Engaging High School Students: The Student-Centered Assessment Network

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Partners for Network Improvement

Research, Strategy, & Evaluation

Partners for Network Improvement (PNI) is a research and evaluation group based at the University of Pittsburgh's Learning Research and Development Center. Led by Jennifer Russell, one of the key developers of the Network Improvement Community Development Framework, PNI both leads networks and supports network leaders in their work to design, implement, and adapt improvement networks. Developmental evaluation is one tool PNI uses to help network leaders develop strong improvement networks.

Developmental Evaluation

Although industries such as healthcare have used improvement science for decades, the use of improvement science and networked improvement communities is relatively new in education. Because this work is complex and innovative, and because improvement science by nature requires rapid tests of change, adaptation to context, and systems thinking, the Nellie Mae Education Foundation invested in an intensive developmental evaluation of the Student-Centered Assessment Network (SCAN).

PNI's developmental evaluation of SCAN aimed to:

- Infuse an evidence-based critical friend/thought partner perspective into the network development process

- Track growth and the development of the NIC as a learning organization

- Produce useable knowledge for the education field and specifically for other educators, policymakers, funders, and researchers interested in the NIC model as a way to organize for improvement and address high-leverage practical problems

- Advance the evaluation field by testing and refining models for evaluating improvement processes and NICs in education contexts

Acknowledgements

We would like to thank the SCAN hub leaders for their inspiration and collaboration. SCAN was led by Stephen Plank. Matt Welch led the research/data team of George Atupem and Mary Burns. Alicia Espinoza, Doug Fireside, and Will (Tad) Johnston were the hub team instructional coaches. Victoria Lennon led communications. The work was supported by Nicol Christie, David Kamm, and other American Institutes for Research (AIR) colleagues. We would also like to thank the 59 teachers who opened up their practice and their learning spaces, and welcomed us in. We were inspired by how thoughtfully teachers considered students as they changed classroom routines and continually sought to improve their teaching, and their students' learning.

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The Student-Centered Assessment Network

From the fall of 2017 to the winter of 2020, the Student-Centered Assessment Network (SCAN) aimed to transform high school teaching in Rhode Island. Researchers and teachers worked together to make high school classes more student centered by increasing teachers' use of student-centered formative assessment. Launched by researchers at the American Institutes for Research (AIR), the network was supported by the Nellie Mae Education Foundation (NMEF).

Network leaders (the hub) organized SCAN as an improvement network to address a shared problem of practice using improvement science. By joining the network, SCAN teachers committed to working collaboratively to make their formative assessment practice more student centered, using iterative testing cycles—Plan-Do-Study-Act (PDSA) cycles—to hone their instructional practices.

SCAN was launched with a group of 23 high school teachers during the 2017–2018 school year. New teachers joined in the fall of 2018 and in the fall of 2019. The network was made up of educators from three public high schools that served a wide range of student demographics. In all, a total of 59 teachers representing seven content areas participated in SCAN. They engaged collaboratively to continuously improve their teaching, enhancing learning for thousands of Rhode Island high school students.

In the sections that follow, we present findings from our three-year developmental evaluation. We begin by describing how the hub designed the improvement network. We then describe how the hub built school structures and routines to support teacher collaboration. We present our findings on within-school and across-school connections facilitated by these network routines. We also present findings on how SCAN influenced teaching, and teachers' expanded use of student-centered formative assessment. We then turn our lens to the network's influence on students, specifically examining how teachers' participation in SCAN and their uses of formative assessment resulted in students' deepened engagement with their own learning. We include a section on sustainability and conclude with Lessons for the Field.
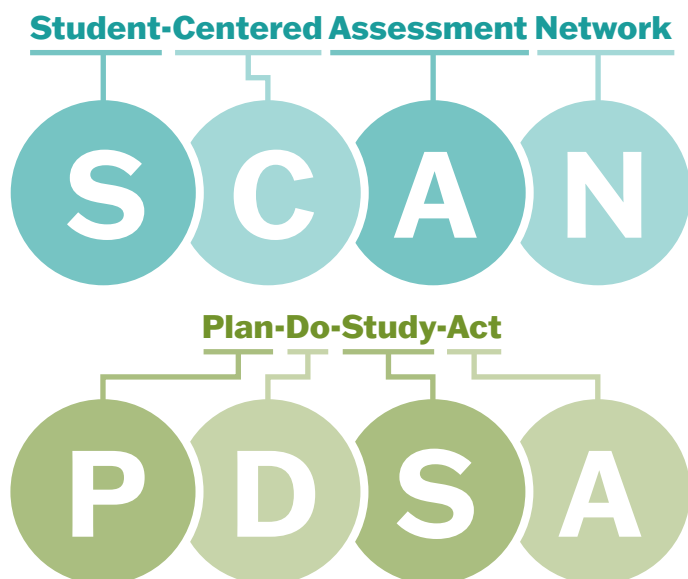
Designing an Improvement Network

An instructionally focused improvement network is a temporary social organization in which teachers come together under the guidance of hub leaders to make improvements to their instructional practice. Leading a hub involves a complex array of practices, yet hub leaders have little authority. As such, the SCAN hub had to grapple with how to simultaneously support high school teachers to change their teaching practice, increase student engagement, and use inquiry cycles to guide their improvement work, all while maintaining teachers' voluntary engagement.

In this section, we briefly examine how the SCAN hub designed for this challenge. We begin with a description of the participants, and how those participants co-constructed a definition of student-centered formative assessment. An explanation of the principles that drove the work follows. We then describe teachers' use of inquiry cycles, and the collaborative structures the hub used to support learning and improvement.

Creating a collaborative network with teachers from three Rhode Island high schools

In Year 1 (2017), 23 teachers from two Rhode Island high schools became SCAN's first cohort. In Year 2 (2018–2019), new teachers from those two schools joined. In addition to those teachers, the hub invited teachers from a third high school. In Year 3 (2019–2020), seven more teachers from two of the high schools joined. In total, 59 teachers from three high schools in Rhode Island participated in SCAN.

Number of teachers involved in SCAN from each Rhode Island school, per year

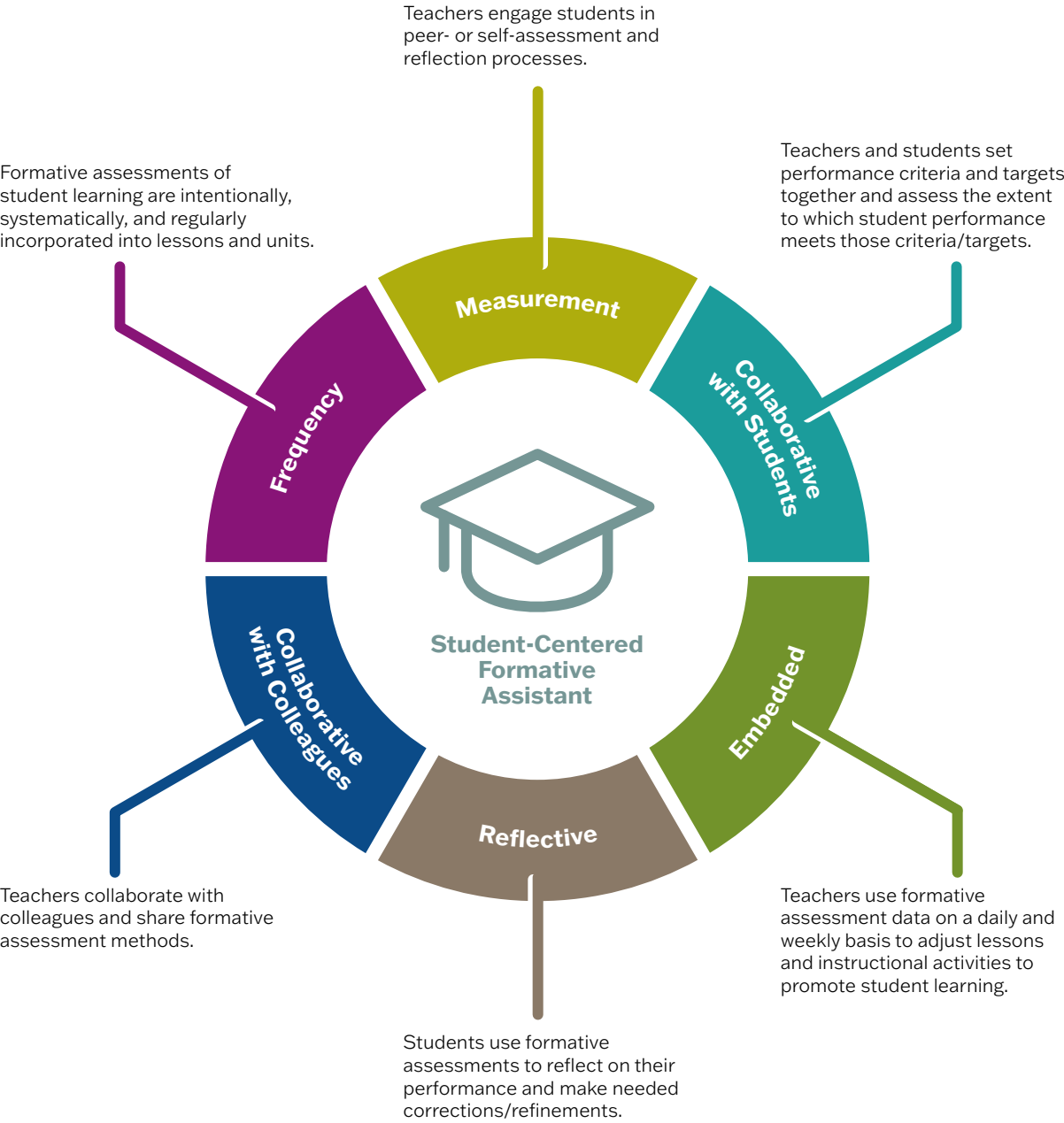|	Year 1 (2017–2018)	Year 2 (2018–2019)	Year 3 (2019–2020)
School 1	**12** Cohort 1: 12	**19** Cohort 1: 10 Cohort 2: 9	**17** Cohort 1: 7 Cohort 2: 8 Cohort 3: 2
School 2	**11** Cohort 1: 11	**16** Cohort 1: 9 Cohort 2: 7	**13** Cohort 1: 6 Cohort 2: 7 Cohort 3: no teachers added
School 3	**N/A** School 3 didn't join the network until Year 2	**13** Cohort 2: 13	**15** Cohort 2: 10 Cohort 3: 5

The SCAN teachers in Cohort 1—teachers who joined the first year—taught four core subjects (math, English language arts [ELA], science, and social studies) and represented mostly academically advanced courses. In subsequent years, the hub broadened the invitation to teachers with different disciplinary foci and non-college preparation courses. By the third year, the network collectively represented a wide range of grade levels, subject areas, academic levels, and student learning needs.

Content area	Number of Teachers Year 1 (2017–2018)	Number of Teachers Year 2 (2018–2019)	Number of Teachers Year 3 (2019–2020)
English Language Arts (ELA)	8	10	12
Social Studies	5	6	4
Science	4	8	6
Math	5	8	8
Special Education (SPED)	1	6	6
English as a Second Language (ESL)	0	6	6
Arts, library, languages	0	4	3

Type of Course	Number of Teachers Year 1 (2017–2018)	Number of Teachers Year 2 (2018–2019)	Number of Teachers Year 3 (2019–2020)
Advanced Placement (AP)	1	2	2
Honors	8	11	9
College Prep	11	22	20
General Track	2	2	2
Remedial	1	11	12

Co-constructing a definition of student-centered formative assessment

For teachers participating in SCAN, the first step in the process was to build a shared definition of student-centered formative assessment. Drawing on research and teacher experience, the hub and Cohort 1 teachers defined student-centered formative assessment by the six principles below. These six principles anchored teachers' improvement work:

Teachers engage students in peer- or self-assessment and reflection processes.

Teachers and students set performance criteria and targets together and assess the extent to which student performance meets those criteria/targets.

Formative assessments of student learning are intentionally, systematically, and regularly incorporated into lessons and units.

Measurement

Collaborative with Students

Frequency

Student-Centered Formative Assistant

Collaborative with Colleagues

Embedded

Reflective

Teachers collaborate with colleagues and share formative assessment methods.

Teachers use formative assessment data on a daily and weekly basis to adjust lessons and instructional activities to promote student learning.

Students use formative assessments to reflect on their performance and make needed corrections/refinements.

These principles helped SCAN teachers focus their improvement work in order to make progress toward the shared aim of increased student-centered formative assessment.

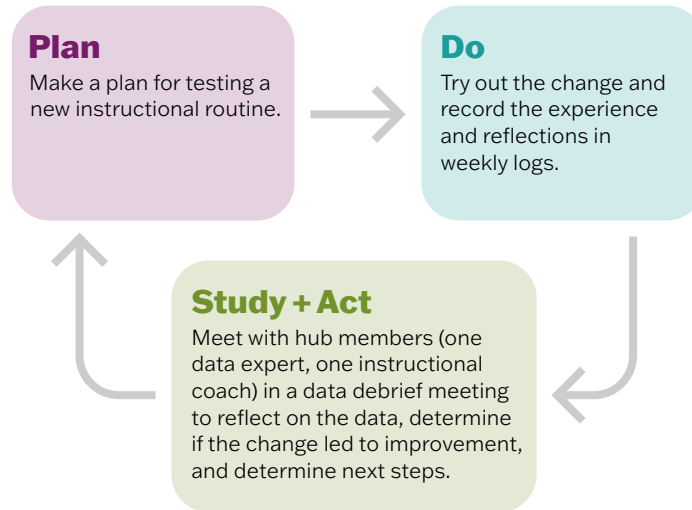# Using inquiry cycles to guide improvement

In instructionally focused improvement networks, teachers use inquiry cycles to test new teaching routines. A key tool in improvement science methodology is the use of inquiry cycles. In SCAN, the PDSA inquiry cycle was introduced by the hub so that teachers could test new student-centered formative assessment routines in their classrooms.

Hub members worked closely with SCAN teachers to support their use of the inquiry cycle routine to guide their improvement work, offering a wide range of supports:

1. Design of a PDSA routine with built-in accountability

2. Assistance with identifying change ideas

3. Assistance with practical measurement

4. Coaching for student-centered teaching

Design of a PDSA routine with built-in accountability

The PDSA inquiry cycle consisted of these steps:

Plan
Make a plan for testing a new instructional routine.

Do
Try out the change and record the experience and reflections in weekly logs.

Study + Act
Meet with hub members (one data expert, one instructional coach) in a data debrief meeting to reflect on the data, determine if the change led to improvement, and determine next steps.

SCAN teachers completed between one and four PDSA inquiry cycles each year. The PDSA cycle involved documentation and regular contact between SCAN teachers and the hub. As teachers enacted changes in their classrooms, the PDSA routine provided built-in accountability. Nearly half of the teachers we interviewed in the spring of 2020 noted this[1].

> *We're so busy that it's easy to get off track. . . . I think the structure and the format of [the PDSAs] absolutely helped—I think that it was done very well in the flexibility that was allowed. However, there was a structured timeline. I think we needed that.*
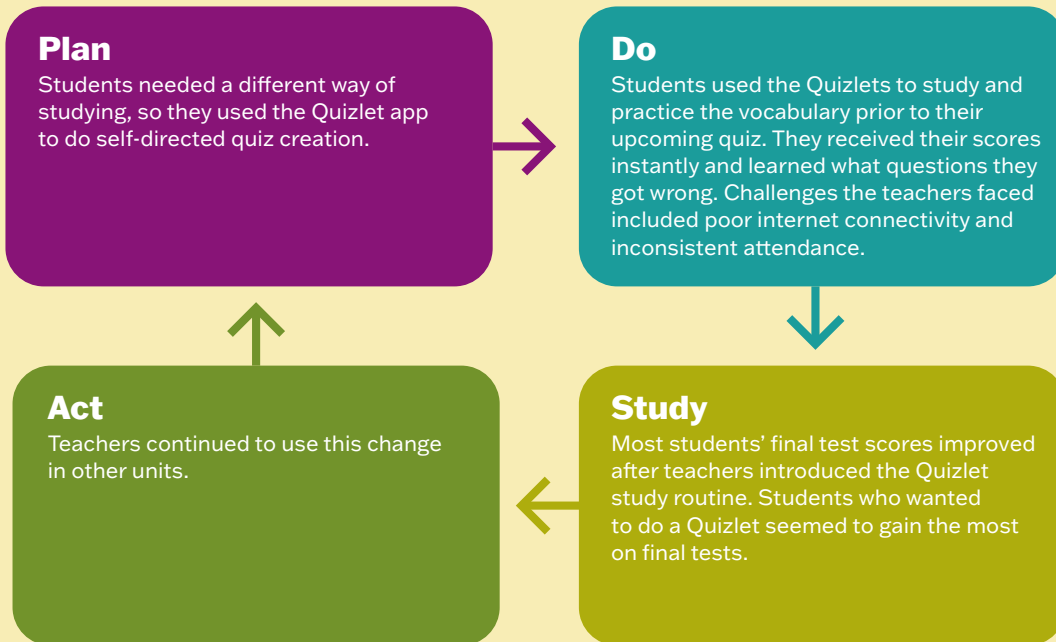>
> *– Science teacher*

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[1] Due to the COVID-19 disruption, we chose to sample SCAN teachers from all three schools and all content areas for final, reflective interviews. We worked with the hub to identify a sample that was a balanced set of teachers from all three schools, all content areas, a range of student demographics, and different levels of participation in the network. In all, we interviewed 26 teachers in the spring of 2020.

In this sample PDSA cycle, the SCAN teachers engaged their students in the **measurement principle** of student-centered formative assessment. Students self-assessed their performance and reflected on their mistakes.

Using Quizlets to co-construct understanding

In one high school, three social studies teachers worked together to identify ways for their students to co-construct understanding.

Plan
Students needed a different way of studying, so they used the Quizlet app to do self-directed quiz creation.

Do
Students used the Quizlets to study and practice the vocabulary prior to their upcoming quiz. They received their scores instantly and learned what questions they got wrong. Challenges the teachers faced included poor internet connectivity and inconsistent attendance.

Act
Teachers continued to use this change in other units.

Study
Most students' final test scores improved after teachers introduced the Quizlet study routine. Students who wanted to do a Quizlet seemed to gain the most on final tests.

Assistance with identifying change ideas

Identifying a high-leverage strategy to make formative assessment more student centered was a design challenge for SCAN teachers. The hub supported this work, and many teachers we interviewed reflected their appreciation for the hub's technical assistance around the PDSA cycles, specifically, helping them generate ideas to test in their classrooms that yielded meaningful, concrete instructional changes.
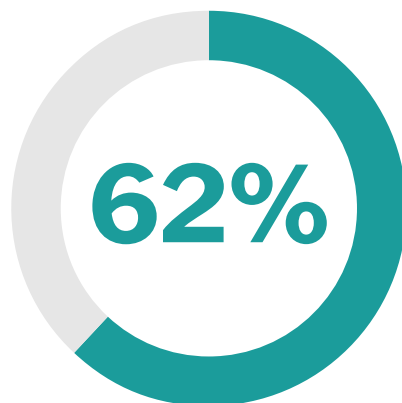
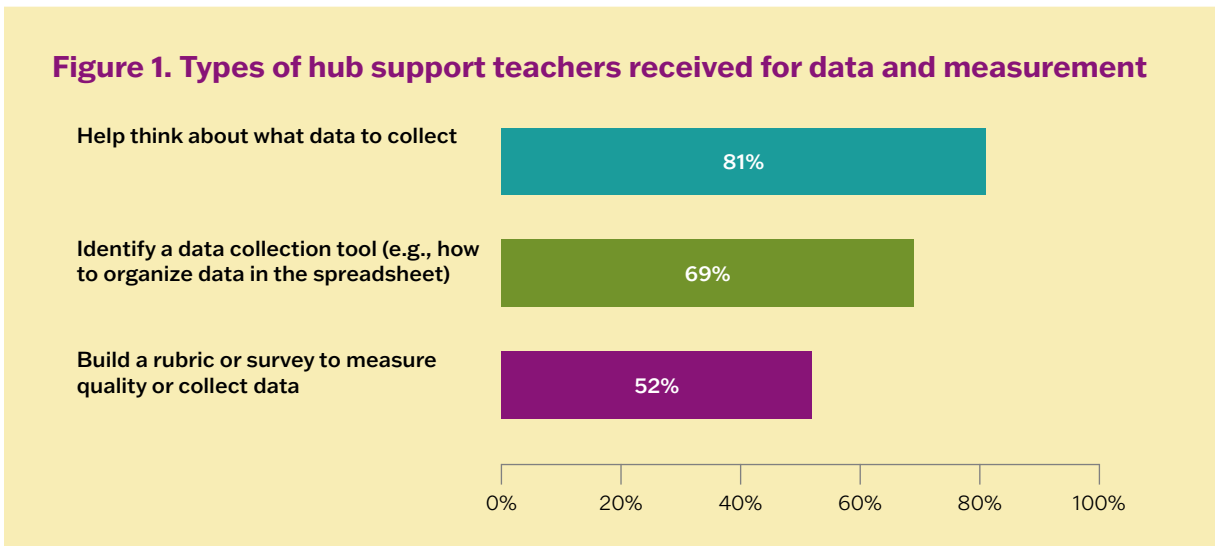**62%** SCAN teachers used a hub member to help them identify a change idea

Assistance with practical measurement

Practical measurement is one of the most common and significant challenges for improvement networks. Hub leaders must help teachers build measures, integrate data collection into their teaching routines, and make sense of whether their change idea is leading to improvement. This becomes particularly demanding in a network such as SCAN where each teacher is testing a unique, self-designed change idea.

To address this challenge, the SCAN hub built extensive measurement support into whole network meetings and school-based meetings, in addition to providing one-on-one support. The hub focused much of their inquiry routine support on building measures, collecting data, creating tools to capture the data, and helping teachers to analyze the data.

For each PDSA cycle completed, SCAN teachers met with two hub members to debrief their data: a measurement expert and an instructional coach. Teachers also had access to hub members at any time during the PDSA cycle via email, telephone, Zoom, and (pre-Covid) one day per month in their schools.

Many teachers appreciated the hub's technical assistance and expertise around data use. Survey data suggests that the majority of SCAN teachers used the hub's support in the areas of data and measurement, as shown in **Figure 1**.

Figure 1. Types of hub support teachers received for data and measurement

Type of support	Percentage
Help think about what data to collect	81%
Identify a data collection tool (e.g., how to organize data in the spreadsheet)	69%
Build a rubric or survey to measure quality or collect data	52%

Before, when I looked at data, it was literally this giant mess of numbers to me, and I didn't know what to do with it. I think that now I look at that in a very different way: planning out what I'm doing, doing it, studying it, and then seeing how I can make that work with the kids in front of me on a daily basis.

> *– ELA teacher*

I think [the hub's] insight around 'what data' really helped me narrow down what I was focusing on and making sure that the data I was collecting was just about that—they helped me make sure I wasn't trying to stretch too far in collecting other information and data that I didn't really need at the time.

> *– Math teacher*

Coaching for student-centered teaching

The SCAN hub included instructional coaches who worked closely with teachers in all aspects of the work. In addition to supporting teachers' enactment of inquiry cycles, these coaches observed teachers' classrooms, suggested specific student-centered teaching strategies to try, and gave overall instructional coaching support to interested teachers. Hub members offered constructive feedback on classroom practices and instructional strategies. In many cases, hub members were able to tailor their suggestions to the teachers based on the PDSA cycles in which the teacher had already participated.

[Hub member] has a really great way of looking at the big picture and looking at the cycles that I've participated in so far and listening to my concerns for improvement . . . how much it's changed and how I collect the information and how I change the cycle from the beginning of the year until where we are now, sort of upping the responsibility, the students' part. . . . So, it's definitely great to have their insight into the project evolution.

> *– ELA teacher*

In interviews, SCAN teachers expressed their appreciation for hub members' insights and feedback on their instructional strategies. Teachers explicitly voiced their comfort working with the coaches and their impression that the interactions were judgment free. Moreover, teachers attributed hub members' unbiased support as critical in bolstering their confidence to implement new routines around formative assessment.

[Hub members] were very supportive and would say, 'Well, if this isn't working, how about if you tweak it and do this?' It was always positive and supportive with great ideas and insight, and it wasn't judgmental. I never felt insecure about sharing a problem with them.

> *– ELA teacher*

Not all teachers, however, took advantage of the hub for student-centered specific teaching.

40% SCAN teachers used a hub member for coaching support specific to student-centered teaching (e.g., giving specific strategies to try)
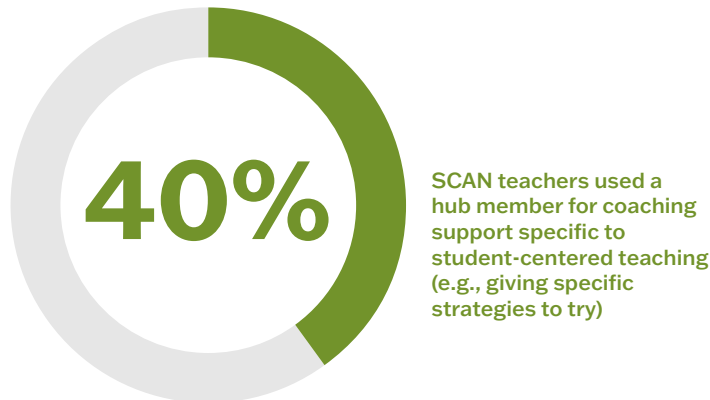
The teachers who took advantage of the hub coaching were very positive.

I feel like AIR has definitely boosted our confidence in understanding how formative assessment works. And not just understanding it, what to do with it, because it really honed in on the specifics of what I was doing in my practice.

  – ESL teacher

The SCAN [hub] was a great resource and great group of positive-minded people who had knowledge to support all of us, but also creative thinking and problem-solving strategies that were meaningful too.

  – ELA teacher

Hub Support for Practical Measurement

Problem: In one math classroom, the teacher noted that students were not reflecting on or correcting their errors by checking notes or getting advice from their peers. Instead, they were copying answers from others to "get it done" or they were not making corrections at all. The teacher also noticed that students were asking her for help right away rather than working on their own. This was making it hard for her to help the students who really needed her help.

Change strategy tested: Have students take a Google Quiz. This way, students would get immediate feedback on their answers and know which ones they need to correct. They talked about strategies for working on incorrect problems without asking the teacher first: ask a friend, look at notes. Students then had the option to repeat the quiz as many times as they wanted to improve their score.

Practical measures: The teacher and hub member co-designed several practical measures to determine if this change was leading to improvement.

- Student survey:
  - How often students consulted notes
  - How often students consulted a friend
  - How often students asked a teacher
- Teacher notes:
  - Number of students who consulted notes or a friend before asking for help
  - Tracking which students the teacher is working with in class
- Google Quiz record:
  - Number of times a student submitted a quiz
  - Each student's highest score
  - Whether or not the students are using the method
 - Number of students with improved scores

Influence on School Structures and Routines

In this section, we describe how SCAN designed school structures and routines for teachers to learn from and with network colleagues, and how teachers valued those opportunities. We also present information on connections that teachers built across content areas, and within- and across-school settings. We include evidence of how SCAN teachers appreciated the collaborative aspect of the network.

Designing collaborative routines to support learning and improvement

A hallmark of improvement networks is how hub leaders intentionally design opportunities for network participants to work collaboratively. Improvement networks are more than after-school professional development offerings. They are also different from sharing networks, which are common in education. Improvement networks press members to test new strategies using improvement science methodologies, learn collaboratively, explore the variation within the network, and share what they learn—what works, for whom, under what conditions—to accelerate improvement. To this end, leaders of improvement networks intentionally structure the work to be collaborative, purposeful, and rigorous.

The SCAN hub designed three collaborative structures (three types of meetings) in which teachers learned together. By engaging in these structures, SCAN teachers had opportunities to learn from hub members as well as colleagues within and across schools.
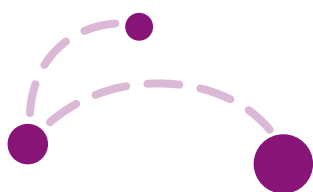
Whole network meetings created opportunities for teachers from all three schools to learn from each other and from hub members.

After-school, school-based team meetings provided opportunities for teachers to engage with their school colleagues across departments. SCAN school teams met monthly for one hour after school.
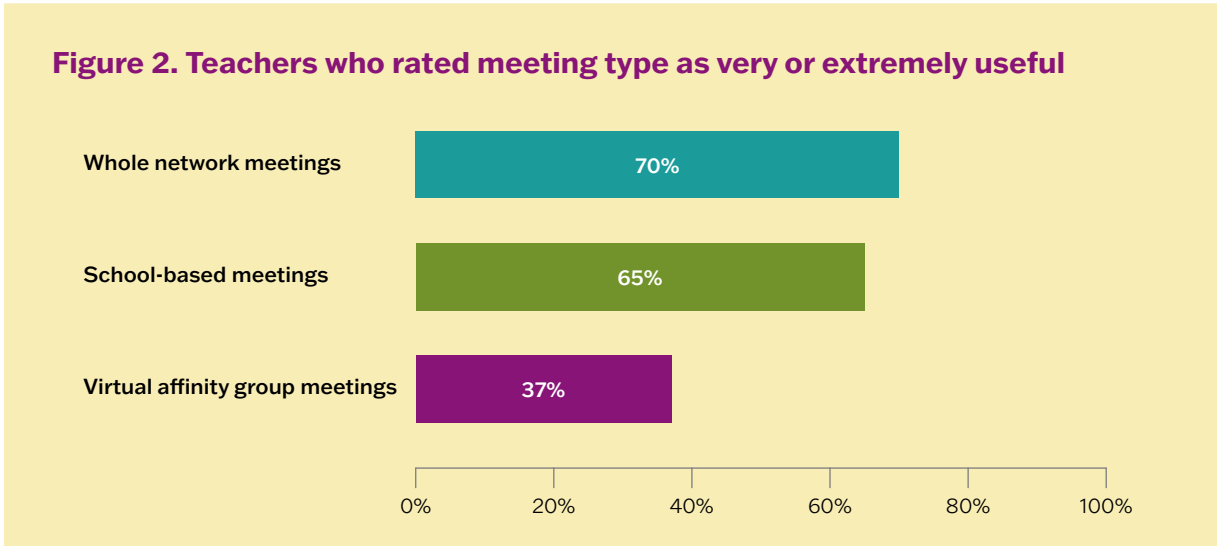
Virtual, cross-school affinity group meetings (held in the final year of the network) supported cross-school collaboration and deeper examination of an area of interest for SCAN teachers. Facilitated by a mentor teacher, these meetings were also an opportunity for a few SCAN teachers to build their leadership skills.

Learning from and with network colleagues

Whole network meetings

Overall, more SCAN teachers rated whole network meetings as the most useful of the three collaborative structures, as shown in **Figure 2**.

Figure 2. Teachers who rated meeting type as very or extremely useful

Meeting type	Percentage
Whole network meetings	70%
School-based meetings	65%
Virtual affinity group meetings	37%

The whole group meetings helped me look globally at what was happening, but they also addressed and were more responsive to our needs in terms of what kind of little mini professional developments we needed and wanted to grow our practice.

> *– ELA teacher*

What I found to be the most helpful was seeing other people present information from their own PDSAs because it gave me ideas of what I wanted to do and helped solidify some plans that I had around what I thought I wanted to do.

> *– Math teacher*

However, not all teachers agreed that whole group meetings provided meaningful opportunities to learn from the hub or other teachers.[2]

50%

SCAN teachers reported whole group meetings provided meaningful opportunities to learn from other SCAN teachers

63%
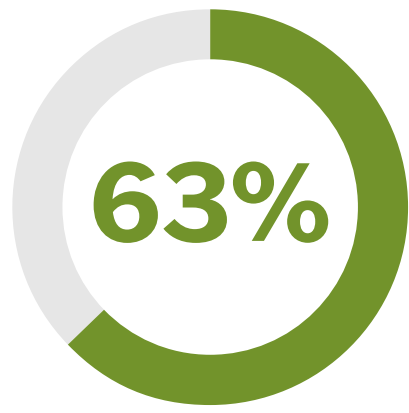
SCAN teachers reported whole group meetings provided meaningful opportunities to learn from the hub team

This finding suggests there was further work to do to make the whole network meetings an optimal learning structure for all teachers, and points to the challenge associated with designing network meetings.

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2 Data taken from the following Spring 2021 Survey question: Check the meeting type(s) that provided meaningful opportunities for you to learn from other SCAN teachers, learn from the hub team.

After-school, school-based team meetings

The majority of teachers reported that school-team meetings provided meaningful opportunities to learn from other SCAN teachers and from the hub team.
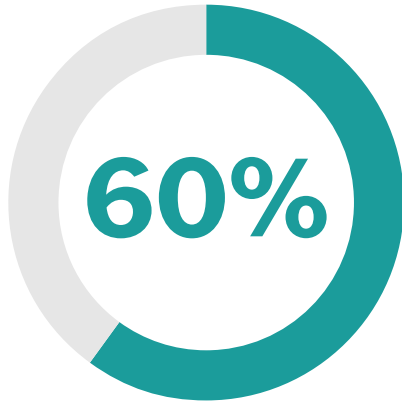
60%

SCAN teachers reported school team meetings provided meaningful opportunities to learn from other SCAN teachers

68%
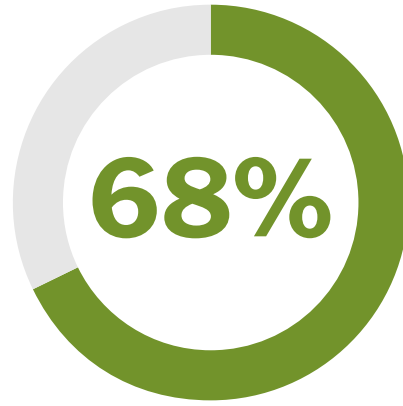
SCAN teachers reported school team meetings provided meaningful opportunities to learn from the hub team

Many SCAN teachers valued structured opportunities to collaborate with school-based colleagues.

I found [school team meeting] time very useful to sit and talk to some of the other teachers at the school to see what they were doing and if we could start to do similar things across classes.

> *– Math teacher*

I really liked the in-school meetings, especially this last year with the protocols. . . . Those were very purposeful and productive. It caused everybody to hear somebody else's voice and even the shyest of people would speak and the loudest of people would listen. And so, to me those were very productive.

> *– ELA teacher*

Being part of a network like this is really good because you can bounce off ideas. . . . My group of students can be very different because—we have to work at a much slower pace because of their disabilities. But there's actually a lot of information from other teachers in the school that I can use.

> *– Social Studies teacher*

For some teachers who had SCAN colleagues in the same department, the school team meetings felt less productive.

We talk about that stuff sometimes in Common Planning Time, or we share out. Some of that could've just been done in an email or a video tutorial.

> *– ELA teacher*

Virtual, cross-school affinity group meetings

In the final year of the network, all SCAN teachers attended hub-structured, cross-school virtual affinity group meetings. These meetings were facilitated by a SCAN mentor teacher. Teachers reported that these meetings tended to be the least useful of the three collaboration structures. However, a handful of teachers found these meetings to be useful in that they were an opportunity for sharing and the cultivation of new technological tools. Learning about how to use tools, such as Zoom, was particularly relevant when teaching moved to fully remote in the spring when COVID-19 shut down in-person schooling in Rhode Island.
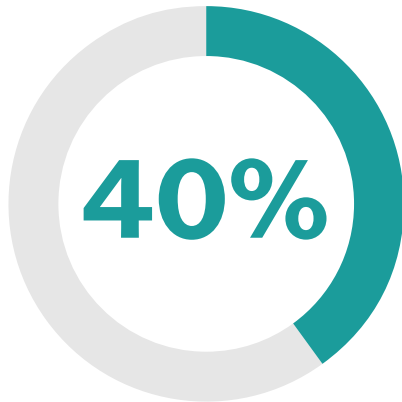
40%

SCAN teachers reported affinity group meetings provided meaningful opportunities to learn from other SCAN teachers

30%
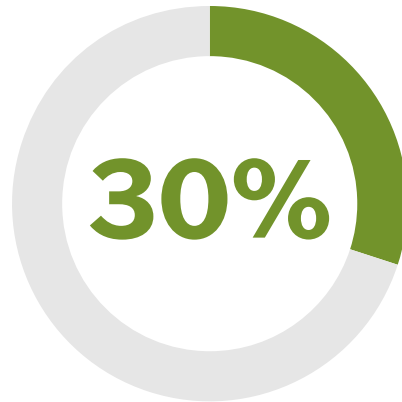
SCAN teachers reported affinity group meetings provided meaningful opportunities to learn from the hub team

I gained technology expertise, which is probably going to come in handy in the next month of—ironically—running an online meeting and the challenges of that.

> *– ELA teacher*

Many of the SCAN teachers did not have protected school time to regularly collaborate around instruction and student engagement with colleagues. For that reason, holding time for these collaborative structures was valued by teachers in the network.

I think any time you have a structured setting like that where you can get all of those professionals together, that's always beneficial. We just don't have time to do that, and a lot of times we just won't plan it.

> *– Science teacher*

Collaborative structures built cross-content, within-school connections

Typically, high schools are not structured for cross-content work, but SCAN broke down those barriers. By catalyzing collaborative improvement work throughout each high school, SCAN deepened cross-content connections within the schools.

Many teachers appreciated these opportunities to collaborate with cross-content colleagues in their schools, expanding their discussions of students they shared as well as opportunities to think about instruction in different ways.

62%
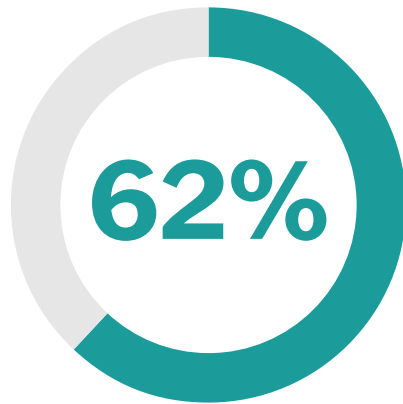
SCAN teachers interviewed noted the benefits of forging new relationships with in-school colleagues

Having time to common plan is unheard of. To have that time set aside where you are in a room with teachers who teach either the same or a different group of kids, but they are all saying the same things. They are all facing the same issues. Having that time to come together and plan and steal ideas from people—it's like there's nothing better for a teacher than a make and take.

– SPED teacher

50%
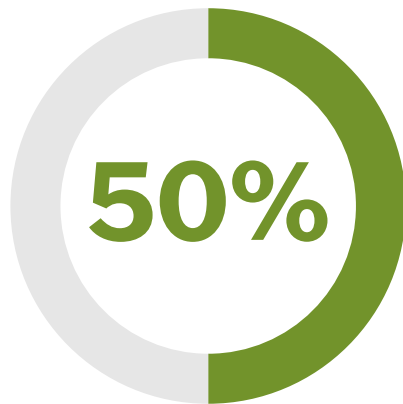
SCAN teachers interviewed noted the benefits of networking across content disciplines

I really enjoyed collaborating with people in different departments and seeing how they thought, how they did things differently, because I thought that was helpful for me to see how other people think because my students think differently than I do.

– ELA teacher

Seeding cross-school connections

Cross-school collaboration was the hardest to cultivate in SCAN. Some teachers noted appreciation for connections with teachers outside their school. A few SCAN teachers noted that because of their participation in the network, they had enhanced relationships with colleagues in other schools.

> *With the people I was working with in [the other schools], we were able to dig in more— because I was working with people who taught [courses similar to mine]—how they were focusing on engaging students for reflection and improvement was really great, to see how they were handling it, and methods and techniques that they were using to get at the big problem.*
>
> *– AP teacher*

However, some teachers noted in interviews the "network" aspect of SCAN was underrealized.

> *I feel like we didn't ever succeed in having a network. I felt like I had a connection as an individual with the hub, but I never felt any connection with any of the other schools. . . . Maybe with more time and more interaction with those people from the other schools, we would've all gotten there, but I never felt like—I felt like schools just kind of stayed in their own little school network, and I definitely felt like we had a network in our school but just not among the schools.*
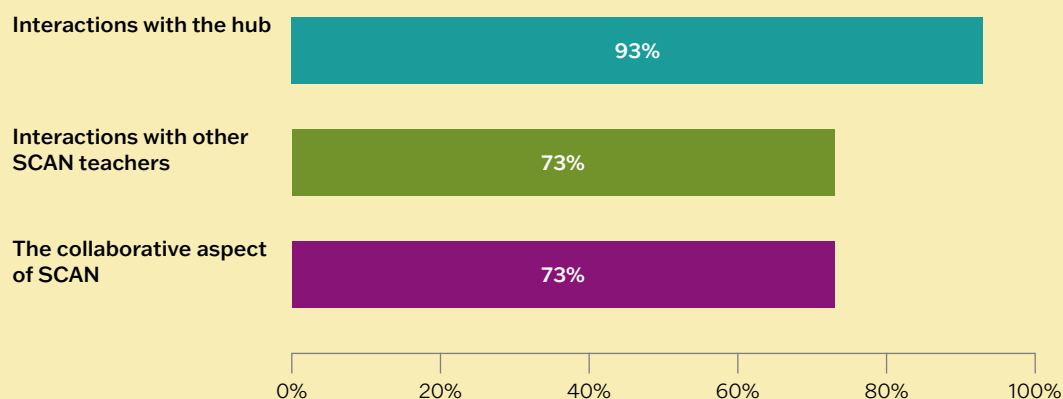>
> *– ELA teacher*

This comment, and others, suggest that building robust cross-school connections among teachers requires more time. It also might require the hub to intentionally design more explicit ways to support meaningful interaction between teachers from different schools.

Teachers valued the collaborative aspect of SCAN

SCAN teachers pointed to collaboration with the SCAN hub and teaching colleagues as the most influential part of their network experience as shown in **Figure 3**. The value of collaboration across the network, within schools, and across departments varied across the three participating sites. The differences were largely dependent on the existing degree of collaboration and school structures already in place to support collaboration. Teachers who were in more collaborative schools were more likely to appreciate the extended collaborative opportunities with cross-content school colleagues as well as colleagues from other schools.

Figure 3. Share of teachers who rated aspects of SCAN as influential to their practice

Interactions with the hub	93%
Interactions with other SCAN teachers	73%
The collaborative aspect of SCAN	73%

0%   20%   40%   60%   80%   100%

I would say that for me personally, the most valuable part of the network was being able to meet with [hub coaches] one-on-one, face-to-face. They knew what I was doing. They were thoughtful. They knew what questions to ask to push my thinking.

> *– ELA teacher*

Many SCAN teachers sought out support from a hub member or a school colleague for a variety of issues related to their inquiry cycle work as well as the development of student-centered formative assessment ideas. In Year 3, hub support outperformed SCAN colleagues in measurement-related areas although teachers sought out their colleagues for teaching related aspects of the work. Some interesting patterns include:

- Teachers were more likely to go to a colleague for support specific to student-centered teaching; 60% identified a colleague versus 40% sought out a hub member.

- Teachers were nearly equally as likely to seek out a colleague or hub member for identifying a change idea.

- Teachers were more likely to seek out a hub member for measurement-related help (e.g., 69% sought hub support to build or think about a data collection tool versus 43% went to a colleague).

Trying out new teaching practices, engaging students in new ways, and testing new ideas using PDSA cycles was complex work. The collaborative aspects of SCAN supported the teachers in their improvement work.

Lessons for the Field:

School Structures and Routines

Improvement networks are a powerful professional development model. Changing teacher practice in sustainable ways is complex and often fleeting; SCAN teachers found the improvement network model—using a networked approach to implementing change through the integration of improvement science methodologies—to be a highly effective professional development model.

A school-based network design can break down disciplinary silos in high schools, allowing teachers to benefit from a broader array of colleagues. By identifying a common goal that spanned content areas (in the case of SCAN: increasing the use of student-centered formative assessment), and providing regular time for teachers to work together, high school teachers were able to learn with and from colleagues with whom they did not normally collaborate.

School leaders must build structured time to nurture and sustain cross-department collaboration. Without this time built into their schedule, teachers are not likely to sustain cross-departmental collaboration.

Teachers benefit from supportive coaching that allows tinkering without judgment or penalty. Learning without evaluation, and an intentional focus on learning from mistakes in an iterative way, was a very powerful model that supported SCAN teachers' learning and growth.

Influence on Teaching

Participating in SCAN influenced teachers in a variety of ways. In the sections below, we present our findings on how SCAN broadened teachers' definition of student-centered formative assessment. We include evidence of how SCAN teacher engagement in the improvement work facilitated the uptake of student-centered formative assessment and how the hub supported teachers' use of data and measurement. We then present our findings on teachers' increased use of student-centered practices. Finally, we include teacher reflections on SCAN as a model for professional learning as well as improvements to teaching they experienced as a result of their engagement in the network.

Broadening definition of student-centered formative assessment

Interview data reflected that there were teachers in the network who had never thought about student-centered formative assessment or had not implemented it in their classrooms prior to joining the network. For some teachers, this meant— as a result of their participation in the network—they expanded student agency in their classrooms.

One ELA teacher noted,

> *I never even thought of student agency or student-centered formative assessments until I started with SCAN.*

A special education teacher shared,

> *I never connected that self-advocacy, self-agency was a form of formative assessment. I always thought it was like, 'Alright, make sure they know the material.'*

Other teachers noted a deeper understanding of student-centered formative assessment through engagement in the network.

> *I think around formative assessment there's a lot more to it than just, did they answer the question right or wrong? I think that's how a lot of people and how I looked at formative assessment before SCAN: at the end of the day, can they do what I tried to teach them, yes or no? I think there's room to take in a lot of other metrics about confidence, about their own perceived ability, their ability to engage with things on their own.*
>
> > *– Math teacher*

Deepening and expanding the use of student-centered formative assessment

Teachers also reported that the six principles of student-centered formative assessment co-constructed at the outset of the network helped them broaden their definition. These six principles served as a guide for teachers as they designed and tested new assessment practices through iterative PDSA cycles. In the final year of SCAN, teachers most frequently worked on the following three principles of student-centered formative assessment:

- **Reflective:** Students use formative assessments to reflect on their performance and make needed corrections/refinements.

- **Measurement:** Teachers engage students in peer- or self-assessment and reflection processes.

- **Collaborative with Students:** Teachers and students set performance criteria and targets together and assess the extent to which student performance meets those criteria/targets.

Trying new assessment strategies

In the course of this work, teachers used new tools and classroom routines to engage students.

Teachers tried out new tools and routines to enhance student engagement

Teachers used tools to give students more agency in classroom routines

Ninth-grade Algebra I students used *Google Quiz Practice* to engage in low-stakes, self-guided practice with some limited, automated feedback, allowing them to revise (using notes and other aids) and to practice as much as they felt was necessary to prepare for an assessment.

Ninth-grade civics students used the Quizlet app to do self-directed quiz creation as a new way to study material for summative tests.

Teachers built new classroom routines to integrate student reflection or increase peer collaboration

Honors Algebra I students examined their errors to reflect on ways to avoid similar errors in the future.

Twelfth-grade English students completed beginning, middle, and end of unit self-assessments, allowing them to identify and track their progress in learning skills that transcend particular content areas and can be applied in other contexts.

Tenth-grade social studies students engaged in self-reflection and peer collaboration as they built skill in using evidence in their short-answer response writing.

Building confidence over time

Engaging in inquiry cycles was difficult at first, but teachers became more confident over time. As one ELA teacher noted:

> *Understanding the whole PDSA cycle and the idea of student-centered formative assessments—it took me a whole year to understand it.*

Survey data shows that teachers' confidence in their use of PDSA cycles typically grew slightly each year they were in the network. This was true for SCAN teachers who were more engaged[3] in the inquiry cycle work. As shown in **Figure 4**, highly engaged teachers were more confident at the end of Year 2 (April 2019) than their less engaged peers. In addition, their confidence grew slightly by the end of Year 3 (April 2020) while the confidence of their least engaged peers declined.

Figure 4. Teacher confidence using PDSA cycles based on their level of participation

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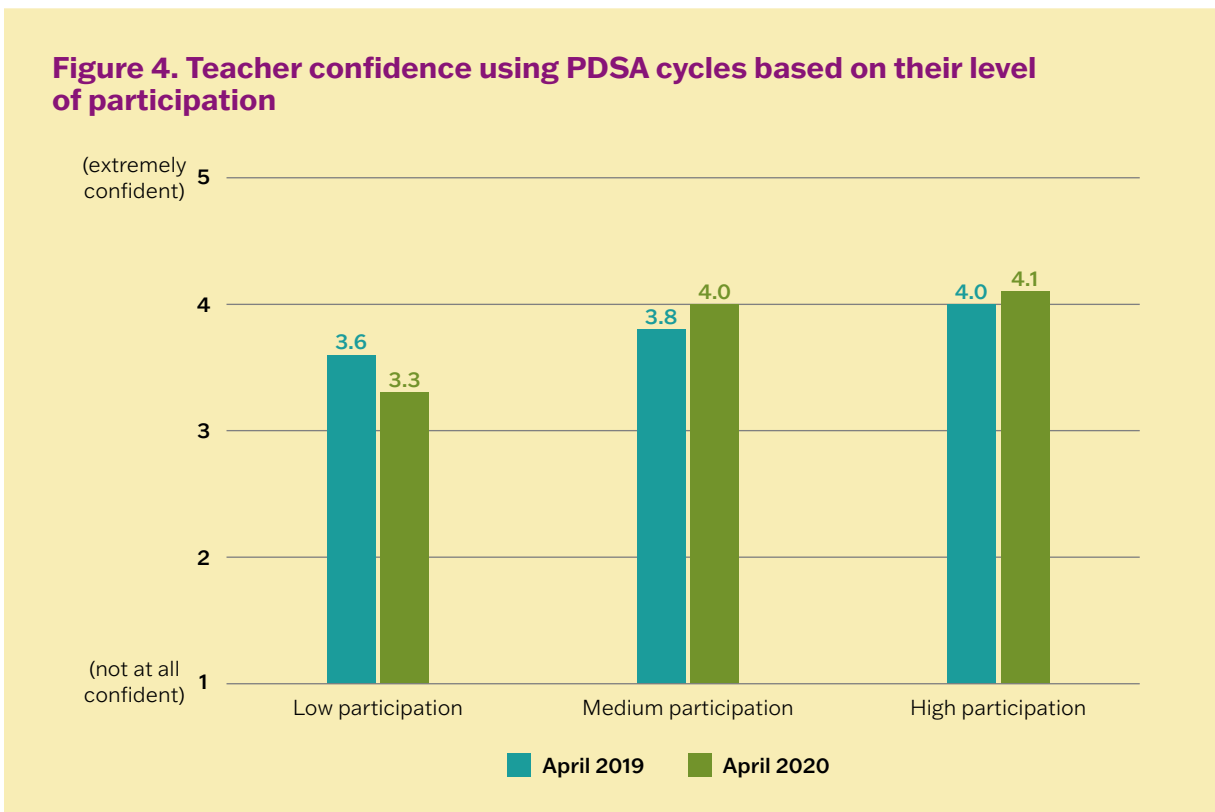
3 We analyzed PDSA documentation to determine engagement levels in the inquiry cycle work. If teachers completed at least two full PDSA cycles in a year, their participation level was considered "highly engaged." A full cycle included documenting their PLAN in a contract with self, writing at least two weekly logs, and engaging in a data debrief with the SCAN hub.

A few teachers noted in interviews that greater familiarity, experience, and use of PDSAs fostered growth and continuous improvement over time.

Growth

I think at first I was really skeptical of [the PDSA cycles], but I've decided I actually really like the nature of them. There's a beginning, there's an end, because it gives you a certain timeframe in which to try different things. If it didn't really work the way you wanted it to, you can just tweak it and start over. And if it did work the way you wanted it to, you can just continue doing it because it was working.

> *– Math teacher*

Continuous improvement

The PDSA structure was definitely the most useful element of this project. It gave us a concrete methodology for trying changes, and it also gave us permission to fail.

> *– ELA teacher*

Experience

I've seen [PDSA results] they've shared at various meetings, I've seen my own experience, I've seen [a colleague's] AP scores, which are ridiculously incredible. Having that PDSA, following all of the steps in that PDSA, and when you do it with fidelity, you're going to create something good. And if it's not good, you're going to make it better. That's been my experience, and that's what I've seen other teachers doing.

> *– Science teacher*

Using data differently

The SCAN hub helped teachers think about data—both qualitative and quantitative data. Teachers reported that they became more intentional in their use of data as a tool, and they shared data more often with students and departmental colleagues. They were more likely to tie data to their instructional practice. Perhaps, most important, the SCAN hub fostered teacher reflection on their practice in order to understand if their changes were leading to improvement.

Using data in new ways

After all this time we spent together and all these meetings, I hear over and over again, teachers feeling like they had no idea what measurement was before they joined the effort. They might have prepared a formative assessment, but using it as a tool and collecting data—I hear teachers all the time saying, 'You know what? I'm not very good at this, but this is what I did.' I feel like, as a network, lots of teachers are doing things that they would not have done, and a lot of them have gotten good at it, too.

> *– Science teacher*

Seeing results has been huge with this process, and I'm not a math person, but this has definitely changed my view of math!

> *– ESL teacher*

Sharing with students

I've been more intentional sharing data with students to show them that they're learning. I'll say, 'The last time we did this exercise, the class average was 71 and the second time we did it, our class average was an 82. We're getting better. You can think about: Where do you stack up with that class average?' . . . It's definitely changed the way I talk to students about data because I never did before.

> *– ELA teacher*

It really had me looking deeply at the data as well and how to present data and why it's important. At first, I was like OK, whatever. But then afterward, I realized wow, [that coach is] really making me look deeply at this work. He's getting me to present information to the students and think about how I had to present the information to the students.

> *– SPED teacher*

Sharing with colleagues

So now since I've been looking more at the data, not just the assessment, but even in the math department, we are going back and looking at common assessments as a whole department and seeing which questions students are getting right, which questions students are getting wrong, and looking at it more like, 'Why are these kids getting these questions wrong?'

> *– Math teacher*

I have a more sound understanding of how to make a change in my classroom, how to analyze the change and look for whether or not it's working and collect the data behind it to prove it and not just go back to the, 'Well, this is what I think was happening before, this is what I see now'; actually being able to see if it's making an impact or not the way I thought it was.

> *– Math teacher*

Using more student-centered practices

Many SCAN teachers reported their engagement in the network had a significant impact on their instruction in a variety of ways. At the end of Year 3, teachers reported that they used more student-centered formative assessment, engaged more students in formative assessment, and shared responsibility with students.

> *I think student-centered formative assessment is a key step to the evolution of education. When it worked well, the students recognized their role in learning—it really took the onus off me. That was the big difference for me: to recognize that the students have a responsibility for what they need to get done. It allowed them to have a choice and a voice. Granted, it didn't work with every kid, but it worked with several.*
>
> > *– ELA teacher*

In addition, about half of SCAN teachers noted the following aspects of teaching that their participation in the network significantly impacted:

- Thinking about how students learn

- Using student-centered formative assessment

- Engaging more students/engaging different students in formative assessment

- Engaging students in assessing their performance against expected outcomes

- Sharing the responsibility with students to assess how they were doing and to make choices that would improve their knowledge and/or skills

Teachers who joined in Year 2 were more likely to report a moderate or substantial impact on adjusting the learning experiences in their classrooms to remediate gaps in learning. This might, in part, reflect a Year 2 shift in network focus that asked teachers to enact changes designed to support students who tend to struggle more in school.

Professional learning and practice improvement

Almost half of SCAN teachers rated SCAN as better or significantly better than their best professional development (PD) experience across the following five dimensions:

1. Change in their actual practice

2. Lasting change beyond the PD experience itself

3. Relevance of PD to their practice

4. Effect on their students

5. Extent to which it deepened the rigor in their work

Effective professional development

This has been, to my teaching practice, one of the best professional developments that I've done. It really made me look at what I wanted, how I could get there and the results from it in a really specific way. And it was really nice to be able to talk to the coaches in the data debrief and have another set of eyes look at my data. As I talked through the PDSA, they noticed things that I didn't, or they had suggestions for assessments or how to get at what I was really looking for.

> *– ELA teacher*

My thing with SCAN from the beginning was that it was so drastically different than any PD I'd ever experienced because I felt like [the hub] actually cared about what I was doing and what they were doing.

> *– ELA teacher*

This has been one of the most powerful professional learning experiences for me.

> *– ELA teacher*

Improved teaching

The nature of the [PDSA] cycle forced me to get away from assigning something, correcting something, moving on. That's a big change, because for me now, it's a lot of the writing pieces: assign something, feedback, fix it, feedback, fix it. . . . Now kids have opportunities to go back and see what they did wrong, and to get feedback, and to think about it.

> *– Science teacher*

Surveying the students, differentiating more, trying to make that work in each class. It just seems SCAN was a big benefit for me. Even though it could be time consuming, anything I did inside my classroom that was SCAN-related, I could only see it as a benefit for my students. The reflections, it is making me a better teacher as well.
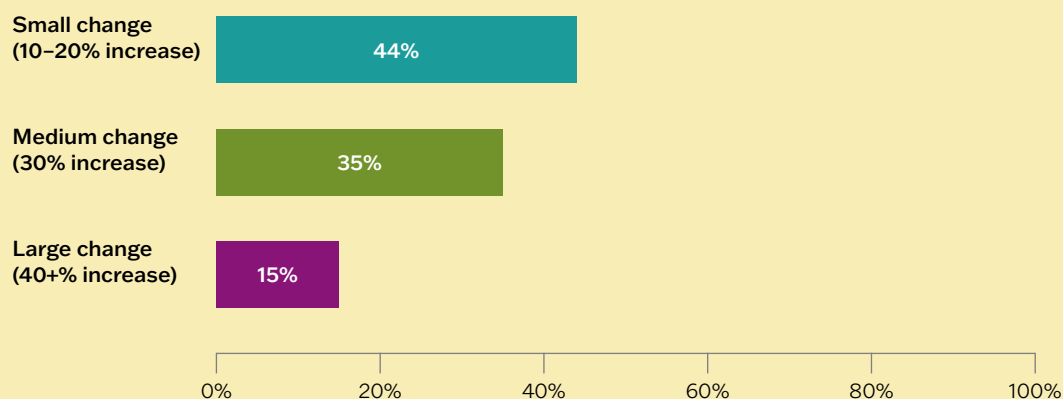
> *– Math teacher*

Instructionally focused improvement networks bring together three main ingredients:

- Collaborative routines

- Improvement science

- The instructional area the network is seeking to improve—in the case of SCAN, student-centered formative assessment

When asked about these three "ingredients," SCAN teachers reported student-centered formative assessment had the highest influence on their work—more than collaborative routines or improvement science.

The majority of SCAN teachers reported becoming more student centered in their practice as a result of their engagement in the network. As shown in **Figure 5**, 95% of the 41 teachers who took the end of Year 3 survey reported a modest increase in student-centered practice—between 10 and 40%[4]—from the time they joined SCAN to April 2020.

Figure 5. Teachers' self-reported change in student-centered teaching

Small change (10–20% increase): 44%
Medium change (30% increase): 35%
Large change (40+% increase): 15%

(Scale: 0%, 20%, 40%, 60%, 80%, 100%)

These changes to teaching practice translated into changes for student experience in SCAN teachers' classrooms.

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4 Data from the following Spring 2021 survey questions: Before you joined SCAN, how much of your teaching would you characterize as student centered? How much of your teaching now would you characterize as student centered? (Percent options between 0 and 100). It is important to note that there is not space for all teachers to have medium or large changes, based on how student centered they reported they were when they joined the network.

Lessons for the Field:

Influence on Teaching

The disciplined approach of a PDSA cycle provides accountability and supports instructional change. Building documentation and coaching into the PDSA cycle enabled SCAN teachers to deeply engage with the changes they were testing and determine if those changes were leading to improvement.

Supporting practical measurement gives teachers tools they will continue to use. The SCAN hub helped teachers understand new ways to measure student engagement and agency, collect and analyze data using various tools, and make sense of that data to inform their next steps. Many teachers integrated these new ways of using data into their practice.

Influence on Students

The goal of SCAN was to engage high school students more deeply in their learning. As teachers began to shift their teaching practices, they engaged students in different ways. In the section that follows, we look at how students were drawn into the learning process and how students incorporated new ways of working into their studies.

Engaging students deeply in the learning process

Teachers reported that their engagement in SCAN had a large effect on student learning in a number of ways. SCAN teachers found their students benefited from peer editing and feedback. Teachers also noted increased engagement and independence, which affected students' agency and willingness to take intellectual risks.

Peer editing and feedback

Students were more apt to peer edit as they were more accountable to ensure the success of the other student as well as their own success.

> *– Science teacher*

They value their peers' feedback, and they can use other students' work as a model.

> *– ELA teacher*

Engagement

I originally started working on utilizing rubrics with my students. We were working on writing skills and editing, and then it evolved into the students assessing themselves. Then it evolved into the students seeing where they needed growth and what skills they needed to work on. So, they definitely got more independent.

> *– SPED teacher*

Intellectual risks

I certainly think that the ability for [students] to revise has allowed them to take more intellectual risks.

> *– Science teacher*

Engaging harder-to-reach students

SCAN teachers also reported that by engaging in more student-centered formative assessment, they were engaging some of their harder-to-reach students. Less-engaged students became more engaged. In some classrooms, students with special needs benefited even more than their peers.

> *What surprised me is that, when I pulled out the at-risk students, they moved at least as much if not more than the others. Going from the pre-test to the common assessment or the pre-test to the summative assessment (in the second PDSA cycle)—their scores move at least as much if not more than the whole class scores.*
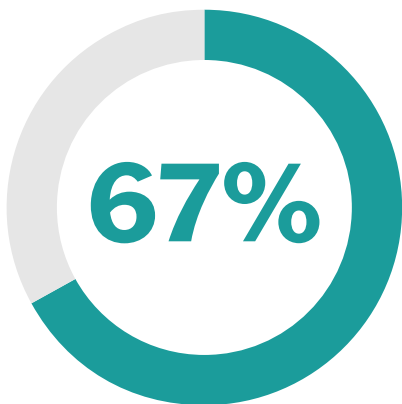>
> *– Science teacher*

> *I think it is super beneficial for my students. I can see growth in them. I can see them being better at advocating for themselves, which is so important. Especially students who have special needs, because they will need to always advocate for themselves because of their learning differences.*
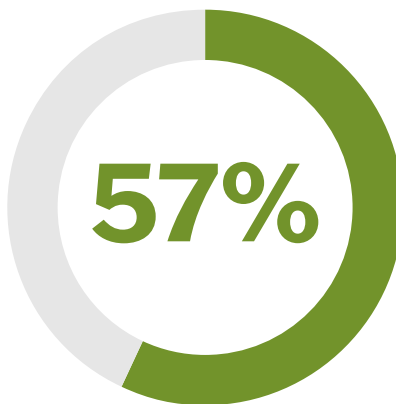>
> *– SPED teacher*

Expanding student agency in the learning process

In June 2020, we asked SCAN teachers to choose—from the following list—the two ways their students had changed the most, as a result of their engagement in the network:
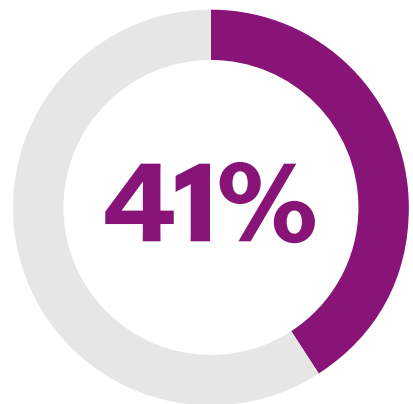
- My students are taking more ownership over their own learning.

- My students feel more agency in my classroom.

- My students are working more collaboratively in my classroom.

- My students are more reflective about their learning or their behavior in my class.

- My students are more engaged during class.

- My students are learning more.

67%
My students are taking more ownership over their own learning.

57%
My students are more reflective about their learning or their behavior in my class.

41%
My students feel more agency in my classroom.

Most students engaged in new ways of working

Students responded to these classroom changes in a variety of ways. Asking students to take ownership over their learning pushes many of them into a very different way of experiencing school. For example, it takes much less effort to ask the teacher for help than it does to reference one's own notes and find the answer without help.

Many teachers reported that it took time, but the students grew to appreciate the changes they were implementing.

> *Most students have adapted and are seeing the gains that they are making.*

> *Once students are comfortable, they have begun to adapt to the idea of having their voice heard in the classroom.*

> *[Students were] hesitant but understanding once the process showed meaning.*

For a few teachers, however, student response was mixed.

> *The students either rise to the occasion or get frustrated with the new ideas in place and struggle.*

> *The students don't love them at first but—albeit sometimes begrudgingly—admit they are incredibly helpful in helping them navigate their learning.*

> *It depends on the class, but only a third of the students truly take advantage of the opportunities they are given on a regular basis.*

Other teachers reflected that their students responded positively.

> *Students have shown appreciation and growth.*

> *I feel students were better prepared to take ownership for their learning and were better engaged during these lessons.*

**Lessons for the Field:**
Influence on Students

Students benefit from a focus on student-centered practices. As a result of giving more power and voice to their students, SCAN teachers noted students had higher engagement, more confidence, and more agency in their learning.

Potential for Sustainability

After participating in SCAN, teachers were positive about their experience, appreciated the learning opportunities, and reported change in their own practice as well as changes in their students' experience and engagement. With support from the hub, SCAN teachers engaged in inquiry cycles to test new student-centered formative assessment practices in their classrooms and started to come together in a networked way to learn from each other. After three years of structured meetings, supplemental pay for engagement, and hub support, what will persist beyond the grant?

Continuing to use student-centered formative assessment strategies

The majority of SCAN teachers reported that they intend to continue to engage in student-centered formative assessment strategies beyond the scope of the grant, as shown in **Figure 6**.

Figure 6. Likelihood of the use of student-centered formative assessment strategies to persist beyond the scope of the grant
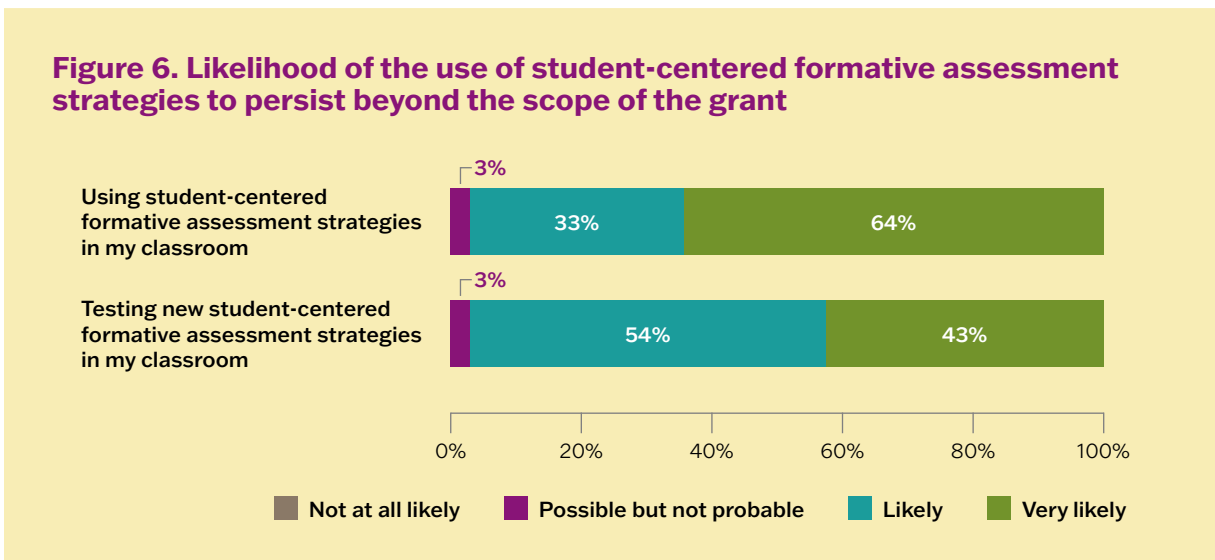
I'll speak for [my department]: definitely. I think you will see a lot of the same techniques and tactics that we've been using. We'll continue to use those.
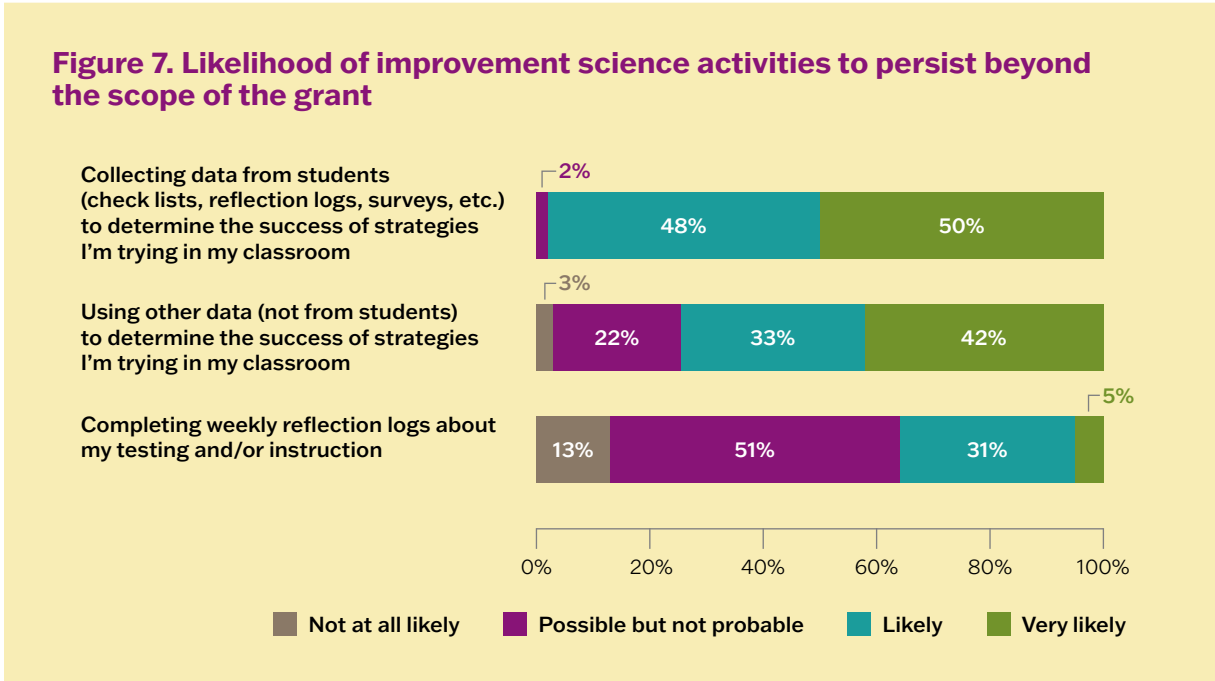
> *– Science teacher*

My school district . . . is really trying to look hard at ways that we can get our students to reflect more on their habits around education, their learner qualities. I definitely see that continuing, and hopefully what we've done, myself and my colleagues, with SCAN will help inform the work that my district is trying to do.

> *– Math teacher*

Involvement in the network influenced the way that many of the SCAN teachers thought about formative assessment and the ways in which they designed classroom activities and tasks to involve students in their own learning. The deep engagement with student-centered formative assessment facilitated by the network increases the prospects of sustainable impact on teaching and learning.

Sustaining the use of new data skills

When asked about improvement science-related practices that will sustain beyond the scope of the grant, teachers reported that they are most likely to collect data from students (check lists, reflection logs, surveys) to determine the success of strategies they are trying in their classroom, as shown in **Figure 7**. Some teachers noted they may do the inquiry work, but with less formality.

Figure 7. Likelihood of improvement science activities to persist beyond the scope of the grant

Activity	Not at all likely	Possible but not probable	Likely	Very likely
Collecting data from students (check lists, reflection logs, surveys, etc.) to determine the success of strategies I'm trying in my classroom	2%		48%	50%
Using other data (not from students) to determine the success of strategies I'm trying in my classroom	3%	22%	33%	42%
Completing weekly reflection logs about my testing and/or instruction	13%	51%	31%	5%

For some teachers, their inquiry work will continue, with a lighter touch:

> *This stuff is an integrated part of my class. The techniques, and tactics, and the process I will continue to use absolutely. I think the biggest change is I probably won't be collecting the same formal data.*
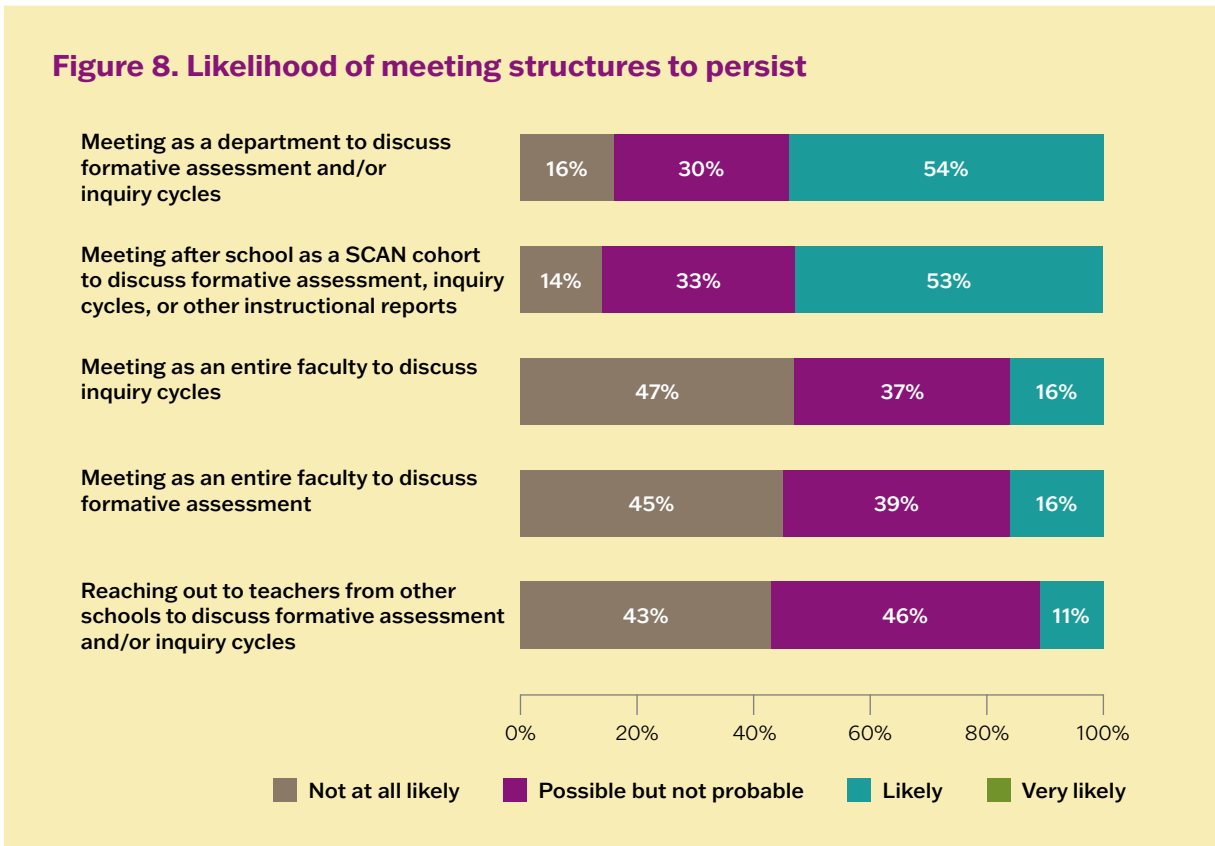>
> *– Science teacher*

> *I know that talking to some of [my colleagues], we'll still be doing some of these things. . . . For some people, the paperwork became overwhelming. I feel like it will become almost informal: not collecting as much data, not looking at it in terms of the way SCAN would be looking at it.*
>
> *– Math teacher*

Engagement in PDSA cycles, supported by the documentation deadlines and conversations with the hub, changed teacher practice in ways that are likely to continue. Many SCAN teachers will engage in student-centered formative assessment as well as use data to inform their work. The rigor with which SCAN teachers documented their PDSA cycles will not continue without the support and accountability the network offered. One lingering question remains: How much does that matter? If teachers are now engaging more students, and different students, and if they have integrated these new strategies into their classrooms, maybe the rigorous inquiry cycle work has been successful. The extent to which sustained, formalized inquiry practices are essential to lasting instructional change is an open question for the field.

Ensuring the future of collaborative teacher networks

Without intentional structures to protect time for teacher collaboration, SCAN teachers are less likely to continue working together. They might continue to try out and discuss new student-centered formative assessment strategies in their existing collaborative structures, such as department meetings, but they are unlikely to do it outside of this structured time. This is reflected in survey data collected just before the pandemic dramatically changed schooling. We asked teachers which meeting structures from SCAN they thought might persist beyond the scope of the grant. Although no teacher rated any structure "very likely" to persist, more teachers reported that meetings with school colleagues were the most likely to persist, as shown in **Figure 8**.

Figure 8. Likelihood of meeting structures to persist

Meeting structure	Not at all likely	Possible but not probable	Likely
Meeting as a department to discuss formative assessment and/or inquiry cycles	16%	30%	54%
Meeting after school as a SCAN cohort to discuss formative assessment, inquiry cycles, or other instructional reports	14%	33%	53%
Meeting as an entire faculty to discuss inquiry cycles	47%	37%	16%
Meeting as an entire faculty to discuss formative assessment	45%	39%	16%
Reaching out to teachers from other schools to discuss formative assessment and/or inquiry cycles	43%	46%	11%

Legend: ■ Not at all likely ■ Possible but not probable ■ Likely ■ Very likely

Interview data confirm that within-school collaboration may persist, but cross-school is less likely to endure. Most teachers did not expect to see connections with teachers from other schools continue. Many did, however, plan to continue collaborating around student-centered formative assessment approaches and talking about their work with the colleagues with whom they were already connected. In most cases, this translates to teachers with whom they already have common planning time, such as at department meetings, or a pre-existing relationship.

> *I think that you probably will see a significant amount of continued collaboration within departments. Right? But between departments? Probably less. Just because there's no time available. They don't have time off together.*
>
> *– Science teacher*

This suggests the need for school leaders to hold time for teachers to collaborate if they want to sustain the cross-department collaboration that SCAN built. Individual changes are easier to sustain than collaborative ones, especially if the collaborative spaces are not as clearly carved out.

Unfortunately, the pandemic amplified these challenges. In March 2020, the network was winding down its formal work together. When we spoke with a sample of teachers during this time, some teachers noted that the SCAN collaboration became more challenging after the pandemic required a shift to virtual learning. While this had a negative impact on the sustainability of the work, teacher interviews prior to the pandemic provide a window into other barriers to sustainability.

The intensive hub coaching support—which was effective, well received, and well utilized—ended in the fall of 2020. After that time, SCAN teachers had to seek out support from each other to sustain the motivation, learning, and engagement the hub coaching provided. In Year 3, the hub trained mentors to support their SCAN colleagues. This sustainability strategy might serve as one possible resource to support engagement in cross-departmental work or to receive targeted support, although this effort did not have the intended results in Year 3. Only 25% of SCAN teachers ranked their interactions with mentors to be highly influential, and teachers were more likely to seek out other SCAN colleagues than they were to tap mentors for support. Developing SCAN leaders in each school was a strategic move the hub made to support sustainability. Although an important step, it proved to be a difficult one to enact with impact.

Lessons for the Field:
Sustainability

Without extensive support, changes to individual teacher practice are easier to sustain than ongoing collaborative routines. SCAN teachers reported that student-centered formative assessment had the highest influence on their work over the other two aspects of the network (collaboration and the improvement science methodology). Teachers intended to continue the changes in their individual practices, but the collaborative work they enjoyed in SCAN will not sustain without direct support from school leadership. This support requires both a priority for the work (giving up other responsibilities) as well as regular time to meet.

Building teacher leaders to support this work requires time and scaffolded supports. Developing SCAN leaders in each school was a strategic move the hub made to support sustainability. Because the SCAN hub support was so intensive, training teacher mentors to support their peers in each school was an essential step toward sustaining testing, learning, and collaboration. The SCAN teacher mentor program launched in the final year of the work, was disrupted by the pandemic, and was not ultimately successful. This points to the time and resources necessary to support effective teacher leaders.

Conclusion

Overall, SCAN teachers valued their participation in the network. Eighty-five percent of SCAN teachers agreed or strongly agreed that their involvement in the network helped them do their job better. The three top tools teachers identified that they valued from their work in SCAN were ideas (85%), measures (80%), and strategies (78%). They shifted their practice to be more student centered and they more frequently involved students in formative assessment practices. They benefited from, and greatly enjoyed, the hub coaching. They appreciated the time to work with their school colleagues, both within and across departments. The work of SCAN helps us better understand the opportunities and challenges of instructionally focused improvement networks.

Lessons for the Field

School Structures and Routines

- Improvement networks are a powerful professional development model.

- A school-based network design can break down disciplinary silos in high schools, allowing teachers to benefit from a broader array of colleagues.

- School leaders must build structured time to nurture and sustain cross-department collaboration.

- Teachers benefit from supportive coaching that allows tinkering without judgment or penalty.

Influence on Teaching

- The disciplined approach of a PDSA cycle provides accountability and supports instructional change.

- Supporting practical measurement gives teachers tools they will continue to use.

Influence on Students

- Students benefit from a focus on student-centered practices.

Sustainability

- Without extensive support, changes to individual teacher practice are easier to sustain than ongoing collaborative routines.

- Building teacher leaders to support this work requires time and scaffolded supports.

Appendix: Data Collection

Data collection was cued to the network design and activities. The table below summarizes the data sources used in this report and indicates the number of administrations and respondents.

Data sources	Data collected
1. Hub/PNI meetings	Field notes N = 6
2. Network member survey	April 2020: N = 50 teachers June 2020: N = 42 teachers
3. Teacher interviews (general)	Spring 2020: N = 13 teachers
4. Teacher interviews (artifact)	Spring 2020: N = 8 teachers
5. Teacher interviews (exit)	Fall 2021: N = 11 teachers
6. Observation and artifacts from all network meetings and school-based meetings	Field notes and artifacts, 1–3 meetings in each of the following months: 2019: September, October, November, December 2020: January, March, April, May, September, November
7. PDSA documentation	Cohort 1 and 2 teachers were expected to complete 4 cycles. Cohort 3 teachers were expected to complete 2 cycles. Some of the cycles shifted into fall 2020 due to the COVID-19 disruption in spring 2020.
• Contract with myself	2019–2020 school year Cycle 1 N = 23 Cycle 2 N = 32 Cycle 3 N = 11 Cycle 4 N = 2 Fall 2020 N = 28
• Weekly log reflections	2019–2020 school year Cycle 1 N = 154 Cycle 2 N = 116 Cycle 3 N = 42 Cycle 4 N = 8 Fall 2020 N = 65
• Pre-data debrief reflection	2019–2020 school year Cycle 1 N = 22 Cycle 2 N = 15 Cycle 3 N = 4 Cycle 4 N = 1 Fall 2020 N = 11
• Data debrief form	2019–2020 school year Cycle 1 N = 28 Cycle 2 N = 20 Cycle 3 N = 8 Cycle 4 N = 2 Fall 2020 N = 26