on the First2 Network portal use, outreach to industry partners, and student database development. As shown in Exhibit 2, however, the capacity-building group respondents were the least likely to agree with the statements about ways their participation in the group is applied (e.g., accomplished a task, used a document, or made changes to their organization) based on their group work. Members suggested that the in-person meeting, scheduled in August, will work as a catalyst for accomplishing some of their goals. One member said, “This working group is planning a face-to-face event in August that will support its work.”

Quarterly assessments also showed similar results about meetings scheduled. For example, members responded that meeting regularly was neither a clear strength nor weakness (~3.0 out of 5.0), so perhaps reliance on the scheduled weekly meetings to connect with group members has not been fully developed. Members suggested that working groups may need to bring active members together at key points in programming, such as when developing ideas, making decisions, or launching products, to get increased member feedback. One member described the challenge of attending scheduled meetings: “It is strictly a timing issue. The meeting in May where I learned the most about the Network started the conversations. Since May 2019, there have been a few online meetings, but [I have had] other commitments. I am hoping that things will change in July.”

2.2.4 Methods of Communication

Member respondents also expressed different views about progress towards consistent methods of communication. A majority of working group members said, and chairs confirmed, that there are regularly scheduled meeting times to discuss group planning and questions about next-step action items related to group topics. These various methods of communication within the First2 Network (e.g., phone conferences, online and in-person meetings, Zoom, GoogleDrive, and the First2 Network portal) are still in-progress. In the absence of an official “communications plan,” these methods of communication appear to have been a double-edged sword for some members—as one member aptly described, network communications are “a little great and not great.” There was consensus among network member and collaborative change interviewees that at times there is “too much communication” and “sometimes we over communicate to the point where it’s like I’m just being inundated with emails.” While committee members agreed they are working hard “to develop communication practices that will include everyone,” there was also recognition that members were not always receiving pertinent messages. For example, “There are times when I’m really out of the loop on something . . . and I’ll think, ‘why wasn’t I part of this?’ Or I’ll see that someone else wasn’t part of something who really needed to be in a conversation.” Adding to this conundrum is the varying levels of quality communication skills and practices among members, as well as the sheer magnitude in trying to incorporate feedback from everyone in a collaborative network environment.

Scheduling Meetings. In addition to the larger planning challenges, members’ efforts to meet have been only partially successful, in some ways because of conflicting schedules. One member stated, “The Working Group is still working on how to establish and maintain meeting times so that a majority of Working Group members can attend.” While content and structure may influence attendance, network members expressed a sentiment of confusion and imbalance around who is attending and able to attend the scheduled meetings. In describing an

incident highlighting the difficulty in trying to schedule meetings when all participants were available, one member lamented, “That has been a nightmare, it’s incredibly difficult, somebody is always in class.” Another individual noted the inherent difficulties in having large groups participate by phone (e.g., lag time with muted phones, speak-overs, dominant voices), adding that current practices of asking each person in a round-robin fashion for comments is helpful, “yet takes extra time.” Yet another person recognized that having a “communication feed” that is not working well is “making life a little complicated,” especially given that over the summer people are in and out on vacations. Another person mentioned that members may be getting fragmented “bits and pieces” of information. Similarly, one member suggested that “some people still feel a little lost as to where they fit in.”

Streamline Communication. Several interviewees offered potential solutions or strategies for improving communication flow. For example, one suggestion is to send out a weekly “all points broadcast” for general informational messaging, instead of individual emails throughout the week. Another member similarly described, “I think we need a set of announcements coming out to keep people feeling more connected to the cool things happening, and so that needs attention from someplace.” Another suggested that network leadership “figure out who needs to get what information so that we’re not overloading people.” Yet another member suggested a need for alleviating the perceived pressure (“poking”) to respond to email requests. This individual described receiving email messages with language such as, “We need this from you right now . . . have heard from everybody but you,” which the recipient viewed as “stress inducing.” According to this member, some email etiquette rules are needed to reduce such pressure, as well as to help differentiate the importance of each message (i.e., general informational messages versus those with urgent requests). Event participants also requested clear, timely communication updates on network progress, as well as updates on and reminders about working groups.

First2 Network Portal (HubZero). For some, the First2 Network portal serves as a repository for finding and storing materials; other members expressed difficulty in navigating the website, or found that the earlier vision of the website was “inaccurate or unrealistic.” One member confirmed that with the switch to the First2 Network portal, they were no longer receiving some meeting notifications; another person indicated that finding posted meeting announcements on the website is difficult, causing the person to sometimes overlook meetings. One member suggested that the HubZero site could be used to post updates about what each working group was working on, to help keep the full network informed of progress. Similarly, another member noted the First2 Network’s original intent to send out a newsletter with updates every two or three weeks, but wasn’t sure if that task had been clearly articulated to anyone. One member suggested that someone should be responsible for developing the project highlights, at least monthly, to keep the network members connected.

The ad hoc working group dedicated to the First2 Network portal continues to develop the infrastructure necessary that would allow members to more actively communicate through the First2 Network portal and “for all [to] get messages from that site.” One member noted that the First2 Network portal website was one mechanism for expanding network reach and also noted that an article about the network was published in the HEPC magazine, the *Neuron*. The development of the First2 Network website has provided some consistent channels for working

groups to track and communicate relevant information. HEPC efforts to customize the website for specific needs of the First2 Network are still underway. One member states, “I am learning a lot about the HubZero resource and find it very useful in communicating about our network activities.” Web development began with one partially resourced staff person and has expanded to include several working group members, including a student intern. One member described, “There are dedicated participants who support this work and provide the knowledge for this work. In addition, utilizing technology as a means for communication has been effective as well as setting up an agenda for each meeting by the group leaders.”

2.3 Implementation

2.3.1 Student Voice

The importance of involving students—as leaders, co-developers, and sources of insight—and making sure their voices are heard and infused into the network, beyond their participation in immersive research experiences, was evident in feedback from both the December and May conferences. Participants at the December event noted that the meeting offered an opportunity to better understand students' perspectives. Several interviewees specifically noted the importance of having student involvement in the network. One individual commented that First2 Network members “are doing a good job of always reminding themselves to try to keep student voices front and center and to try to get as many people’s voices involved as they can.” Another noted, “I think it’s building leadership in the students, because there is this shared network vision that students are at the center of everything and that students need to be involved.” Others suggested that the amount of student involvement was one of the features that was working well in the network. One member commented that the network does “a really good job at targeting students . . . and giving them opportunities . . . and valuing students.”

Similarly, participants at the May event identified hearing from students as a high point of the conference. One respondent noted, “Listening to the feedback and world views of the students involved were by a large margin the high point of the workshop.” Another said a highlight was “Hearing from students, and watching how change ideas are generated from student ideas.” Another person also voiced the opinion that having students involved in the decision-making process “is actually great professional development for becoming a leader.” All members described student voice as a priority in their programs, across working groups, and within the network, although there was at least one member viewpoint that differed about the strength of the students' voice in the process so far. As this one member put it, “The fact that there wasn't as much networking opportunity there for me, in my position, really spoke volumes to me and I was proud to be able to make the deafening silence created by the lack of student involvement roar in everyone else's ears just like it roared in mine. Typically my philosophy is that every second I spend with students should be the most important seconds of my job, but for those couple of days I felt like I (along with all of my wonderful colleagues) was able to make their [students] absence felt in a way that I think the higher-ups at NSF INCLUDES needed to recognize.”

Some working group members also recognized the imbalance in students' voices, geographical diversity, and issues of underrepresentation and expressed their current efforts and challenges

that exist. A member stated, "We're already working on this issue but more outreach [is needed] for a more diverse group of students and trying to reach all colleges in the state."

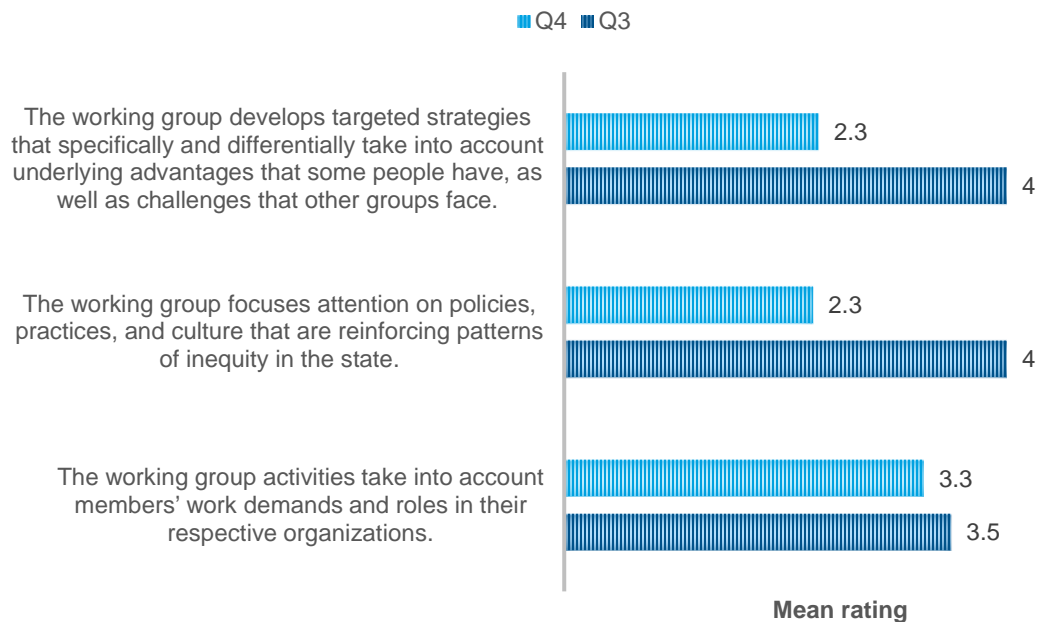
2.3.2 Diversity and Equity

Other members voiced concern over the concentration of members from specific institutions. One member noted, "Too many faculty/staff from one institution and not enough buy-in and participation from faculty at other institutions." Governance by-laws indicate that each working group should have a diversity representative, and members do not seem to believe that this practice has been fully implemented. One member stated, "I think it is a goal to do so, but I think that we do not...Diversity, we certainly need more community partners. We need more K-12 representation. We need way more workforce representation. It's pretty heavily centered in higher ed, the combination of chemistry and astronomy, which is not surprising, considering the two PIs from our launch pilot were a chemistry professor and worked in an observatory."

To better understand other strengths and weaknesses around efforts of equity, the evaluation team asked members to reflect on whether the working group focuses attention on policies, practices, and culture that are reinforcing patterns of inequity in the state. Members indicated their strengths and areas of improvement regarding the development of practice to both include and consider issues of equity. One member reported, "This is a work in progress, but the W.G. is strongly encouraging of faculty and students from many institutions throughout the state." Additionally, members were asked to rate the strength of which the working group 1) develops targeted strategies that specifically and differentially take into account underlying advantages that some people have, as well as challenges that other groups face and 2) engages in activities that take into account members' work demands and roles in their respective organizations.

As displayed in Exhibit 3, the strength of equity efforts, specifically targeted strategies and attention on policies and practices that account for inequity, has declined from Q3 to Q4. A couple of issues can impact this level of shift in response patterns. First, respondents are more aware of the goals around equity and thus, are highlighting the limitations based on that level of clarity. Second, another possibility is that because there was a smaller number of working group member respondents for this question from Q3 to Q4, the responses in the first quarter reflect a broader viewpoint (N=7 vs. N=4). Overall, members expressed the strong need to explicitly and intentionally discuss equity topics. One working group member respondent said, "We need to more openly discuss those facing adversity by bringing them to the table."

Exhibit 3. Extent to Which Working Groups Target Equity



2.3.3 Collaboration

Results from the social network survey reveal that the four working groups are beginning to show patterns of collaboration with network members from within their organizations and across organizations. These early maps also indicate collaborators who have very weak ties to others within the working group, however. (For more complete details from the social network survey, see the network alliance section of the impact findings.) The value of collaboration was also a common theme from the December and May network conferences and working group self-assessment rubric. Respondents noted as high points the opportunity to meet colleagues with a shared interest in improving outcomes for rural, first-generation STEM students and the opportunity to hear others' perspectives, ideas, and challenges.

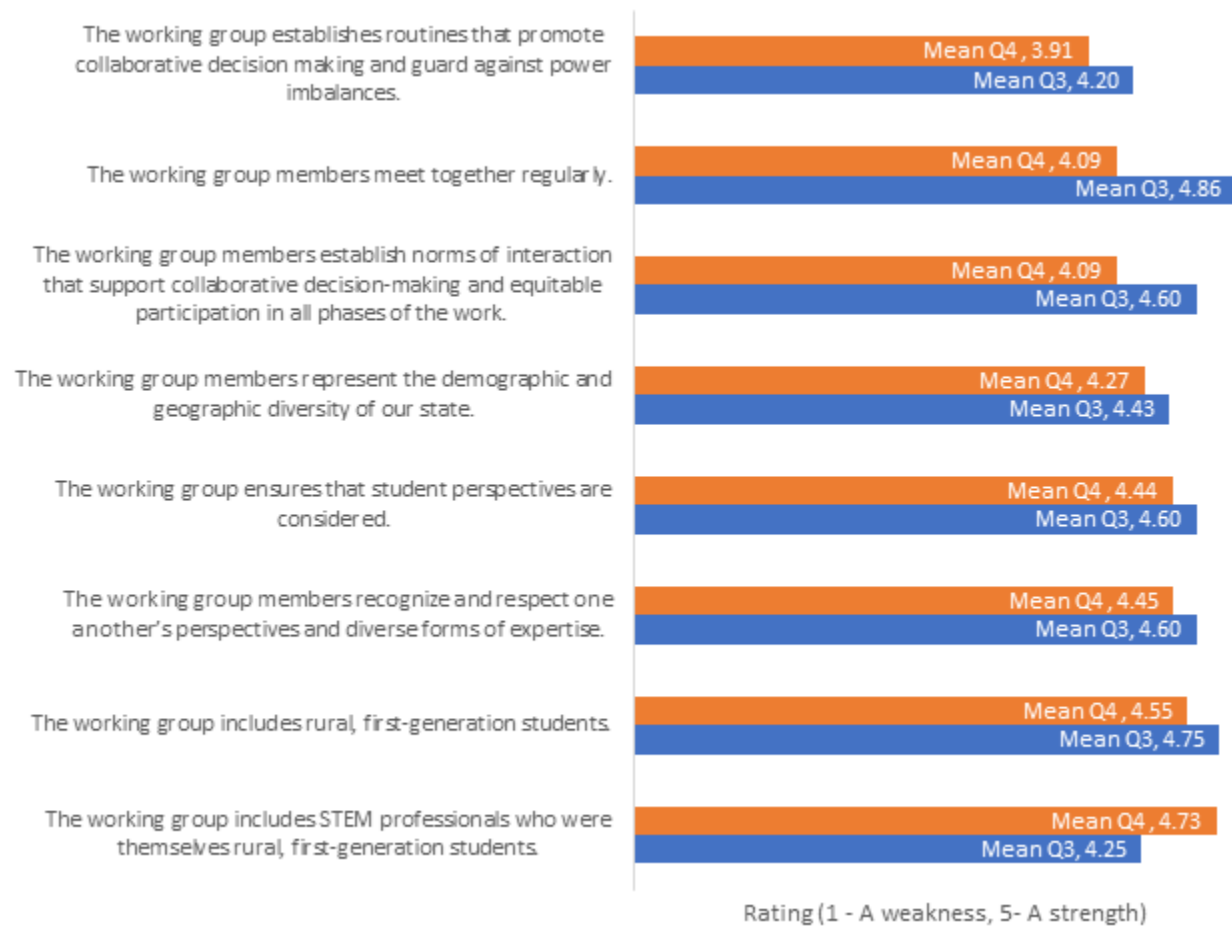
The collaborative nature of the First2 Network was identified by members as one of the network's greatest achievements to date. When describing the level of commitment of the network members, one commented, "I think that that's our biggest strength, just having those highly driven professional moments where everybody is really on the same page." They noted the rapid growth of the network, the relationship building that is occurring, the expansion of the network to include members who were not part of the pilot project, the leadership roles being filled by new members, the addition of new organizations, and the inclusion of more students as indicators of successful collaboration. Other members believe that more collaboration is still needed, given the lack of active participation across diverse entities, specifically the Health Sciences & Technology Academy (HSTA) organization. The member explains, "HSTA is a tight-knit organization which is a little hard to penetrate right now. While the HSTA group seems to be making progress on First2 objectives, I don't think the team is as involved as it could be. We have finally established a monthly teleconference time so I am hopeful that the next time this survey is conducted, there will be progress in all of these areas."

One member acknowledged worrying about the next step (after the May conference), noting at times the tendency to “overthink” and instead urges movement forward—“We spend too much time talking about how we’re going to pick up our left foot and where we’re going to place it and who’s going to be in charge of all of that. Pick it up and set it down.”

Other members noted the balancing act in trying to honor and operate within a collaborative networking environment, yet recognized the need to make decisions in a timely manner. One member cautioned, “We have to stop constantly changing the game plan in the middle of the game,” speaking about members who may provide input or feedback at the last minute, which results in subsequent changes. “It feels like people swoop in at the very last minute and change what we’re doing a lot.” Similarly, another member also noted the tension among collaboration leadership versus “top down” decision-making. While recognizing that it may be “a little bit tense at the beginning,” as people negotiate how to operate within a network improvement community, ultimately having that variety of viewpoints “will hopefully help us achieve something that works across institutions and experiences.” Exhibit 4 shows members reported this same sentiment when responding to the working group self-assessment. When they were asked about whether the working group establishes routines that promote collaborative decision-making and guard against power imbalances, members were least likely to rate it as “a strength” compared to all other topics within collaboration (range 3.91 to 4.73 out of 5).

As shown in Exhibit 4, each topic included on the working group self-assessment in the area of collaboration is more of a strength than a weakness for the network. In fact, for the collaboration statement that showed an increased rating from the first quarter to the next, it demonstrates the strength of the working group to include STEM professionals who were themselves rural, first-generation students.

Exhibit 4. Extent to Which Working Group Members Collaborate



2.3.4 PDSA Activities

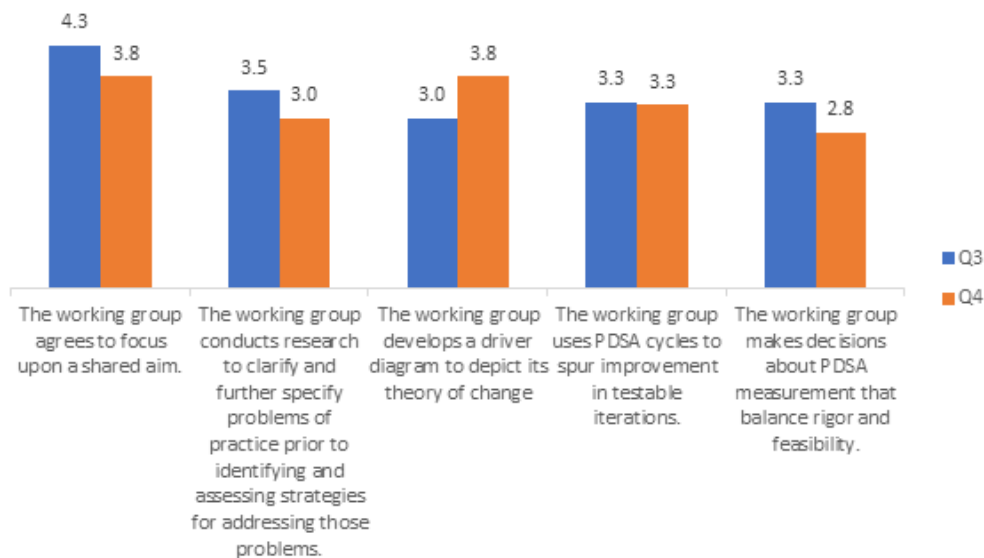
PDSA cycles are the primary means by which working groups test, measure and learn from their use of improvements to practice. While some working group members are gaining knowledge in the use of PDSA cycles, it was less likely to be applied in this first year of implementation. One leader expressed sentiments of hope through the announcement of the pilot use of [the Networked Improvement Learning and Support platform] NILS, stating it should encourage working groups to apply the improvement science framework. “I am looking forward to using the NILS for PDSA cycles. I think it will help to keep track of the PDSAs and encourage the use of the PDSA as a cross-network form of assessment for instituting and tracking changes.”

Through the quarterly working group self-assessments, respondents confirmed that the application of PDSA was still premature. Specifically, respondents commented on the extent to which they believed they could answer statements related to the PDSA improvement science cycle in their working group. This additional skip logic was helpful to streamline the survey but reduced the total number of respondents from Q3 to Q4 who responded to the actual scale items. In general, very few member respondents believed they could answer questions

regarding the plan stage of the improvement cycle, and even fewer reported the ability to answer the "do," "study," and "act" stage (4 out of 11).

From those members who responded, an overall score was calculated for each plan, do, study, and act stage, as shown in Exhibit 5. This score was operationalized as the average of participant self-ratings for the five items on the scale. The range for this variable was 0–5 points, and a score of 5 points indicated being "A strength", a score of 3 indicates its "Neither a strength nor a weakness" and a score of 1 point indicated being "A weakness".

Exhibit 5: Extent to Which Working Groups Employ Improvement Science



Very few members assessed the planning stage items on behalf of their working group, but those who did reported that such planning efforts were neither strengths nor weaknesses. In all but one case, the strength rating decreased between quarters. The only item with a slightly higher strength rating than in the previous quarter is, "the working group develops a driver diagram to depict its theory of change." Although this item shows a level of growth in understanding and use of improvement science skills, the limited number of responses reflects the early stages of use with the PDSA cycle and may not be representative of the overall membership. Other data sources reflect that "Lack of larger numbers of member attendance and involvement" is one of the greatest barriers to the use of the PDSA cycle.

2.3.5 Student Experiences

Members reported that student immersive experiences and internships were implemented successfully. The process to track and work through the appropriate improvement cycles may have been missed, however. For example, one member stated, "all the people involved in that immersive experiences group feel like they're involved in meaningful change ideas." But the member also indicated there were challenges to tracking that change process this past year.

Of the student respondents, nearly all are working group members who expressed gaining new skills in STEM content and 21st-century skills as a result of participation in network activities.

Specifically, 31% of the 42 respondents were self-reported students. Distribution of member responses across working groups was not descriptively different when compared to that of student respondents, except in one case. The highest number of student and member respondents came from the college readiness working group.

Exhibit 6: Mean Ratings of Value Survey Items by Students and Total Respondents

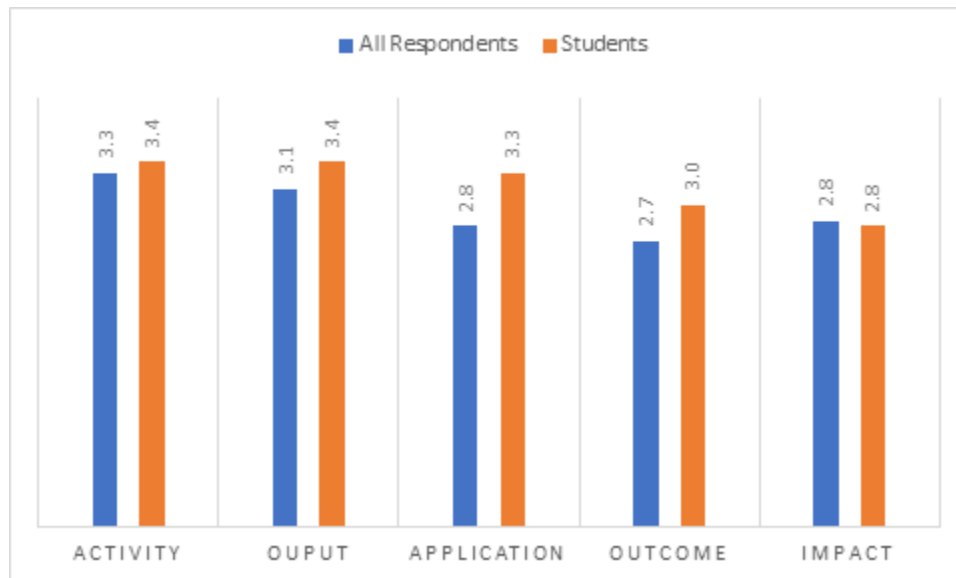


Exhibit 6 shows that students reported the strongest levels of agreement in the value of the network efforts across areas of activity, output, application, and outcome. Specifically, all students agreed or strongly agreed they 1) made connections with colleagues around shared goals (3.6 out of 4.0) and 2) gained insight about a person or group they can turn to for information (3.4 out of 4.0). Additionally, nearly all students agreed that they used a document produced or made accessible by the network (3.6 out of 4.0).

In addition, student respondents participating in the summer internship experiences reported higher levels of self-efficacy for all five areas measured on the pre/post survey (career, efficacy, belonging, STEM identity, and STEM plan). They reported valuing the opportunity to meet other people in the STEM field, make new friends, interact with the mentors, and meet their professors. This finding is also illustrated by a member's response in the value survey: "I am much more confident in speaking up for myself, especially towards those I see as superior to me (professors, advisors, etc.). I learned that if I think something is unfair, I should tell the professor because they don't always know what's best."



West Virginia State University, 2019 Summer Internship

Students involved in summer experiences learned specific content and processes necessary for use in a STEM field. One reported, "I was able to gain valuable knowledge in the field of chemistry that is actually affecting everyone." Most students noted that they were involved in network activities outside of their normal student responsibilities and found the experiences highly valuable and rewarding.

One student noted the influence of participation in the program on their career path: "I got to work with hands-on research that helped guide my career path into something that I would love to work with."

2.3.6 Expanding Professional Networks

Looking across the role of networking in new member recruitment, most members believed that First2 Network is making substantial progress in expanding professional networks, building connections, and raising awareness among institutional, student, and industry partner members about First2 Network goals

related to increasing rural, first-generation college student persistence in STEM programs of study. Members know more because the network has provided them with a new opportunity to connect and with some level of information on improvement science.

"I think that we've done a great job at having two conferences in the very first year that has brought, I think now, over 200 people to the table from diverse background, industry and different universities from across West Virginia, and giving them the opportunity to network together and to share their ideas through those kinds of collaborative events. That has been a real benefit to the alliance. In just nine months, it's been tremendous." –Network member

Convenings. The increased professional connections and new knowledge gained through networking events has translated into basic knowledge about the status of STEM outcomes for rural, first-generation students and understanding of the language and processes associated with it. Value survey respondents agreed they made connections with colleagues and students around shared goals, many of whom attended a convening (range between 3.0 and 3.8 out of 4). One member describes, "Knowing I can connect with a group of first-generation students interested in promoting STEM is a valuable resource." Another member stated, "Just having time to get to know the other interns and mentors, we really connected with each other and made strong friendships that we will cherish for years to come because of the first 2."

Event surveys also suggest that the most popular means for increasing awareness and building partnerships is through convenings. Members had positive reflections about their experience at in-person meetings. Several described the convenings as welcoming, informative, and helpful, with many leaving the meetings energized and ready to apply some of this new knowledge and connections to their institutional work with students. One member stated, "We are planning for a summer research immersion for rising freshmen. We already have summer research opportunities for rising SO, JR, and SR, but not for FR. It has allowed for expansion of what we are already doing." When asked to elaborate on a positive, meaningful networking opportunity, several described the role of making connections. One said, "We are now working to expand

programming to new areas and made the contacts that make this possible through the Network.” Another member stated, “I really appreciated being allowed/invited/encouraged to attend the NSF INCLUDES National Convening. It was so important for me to be able to see the bigger world our project is living in. It gives me a better idea for how what we're doing fits into the really, really, really big picture and I'm not sure I could have gotten that any other way.”

Looking ahead, members believe that hosting in-person convenings are necessary to develop partnerships and create a level of agreement amongst the network members to advance the network goals. One member explained, “We could use a mini conference where we get together in person again, and we're working on one.” Another member noted, “I already had a lot of connections and professional relationships, but this gives us an opportunity to have more structured face-to-face networking opportunities to move things forward.” Leadership considered the in-person convenings the primary way they connect with members and new partners to expand their own programming.

2.4 Sustainability

2.4.1 Building Leadership

In general, members recognized First2 Network efforts to build and support leadership among members. One interviewee explained how the network “definitely” supported leadership because “members are continually being asked to

“It is really heartening to me that we’re starting to connect to other networks and I think that’s the power of this, that if we can have value and then connect into another networks and propagate that value over the next five years, change has been made, again, and people have started to own ideas that are working. I think the only kind of change we should be making is things that matter and make a difference.”
–Network member

step up and chair committees or to reach out to others to be a part of the Network.” Another suggested, “we probably have an abundance of leadership” which could lead to difficulties in determining “who’s in charge” and that some leaders may “feel left out.” Another example of building leadership was having members take leadership roles by facilitating sessions at the December and May conferences.

Not everyone held such an optimistic view; one member in particular noted, “I haven’t seen a lot of grooming the next generation of leaders.” Another recognized that High Rocks has leadership training capacity focused on students but was unclear on who or what organization would have leadership training targeting partners and faculty. Another noted “I don’t think we’re there yet,” describing the struggle in balancing responsibility for working group co-chairs (i.e., turning action over to working groups but not fully equipping co-chairs to carry out their functions). One member noted, “We did a great job of building student leadership,” but “I do not yet think we have built the leadership of the general membership of the working groups. Or if we have, I haven’t seen it yet.” Others agreed, and one stated, “We have a lot of meetings...there hasn't been anything written down on, hey as a working group chair, this is what you need to do.”

2.4.2 Partnerships

In terms of First2 Network partnerships, members reported that connections and partnerships were developing and that they were meeting new potential collaborators “through the partnerships.” One commented that even though “it’s early days,” partnerships are beginning to form, both within institutions as well as with outside partners. Another recognized getting to know people from across the state and noted “it’s cool to be connected to this national effort of Alliance projects.” This member cautioned, however, that “we definitely need a few more networks throughout the state and with industry,” noting the frustration with trying to help students learn about STEM jobs but not being aware of the possibilities. “That’s where I think the industry partnerships are going to be so important.”

Others confirmed the value of the partnerships in sharing “things that worked and things that didn’t work.” One member suggested that these partnerships were developing to a level “that we wouldn’t have been talking to each other about before without the Network.” And, one member specifically noted seeing smaller universities joining the partnership that hadn’t been part of the earlier pilot. One member noted, however, that involvement of K-12 partners “is a little spotty,” as is industries to some extent. Another noted a need for more community partners and more workforce representation.

One member discussed how partnering with outside entities is expanding the network’s efforts, for example to include the STEM ecosystem, STEM connector, the Denver global-minded conference, and potential industry partners (such as Walmart and the West Virginia Science Teachers Association). One individual appreciated the numerous opportunities for students “to stand up in front of really important people and tell their story.” Another voiced the hope that as HEPC serves as the network backbone, and given its involvement with institutions across the state, that in the future “they could help encourage institutions in the state to adopt things that our PDSA” cycles are showing as “really high leverage.”

One member noted the First2 Network portal website was one mechanism for expanding network reach and also noted that an article about the network was published in the HEPC magazine, the *Neuron*. This individual suggested, however, that the network has not used social media to the same extent that other alliances have and offered that up as a way to publicize the network even more in the future.

Although only in its first year, network members believe that sustainability has been a focus from “the very beginning.” One member noted how one university and several industry partners are already subsidizing some of the network costs. Another suggested that finding ways to share cost responsibilities among partners after the NSF funds are gone “will be a challenge” but that sharing that financial load across institutions may help “maintain a collective presence.” Yet another member noted the goal is to make changes now that are “just part of the way things are done five years from now.”

2.4.3 Engagement in Meaningful Change



Members shared several examples that pointed to the beginnings of meaningful change—for example, designing a new course at one university, refining the immersive internship experiences, and recognizing the gap in hearing student voices. One member suggested an example of meaningful change was engaging members “in their own professional development and analysis around really understanding what systematic change work could look like in a network improvement community model.” Another member described how one industry partner (Chemours) was involved in a summer internship experience by bringing students into the lab, adding “that’s a change idea in itself whether or not we had captured that appropriately in the NIC methodology.” And, that “students most definitely feel like they’re involved in meaningful change, just [by] being student leaders for our Network and being part of these working groups.”

Marshall University, 2019 Summer Internship

3. Systems Targeted by the First2 Network

The First2 Network aims to improve persistence by testing and learning from improvements both at the individual and systems levels. This section discusses early findings about changes in the systems targeted by the First2 Network. Such systems include higher education, K-12 schools, and business and industry. The findings are organized by individual behavioral changes, institutional policies and practices, and the statewide system supporting the Network.

3.1 Individual Behavioral Changes

As members engage in First2 Network activities and collaborate with others, they may gain new knowledge and skills and subsequently begin changing their own practices. The network value survey solicits members’ assessments of the value of the First2 Network—to their professional networks and communities, knowledge about the issues targeted by the project, and the subsequent application of learning and practices.³¹

3.1.1 Networking

On average, respondents agreed (means of 3.24 to 3.32 on a 4-point scale) that they engaged regularly with the network, participated in meaningful network activities, made connections with colleagues around shared goals, and gained access to professional relationships that changed their perspective or understanding. Respondents agreed that, as one member put it, network activities “felt like meaningful work” and they valued meeting new colleagues, mentors, and

professors. Specific examples of connections experienced by network members include the following:

- “I really appreciated being allowed/invited/encouraged to attend the NSF INCLUDES National Convening. It was so important for me to be able to see the bigger world our project is living in. It gives me a better idea for how what we're doing fits into the really, really, really big picture and I'm not sure I could have gotten that any other way. It was also a great opportunity for me to realize how what we do as a group and what I do in my position every day really is radical and different and amazing. The fact that there wasn't as much networking opportunity there for me, in my position, really spoke volumes to me and I was proud to be able to make the deafening silence created by the lack of student involvement roar in everyone else's ears just like it roared in mine. Typically my philosophy is that every second I spend with students should be the most important seconds of my job, but for those couple of days I felt like I (along with all of my wonderful colleagues) was able to make their absence felt in a way that I think the higher-ups at NSF INCLUDES needed to recognize.”
- “The STEM Learning Ecosystems conference was a wonderful opportunity. It really helped me envision how the First2 Network could build industry partnerships and new workforce development programs. New Orleans was beautiful, and traveling together as a network help[ed] us build and deepen our relationships to each other.”
- “Conversation with a non-academic person at the last conference that led to an invitation to speak/serve on a career mentoring panel and acceptance of that invitation.”

3.1.2 Knowledge Gains

Similarly, First2 Network members agreed (means of 3.04 to 3.24) that they acquired a new skill or new knowledge; saw new opportunities; gained insight about a person or group to turn to for information or support; and gained access to new tools, information, or processes. Several respondents provided examples of specific resources they learned about through the network, including the HubZero platform and the NILS for PDSA cycles. Others described more social skills type of knowledge, such as engaging in public speaking, working as a team, and gaining self-confidence. Yet others focused on more academic learnings, such as lab safety, computer science skills, and chemistry skills.

3.1.3 Practices

Network members' ratings were some lower, though still closer to agreement than disagreement (means of 2.62 to 2.88), for the application of new practices. Respondents agreed that they applied skills or practices learned through the network to accomplish a goal, leveraged a network connection to accomplish a task, used a document produced or made accessible by the network, and made changes in their organizations based on network work. Respondents shared examples of actions they were taking as they applied network learnings to their practices, including the following anecdotes:

- “We are currently working on totally re-tooling the approach to student programming from the fall. The process of engaging with our work using the NIC framework has been really useful for me. My VERY logical brain is often not comfortable with tasks like writing a programming approach that differs significantly (it doesn't differ in spirit, but does in practice) from what I saw as my directive from the proposal. But using the framework of

iterative learning and responsive change has really helped me to be able to embrace the directive of change in order to produce programming that is even better than originally planned.”

- “We are now working to expand programming to new areas and made the contacts that make this possible through the Network.”
- “I find the idea of tuition vouchers totally fascinating. Based on the HSTA model, I am still working slowly towards developing a bill that would grant tuition vouchers to AmeriCorps volunteers.”
- “I have helped others use documents provided by the network.”
- “Working with the Governance Team, I have learned about the need for specific bylaws that need to be put in place to guide our Network. I have applied some of these to other projects that I work with.”
- “This past week I went back to Fairmont to teach a group of teachers about knowledge I learned from the internship.”

Others described how they were thinking in new ways or were currently planning to employ new practices in the future. For example:

- “I am thinking in a new way about the importance of showing relevance in my courses.”
- “Just starting out, but plan to use some of the faculty-student interaction information in the fall.”
- “We are planning for a summer research immersion for rising freshmen. We already have summer research opportunities for rising SO, JR, and SR, but not for FR. It has allowed for expansion of what we are already doing. In addition, I have become more aware of the benefits of using undergraduates to assist in many of my activities and to provide input on behalf of collegiate end users of my office's programming.”

3.2 Institutional Practice and Policy Changes

Not surprisingly, given that the project is only in its first year of implementation, First2 Network members reported fewer changes to institutional practices and policies (means of 2.41 to 3.00). Respondents somewhat agreed that observed practice/policy improvements at their organizations resulted from network efforts, that they observed data indicating their organizations’ performance improved, that they observed evidence of improvement in the key student outcomes the network is pursuing, and that they encountered evidence that the network has advanced its reputation. Nearly half of the respondents indicated it was too soon to see institutional or policy changes yet, either because of the network is too new, having had no chance yet to implement changes, or the timing of summer break precluded changes. Other respondents were able to provide specific examples of how their network participation led to success in making institutional practice or policy changes:

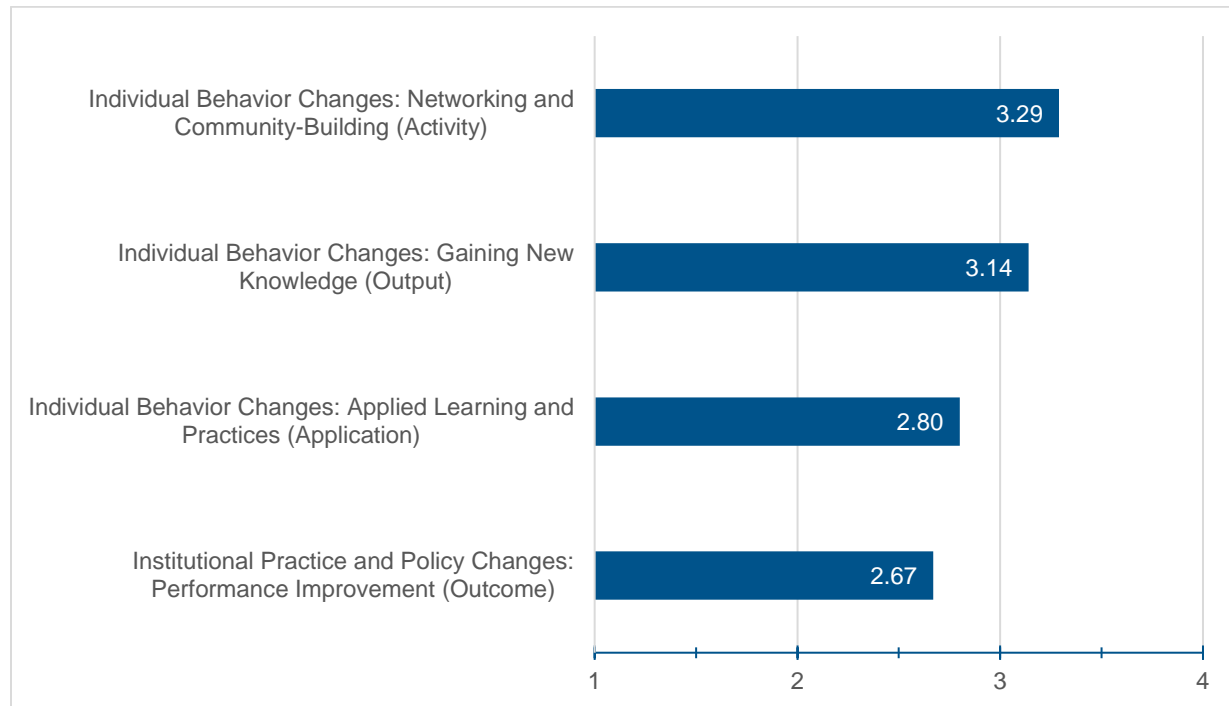
- “I think that the First2 Network has given me tons of opportunity to grow and evolve as a leader. We recently took a group of students to meet with WVDE, and although in the end we found that the content of that meeting wasn't incredibly important what IS important is that we were invited to the table. That happened because our students were

so active and engaged at the spring conference that they caught the eye of some of the higher-ups at WVDE. Their reputation as engaged and informed ‘experts in their own experiences’ is starting to precede them when they walk into the room and it’s so cool to watch that happen and watch how it transforms their leadership and confidence over time.”

- “Association with the Network has opened many doors. This in turn has allowed sharing of best practices and provided opportunities which otherwise were not known to exist thus leveraging resources and expanding the reach from regional to state-wide.”
- “It has been wonderful to partner to produce the First2 videos! What a great opportunity for young people to learn how to produce professional videos while telling the stories of the First2 Network!”
- “Personally and professionally, I have met many new people involved in STEM education and this has aided me in my current position. Some of these people are from my own institution but many are from other institutions statewide.”
- “More people are joining the network from my organization.”
- “I have successfully gotten many students and others to use the First2 site, and learn how to do things.”
- “First2 Network helped my success in college because it gave me the ability to make connections to students and teachers that I wouldn’t have been able to create without the organization.”
- “Participation in the First2 Network has enlightened me about the challenges facing West Virginia and rural areas. This has helped me to understand the challenges faced by other rural partners that I work with on other projects.”
- “Through the organization I was able to confidently present to a group of peers about the network and my accomplishments during the internship.”

In sum, it appears that network members value their interactions with other network members, and the activities in which they are engaged; are gaining new knowledge and insights; are beginning to apply those learnings; and are starting to see some individual-level successes. On the other hand, institutional-level improvements are few and more likely to emerge in the future as network activities proceed. Exhibit 7 shows the average scores for the network value survey.

Exhibit 7. Network Value Survey Ratings



In addition to the changes noted above from the network value survey feedback, the evaluation monitors systems-level institutional changes across the network (e.g., at institutions of higher education, K-12 schools, STEM businesses, and other organizations that become part of the First2 Network). At the present time, limited data exist about such changes; however, a few data points indicate that the First2 Network is laying the groundwork to yield future improvements. For example, there were four internship research opportunities held this summer, involving students from Fairmont State University, Marshall University, West Virginia State University, and West Virginia University. The Fairmont internship included as a partner The Chemours Company, a global chemical company with a branch office in Washington, WV. These internship experiences are now being studied through the network as part of PDSA improvement cycles. Another example is that even though lack of sufficient enrollment led to the class not being offered this semester, a new course was planned for West Virginia University that focused on STEM leadership.

3.3 Statewide System to Support the Network

HEPC is tasked with serving as the backbone organization supporting the First2 Network. SRI is providing mentoring support and training as needed to build HEPC's capacity to fulfill this coordination role. In a March 2019 NSF webinar showcasing the First2 Network, SRI and HEPC staff identified six key roles of a backbone, which mirror the six common activities of a backbone organization referenced in the NSF INCLUDES Request For Proposals³²:

1. Guide vision and strategy
2. Support aligned activities
3. Establish shared measurement practices

4. Cultivate community engagement and ownership
5. Advance policy
6. Mobilize resources

Currently, four staff from HEPC's Division of Science and Research have some portion of their FTE allocated to this coordination support for the network. Interviews conducted with each participating HEPC staff member revealed several themes described in the next few sections.

3.3.1 Roles and Responsibilities

All four of the HEPC staff noted they were involved with multiple working groups (capacity building and faculty-student engagement) and/or informal working groups (such as the steering committee, leadership team, governance, conference planning, and marketing and branding). Further, they recognized they were involved in tasks that were beyond their anticipated scope of work, and that they were spending more time working on network tasks than they originally budgeted. As one HEPC staff member commented, "I don't think we're really staffed to do the kind of things that we're learning we really need to do."

3.3.2 Capacity-building Activities

Not all HEPC interviewees recalled the same activities when asked to describe the types of capacity-building activities in which they had engaged with SRI. There was consensus that SRI staff had come to the Charleston HEPC office at least once to provide an orientation session on backbones. One HEPC staff member mentioned that SRI provided quarterly webinars, while another said an online session had been provided. All of the HEPC staff interviewed were in agreement that it took a while for them to "wrap their heads around" what a backbone should be, the type of support backbones should provide, what that meant for individual responsibilities, and how to carry out those responsibilities.

3.3.3 Current Hub/Backbone Status

HEPC staff also agreed that the organization was not yet serving as a backbone and fully carrying out associated responsibilities. One staff member perceived that HEPC was at least involved in each of the six key areas described earlier but noted "we're not doing everything in each of those areas." Another commented, "I don't see us acting in that role right now. . . . I have my hands in so many things that aren't necessarily . . . functions that a backbone would do."

3.3.4 Challenges

HEPC staff members identified several challenges, the most pressing of which was the remaining uncertainty about the role parameters between HEPC as the backbone and SRI as the mentor for HEPC. Staff mentioned the need to determine which organization was responsible for what, how responsibilities should shift or transition over time, and what those specific backbone responsibilities would involve. For example, one interviewee questioned whether the backbone was supposed to be in charge of knowing where the network stood in terms of meeting milestones and making progress.

HEPC staff identified the insufficient level of staff time to cover backbone responsibilities as another challenge, as well as the expanded scope of their responsibilities during the first year. One interviewee noted that network responsibilities have been “nearly a full-time job” and “that’s not sustainable.” Related to this challenge is the fact that all of these staff members are also committed to other projects, with competing deadlines for accomplishing tasks and responsibilities.

Yet another associated staffing challenge is the upcoming retirement of one of the key HEPC staff members involved and the need for a subsequent replacement. Finally, several interviewees noted that the full capacity of HEPC as an organization is not being tapped because only staff from the Division of Science and Research is currently involved.

3.3.5 Needed Modifications

To clarify the role differentiation between HEPC (as the First2 Network backbone organization) and SRI (as the mentor to HEPC), one interviewee suggested developing a clear delineation of SRI’s and HEPC’s role and responsibilities for each year of the network, recognizing that specific tasks might transition over time as HEPC capacity increases. Another HEPC staff member suggested increasing the amount of staff time for HEPC to serve as the backbone and mentioned learning during an INCLUDES national convening that all other alliances had a person “who was totally devoted [full time] to INCLUDES” and raised that as a possibility for the First2 Network. Finally, another suggestion was to refocus HEPC staff time on strictly backbone-related responsibilities, while transitioning away from the other types of activities it has been involved with during the first year.

4. Impact of the First2 Network

Impacts are the broader, long-term changes occurring as a result of short- and medium-term outcomes. The desired impact of the First2 Network over the next 10 years is to double the graduation rate (from 30% to 60%) of students in West Virginia who enter college with a declared STEM major and who complete a STEM degree within four years. According to the First2 Network logic model, necessary components of that impact include increasing STEM graduation rates, building the knowledge base about first-generation STEM persistence, and expanding a sustainable network. The impact findings are organized into three categories: 1) college readiness, participation, and persistence rates; 2) STEM persistence knowledge base; and 3) network alliance.

4.1 College Readiness, Participation, and Persistence Rates

4.1.1 College Readiness

The 2018 Academic Readiness Report for West Virginia provides information about the level of college preparation of West Virginia’s students (the 2017 cohort of West Virginia freshmen).³³ The following points are drawn from that report:

- The average ACT score of 2017 West Virginia first-time freshmen at 4-year public institutions was 22.2.

- 43.7% of 2017 West Virginia first-time freshmen at 4-year public institutions scored at or above the ACT Math Benchmark.
- 48.8% of 2017 West Virginia first-time freshmen at 4-year public institutions scored at or above the ACT Science Benchmark.
- In 2017, 27.8% of West Virginia high school graduates performed at or above the benchmark across all ACT subsections.
- 23 of the state's 117 high schools had a higher number of students enrolling in public postsecondary education and higher average ACT scores in 2017, compared to 2016.
- Seven counties recorded higher enrollment at public postsecondary institutions and higher average ACT scores.
- High school GPA is still a strong indicator of college success. Students with high school GPAs of 2.99 or lower achieved lower first-semester college GPAs compared to those who had high school GPAs of 3.0 or higher. The same pattern was observed for students attending both 2-year and 4-year public institutions.

4.1.2 College Participation

The college-going rate for West Virginia in fall 2018 was 52.6%, with county rates ranging from 34.7% for McDowell County to 72.8 for Ohio County. In fall 2017, the state rate was slightly higher at 54.5%; Calhoun County had the lowest rate at 23.0%, with Ohio County again having the highest rate at 70.4%.³⁴ The overall fall 2018 headcount enrollment for West Virginia public 4-year institutions of higher education was 63,159.³⁵

4.1.3 College Persistence

Currently, West Virginia falls below the national and regional statistics related to persistence and degree completion.³⁶ In the 16-state Southern Regional Education Board (SREB) region, the 1-year persistence rate (enrollment at the institution first attended or transferred to other colleges) for the 2016 cohort of first-time, full-time bachelor's degree seeking students enrolled in public 4-year institutions was 86%; West Virginia's 78% is higher only than Mississippi's 77%. The region's progression rate (first-time, full-time students enrolling in the fall of each academic year who graduate from the college they first attend, remain enrolled, or transfer to another college) was 78% for the 2011 cohort, while West Virginia had a 79% rate. The 6-year graduation rate for the 2011 cohort in 4-year public institutions was 60% nationally, 57% for the SREB region, and 49% for West Virginia. The 4-year graduation rate for the same cohort was 37% nationally, 35% for the region, and 29% for West Virginia.

The number of STEM bachelor's degrees awarded in West Virginia has increased about 11.5% from 2013 to 2017, as shown in Exhibit 8.³⁷ Note that data were not available on STEM education at the time of publication.

Exhibit 8. Number of STEM Bachelor’s Degrees by Year in West Virginia

Degree	Level	2013	2014	2015	2016	2017	2016-17 % Change	2013-17 % Change
STEM	Bachelor’s	2,572	2,732	2,850	2,807	2,869	2.2%	11.5%

The data points serve as a set of baseline indicators for West Virginia’s higher education outcomes for students in 4-year public institutions. Inspection of these data each year will provide an opportunity to observe trends and see how educational outcomes change for West Virginia’s youth, especially rural, first-generation STEM students. In addition, the evaluation team is coordinating with HEPC to obtain impact data disaggregated by rurality and other important demographic factors, and is determining how to identify first-generation status (although college applicants are asked about first-generation status on the Free Application for Federal Student Aid, such data can only be used to determine financial aid eligibility, the amount of aid, the conditions of the aid, or to enforce the terms and conditions of the aid).

4.2 STEM Persistence Knowledge Base

One of the principal impacts of the First2 Network is improved knowledge about first-generation STEM persistence. The following sections summarize findings related to STEM persistence from network activities, student STEM efficacy measures, and network member perspectives.

4.2.1 Network Activities

As the First2 Network completed its first year, members facilitated a number of activities to contribute to building knowledge about how to ensure rural, first-generation STEM persistence. Four working groups are currently operational, including capacity building, college readiness, summer immersion, and faculty-student engagement. All working groups meet at least monthly, and document their activities via agendas and meeting minutes. Examples of working group progress are noted in the following points, and it is anticipated that the PDSA cycles occurring in the second year will contribute to this knowledge base.

- Capacity-building working group: This group is currently planning a one-day face-to-face meeting to be held on August 9, 2019, in Canaan Valley, WV. Topics include revisions to the working group driver diagram and logic model and planning for year 2 for the full group and for subgroups.
- College readiness working group: This group held an in-person meeting in April 2019. Topics included memos of understanding, measurement (outcomes, outputs, and process measures), partnering with HSTA and replicating the HSTA model, and identifying topics for discussion at future meetings.
- Faculty-student engagement working group: This group most recently met on July 11, 2019, and efforts focused on compiling the driver diagram and coordinating change ideas. The group is deliberating on whether to hold a large full-group in-person meeting in August or whether to host sub-group meetings by interest areas instead, given the large number of members in the full group.

- Immersive experiences working group: This group most recently met on July 18, 2019, and topics included the summer immersion research internships and the mentor/mentee agreement. Four immersion experiences were carried out in the first year of the First2 Network, and included approximately 30 participants:
 - Fairmont State University/Chemours, May 19-31
 - Marshall University, July 15-26
 - West Virginia State University, July 15-26
 - West Virginia University, July 15-26

4.2.2 Student STEM Efficacy

Another way to build knowledge of STEM persistence is through examining the STEM efficacy of those students who participate in the immersion experiences.

Students completed an online survey at the beginning and ending of their internship; 27 students (ages 18 or older) completed a pretest, and 25 completed a posttest. More than half of the respondents were female (56%) and about two-thirds described themselves as White (67%). In addition, 35% indicated they qualified for a federal Pell



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grant, 96% identified themselves as first-generation students, and more than three-fourths indicated they grew up in a town (48%) or a rural area (35%). Students most commonly reported biology as their college major (44%).

Results are shown in Exhibit 9 for the five areas of STEM career, STEM efficacy, school belonging, STEM identity, and STEM plans.³⁸ It appears that the summer immersion internships are having positive effects on students, especially in helping them gain confidence in their abilities, increase their sense of belonging at college, and strengthen their STEM identity. Students rated STEM plan the highest, at both time points (4.43 and 4.65, respectively, on a 5-point scale). They rated identity the lowest at pretest (3.78); at posttest, they rated career the lowest (3.94). Students had higher scores at posttest for each of the five areas, and statistically significant differences were found for the areas of STEM efficacy, school belonging, and STEM identity.

Exhibit 9. Student STEM Efficacy Survey Results

Subscale	Pretest Results			Posttest Results			Statistical Results Mean Difference (Post – Pre)
	Number	Mean	Std. Dev.	Number	Mean	Std. Dev.	
Career	25	3.88	0.52	25	3.94	0.58	0.06
Efficacy	24	3.99	0.55	24	4.27	0.49	0.28*
Belonging	23	3.93	0.53	23	4.52	0.57	0.59*
Identity	23	3.78	0.63	23	4.17	0.72	0.39*
STEM Plan	23	4.43	0.66	23	4.65	0.44	0.22

*Statistically significant at .05.

Students had similar viewpoints about what they told family and friends about the internship at pretest, most often noting their excitement about the internship and perceiving it as a great opportunity to help ensure college preparation and success, make career decisions, provide research opportunities, and meet new people. A few students did not know what to tell others, however, or expressed uncertainty about not knowing what to expect during the internship. After the internship, students were unanimously positive about their experiences. A few representative quotes are provided as follows:

- “It was really fun. I learned so much about the campus and met some amazing people who will be my friends throughout college.”
- “I loved it. So enriching!”
- “It’s a chance for me to be exposed to the world of STEM and make sure I’m prepared for what the future holds.”
- “This is a great opportunity to gain experience and to make contacts.”
- “This program helped me grow and feel confident as a STEM major.”
- “I have made many new friends and have learned about a multitude of resources. I now feel very comfortable at college, and I can’t wait to move in during the fall.”
- “It was an amazing experience and I highly recommend it. I want to go back in as a mentor so I can still be involved in this amazing program.”

Students were asked at pre and post what job or career they expected to have in 10 years. As shown in Exhibit 10, careers in the medical field were the highest at both time points, with such jobs as neurosurgeon, doctor, dentist, orthodontist, or obstetrician. Forensics was the second

most common career field, with such jobs as digital analyst, lab technician, pathologist, or science analyst.

Exhibit 10. Students' Job/Career Expectations in Ten Years

Pretest			Posttest		
Career	Number	Percent	Career	Number	Percent
Computer science	0	0%	Computer science	3	12%
Engineering	2	7%	Engineering	2	8%
Forensics	4	15%	Forensics	4	16%
Medical	10	37%	Medical	9	36%
Scientist/Research	2	7%	Scientist/Research	3	12%
Miscellaneous	7	26%	Miscellaneous	2	8%
Missing	2	7%	Missing	2	8%
Total	27	100%	Total	25	100%

Nearly all of the 25 students shared their perceptions at posttest of what they liked most about the program. Common topics were getting to meet other people in the STEM field, making new friends, interacting with the mentors, and meeting their professors; getting to do research and lab work; becoming familiar with the college campus and more prepared for college; and the events they participated in (such as trips to Pullman Square, Charleston Area Medical Center Memorial Hospital, or Chemours).

Most students also provided suggestions for improving the program. One theme focused on improvements to specific activities, such as putting less focus on safety and cleaning the first two days of the chemistry program; ensuring that mentors get more involved with the students in their projects; and making the chemistry lab projects bigger in scope and more concrete. Another theme focused on time and scheduling and included such suggestions as having more activities, allowing more time to work on presentations, offering more recreational time, starting the morning sessions later in the day, and having shorter workdays. Students also offered miscellaneous suggestions, such as allowing commuter students to stay off campus, providing fresher food, and allowing students to go off campus.

4.2.3 Network Member Perspectives

Network members were asked during two interviews what they were learning about broadening STEM participation as a result of their participation in the First2 Network. No common themes emerged, but respondents identified a range of new learnings about broadening STEM participation, such as:

- Understanding the importance of getting the students' perspective, including their participation in Network activities, and allowing those student voices to remind members about why they are involved in the Network
- Understanding the importance of both the social and academic experiences for students
- Understanding the importance of faculty-student engagement so that students feel comfortable in reaching out to STEM professors
- Increasing awareness of rural first-generation issues
- Recognizing that fostering success in STEM education and careers in West Virginia is a complex problem that will take everyone working together to address
- Trying to build and expand from pilot efforts
- Understanding the challenges West Virginia faces (having few established STEM networks in a rural environment)
- Realizing that, as more people recognize that the work is a statewide effort, it will bring more attention to the problem
- Seeing what is occurring at other institutions, what organizations have in common, and how to learn from one another

“This isn’t really about, ‘Can I be my true Appalachian self and also be a chemist?’ It’s kids who want to be chemists and they didn’t get what they needed, either in their classrooms or in their pocketbooks, to be able to have that be viable.” –Network member

And, one interviewee noted that “I’ve gained more questions in the past year than I have answers . . . but there’s something confounding about STEM in general and that the definition of it means different things to different people.” This individual continued by suggesting students face more of a “preparation barrier” than an “identity issue.”

Network members also completed a value survey that included four items about impact.³⁹ The average score was 2.84 on the 4-point scale, falling just below the Agree level (3). Members gave their highest rating for reflecting anew on what it takes to achieve success (3.21); the lowest rated item was that members were using network learnings to develop new strategic directions for their institutions (2.34). Given that the network had not yet wrapped up its first year at the time of data collection, these results seem appropriate and set a baseline against which future trends can be compared. In fact, two of the respondents’ comments support this premise, with one noting that these goals “will be pursued in the future” and another indicating that “the timing of participation [in the survey] is limiting these responses.”

Several other respondents described how their participation had changed their perspective, direction, strategy, or understanding of what success looks like. For example, one commented that while working with others in developing the summer internships and the student stipends, they revealed “strategic gaps in existing funding and opportunities that the First2 Network could fill.” Another focused on student voice/viewpoint, noting they have included student input on summer program formatting in the past, but that “I now feel the need of including the student

voice in more decisions.” And, one member noted the complex and at times chaotic work involved with a collaborative network.

4.3 Social Network Analysis

Twenty-five Network members completed a social network survey in early spring 2019.⁴⁰ Respondents identified up to 10 members of the First2 Network with whom they

communicated on issues relevant to their work in the network. And, 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 levels⁴¹ include:

1. Networking: Aware of organization, loosely defined roles, little communication, independent decision-making
2. Cooperation: Share information, formal communication, somewhat defined roles, independent decision-making
3. Coordination: Share 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

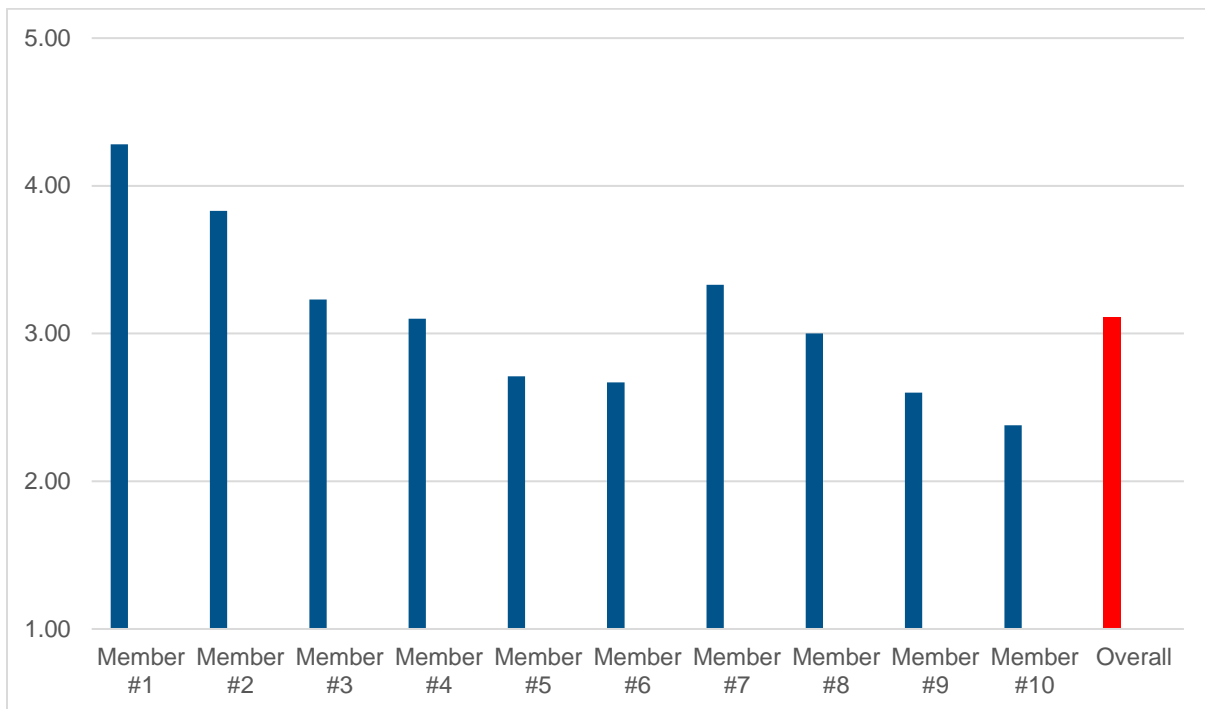
The number of individuals identified, along with the average collaborative scores, are shown in Exhibits 11 and 12. As anticipated, the collaboration score is higher for the first two individuals identified by the network respondents, and collaboration scores generally decrease throughout the remaining individuals identified. The overall score is 3.11, which is at the Coordination level.

“Participation in the First2 Network’s collaborative efforts has enhanced my perspective about what it means to successfully make great progress at building a collaborative infrastructure while facing the constant challenges of promoting and implementing shared decision making.” –Network member

Exhibit 11. Network Members Identified as Collaborators in the Network

Individuals Identified	Number Identified	Average Collaboration Score
Member #1	25	4.28, Coalition
Member #2	23	3.83, Coalition
Member #3	21	3.23, Coordination
Member #4	20	3.10, Coordination
Member #5	17	2.71, Coordination
Member #6	15	2.67, Coordination
Member #7	12	3.33, Coordination
Member #8	11	3.00, Coordination
Member #9	10	2.60, Coordination
Member #10	8	2.38, Cooperation
Overall Score		3.11, Coordination

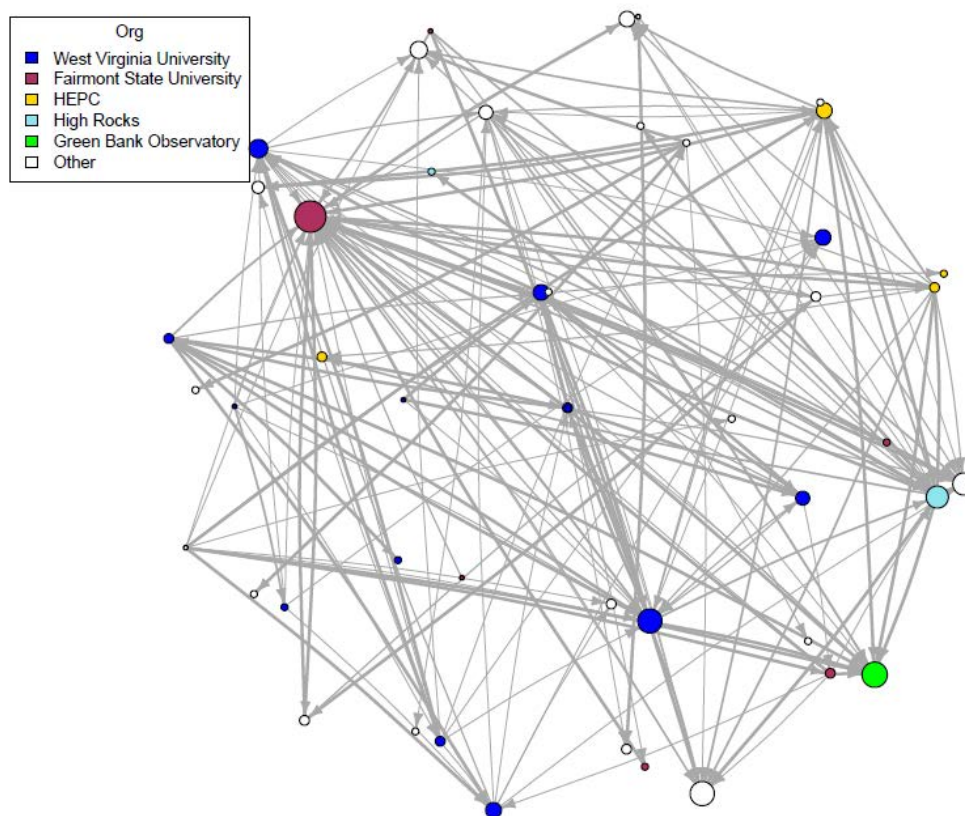
Exhibit 12. Levels of Collaboration by Individuals Identified



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 person identified was most frequently identified as the key contact. Respondents were also asked to identify whether the individuals they identified were prior acquaintances, with whom they were in contact prior to their First2 Network involvement. Again, as might be expected, the first few individuals identified were most often prior acquaintances. For example, for the first member identified, 72% were prior acquaintances; for the second member identified, 52% were prior acquaintances. The lowest percent of prior acquaintances was for the 10th person identified, at 8%.

In terms of the actual structure or configuration of the network, based on the 25 respondents, the graph shown in Exhibit 13 depicts the connections among those individuals identified as collaborators within the network. 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.¹

Exhibit 13. Baseline Map of the Connections in the First2 Network



¹ Network maps were also generated for each active working group and are depicted in Appendix C. These maps should be interpreted with caution, given the small number of respondents involved for each working group.

The overall shape of the current network map is star-shaped, with most frequent collaborators coming from Fairmont State University, West Virginia University, Green Bank Observatory, High Rocks, and HEPC. The Fairmont State University individual is currently the person most linked to others within the network, and West Virginia University Network members are dispersed throughout the map, showing linkages both within and across organizations. Individuals from HEPC, High Rocks, Green Bank Observatory, and other organizations appear most often on the periphery of the map and reflect mostly incoming linkages or ties. Over time, as the network evolves, it is anticipated that more individuals will be depicted as collaborators, that network ties will strengthen, that levels of collaboration will increase, that collaboration with new acquaintances will increase, and that other organizations will become more centrally connected in the Network.

In sum, the overall First2 Network map shows considerable interaction among the identified individuals, with Fairmont State University and West Virginia University members depicted as the most active collaborators. Although this map must be viewed with caution, given the low number of respondents, it does provide a baseline against which to track how the network evolves over time.

III. Conclusions and Recommendations

In this section, we provide conclusions based on the findings discussed in previous sections of this report, and offer recommendations for the leadership team and steering committee to consider as they launch the network's second year of implementation. Conclusions and recommendations are organized by the evaluation's four levels of analysis: 1) context, 2) project structures and activities, 3) the systems the project seeks to change, and 4) impact.

1. Context of the First2 Network

The First2 Network emerged in the nation's only state falling entirely within the federally-designated Appalachian region, a region characterized at once by economic and educational distress and by a history of independence, labor struggle, and cultural richness. These legacies contribute to the problem the network seeks to address—low STEM persistence—and provide the context in which network members conduct their work. As such, context is both a constraint and an enabler for the network's efforts.

Recommendation: Network leaders and members should continue to consider how state (and local and institutional) context can support and might impede efforts to investigate improvements to practice and policy. Similarly, network leaders might want to strategize how best to leverage contextual dynamics (e.g., resurgent educator activism, legislative change, new state department of education initiatives, etc.) to support their progress.

2. First2 Network Structures and Activities

Over the course of its first year, the First2 Network experienced a number of important successes, summarized below.

- Clear shared vision among network leadership, members, and students
- Rapid network expansion, including new college and industry representatives
- New professional and personal connections within the state, and nationally with other STEM professionals and large-scale STEM equity efforts
- Integration of students into leadership roles and as a source of information about students' lived experiences
- Establishment of working groups, with co-chairs, members, meetings, and shared online workspaces
- Preparation for the facilitation of PDSA cycles in working groups, using the NILS platform
- Launch of the first2network.org, a comprehensive online portal to support network operations, communication, and data use
- Facilitation of four summer immersive research experiences for rural, first-generation students, with statistically significant improvements in students' STEM efficacy, STEM identity, and feelings of school belonging
- Early attention to growth and sustainability, through activities such as the facilitation of a Capacity Building Working Group, presentation at the state legislature to build awareness of the initiative, engagement with industry (resulting in, for instance, financial contribution from Chemours to support summer immersive research experiences for students in concert with the network), networking with national STEM equity projects, and building the leadership capacity of members

Recommendation: Leaders and members of the First2 Network should celebrate these accomplishments, and engage the momentum from them to continue project efforts in the network's second year. In particular, the network should continue to engage students as leaders, deepening its commitment to learning from young people's experiences and providing them real opportunities to inform improvement efforts.

As with the launch of any complex initiative, the First2 Network faced a number of issues. Many of these issues arose from the emerging recognition over the course of the year that the First2 Network would have benefitted from a chartering phase. According to the Carnegie Foundation for the Advancement of Teaching, during a chartering phase in the establishment of a NIC, the network recruits and builds its leadership team, establishes norms, and selects the problem of practice to target.⁴² In addition, chartering involves defining and analyzing the selected problem, provides training in improvement science, and defines outcome measures and collects baseline data.

Many network members in leadership roles reported feelings of overwork and stress, which they often linked to the work needed to both define network structures and processes, and launch the core improvement work of the network. Although some issues were addressed (e.g., via the launch of a governance committee and development of by-laws) or are in the process of resolution, several remain, as follows.

- **Project management.** Some network members expressed an interest in a clear project management system, wherein immediate, intermediate, and longer-term tasks are delineated, and in which it is well-defined who must do what task by what deadline. For instance, one such network member additionally recommended the development and use of a project "theory of action" describing how the network is intended to operate.

- **Improvement science support.** Some network participants indicated that they sought further and ongoing support as they employed improvement science tools and processes, and were unsure whose responsibility it was to serve in that role.
- **Shared measures.** What to measure, for what purposes, and by whom are concerns for some network members. Related issues include IRB review and approval; how data are collected, stored, reported, and used; and clarification of data responsibilities across working groups, the backbone organization, the research team, and the evaluation team.
- **Communication.** Communication across the network struck some evaluation participants as uneven—perhaps too much communication among leadership team and steering committee members, and perhaps not enough to and for the wider network. Although many members expressed appreciation for resources for face-to-face conferences and working group meetings, and for the launch of the network portal, some also suggested that communication become more streamlined and consistent.
- **Governance and administration.** Although many issues were addressed by the governance committee, a few remain unresolved, according to evaluation respondents. For instance, some leadership team and steering committee members reported that they sought efficient methods for soliciting collaborative input on decisions, so as not to spend too much time during meetings on one issue at the expense of others on the agenda. A related issue concerns how best to balance commitment to collaborative decision-making with the impetus to make decisions quickly.

Recommendation: As of this writing, the First2 Network leadership team is already pursuing several strategies to address these issues. These include engaging an external facilitator to help the team clarify roles and responsibilities, revising project milestones to support improved project management, and launching a measurement team to address shared measurement matters. Additional tactics the leadership team and steering committee might consider are a milestone check during monthly steering committee meetings facilitated by a dedicated project management professional; the development of a project theory of action to depict key project activities; establishment of routine communications (e.g., monthly newsletters, informal monthly webinars to summarize recent project progress, etc.) following an audience analysis (e.g., a survey of members); and consultation with other similar projects to investigate strategies for balancing efficiency and effectiveness in decision-making.

3. Systems Targeted by the First2 Network

Along the trajectory toward improvements in the system targeted by the First2 Network are individual-level changes. Following the network's first year, members reported some evidence of individual change. In general, these tended to concern new relationships and the acquisition of new knowledge resulting from their engagement with the network, although some members also indicated changes to their own practice. There is less evidence of change in institutional policies or practices; this conclusion is not surprising, however, given that the network was in its first year of operation and PDSAs not yet established practice in working groups.

Another system targeted by the First2 Network is the development of a statewide backbone organization at HEPC to support its work now and beyond the life of the INCLUDES grant. Over the course of the year, HEPC staff have, among other accomplishments, learned about the roles and responsibilities of backbone organizations, coordinated two conferences, launched an online collaboration and communication portal, and organized marketing efforts. Nonetheless, HEPC faces three major challenges to its emerging role of network backbone organization: ambiguity about the respective roles and responsibilities of HEPC and SRI, concern about the adequacy of HEPC staffing levels, and limited capacity within the HEPC Division of Science and Research to serve as the network's backbone organization.

- **Recommendation:** The network leadership team, at the time of this writing, has engaged an external facilitator to help them articulate and resolve role ambiguities. Clarifying responsibilities—and how those responsibilities shift over time as HEPC gains more capacity to serve in this role—will enable HEPC to take ownership of its position as the backbone organization for the network more productively and effectively. Second, discussions about HEPC staffing need to occur soon—both within HEPC and with the leadership team—to determine what level of staffing is adequate for HEPC to carry out its backbone responsibilities, and how those staffing allocations should best be distributed across HEPC staff. Third, to maximize the HEPC contributions as the First2 Network backbone, discussions should also focus on broadening the participation of staff outside the Division of Science and Research as a mean to access additional areas of organizational expertise.

4. Impact of the First2 Network

It is too early in the lifecycle of the First2 Network to estimate impact in terms of improvements to students' STEM persistence rates. Baseline data about STEM student persistence and the state of network connections were collected; over the course of the grant, we will compare emerging data against these baselines.

On the other hand, the network can boast emerging impact in terms of facilitating core project activities intended to build knowledge about how to improve STEM persistence, such as establishing working groups associated with key hypothesized drivers of change and operating and studying four summer immersive research experiences for students. In addition, First2 Network participants report that they value the network for the new insights it provides about STEM persistence and students' lived experiences.

Another early suggestion of impact emerged from pre- and post-tests of students participating in the network's immersive research experiences. Following their participation in such experiences, students indicated to a statistically significant degree that they were more confident in their ability to pursue STEM education, more likely to feel connected to their school, and more grounded in a sense of themselves as people who do STEM work.

- **Recommendation:** Efforts to obtain more targeted baseline data should continue; in particular, the leadership, research, and evaluation teams need to determine how to obtain data about students' first-generation status and STEM persistence, at a minimum, given FAFSA provisions against using first-generation status information for anything other than financial aid. In addition, the research and evaluation teams may want to

collaborate in the refinement of the internship study by conducting validity studies or factor analysis. Finally, the research and evaluation teams should continue their collaboration on social network analysis to track network development over time.

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