Engaging Students in High School Algebra: The Better Math Teaching Network

Summative Developmental Evaluation Report

Summer 2021

AUTHORED BY

Jennifer Zoltners Sherer
Jennifer Lin Russell
Jennifer Iriti
Rosemary McNelis
Christopher Matthis
Stacy Monosmith

Partners for Network Improvement
Research, Strategy, & Evaluation

nellie mae EDUCATION FOUNDATION

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 Better Math Teaching Network (BMTN). PNI conducted a developmental evaluation that studied and supported the networked improvement community's (NIC) initiation, development, outcomes, and dissemination of lessons learned.

PNI's developmental evaluation of BMTN 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 BMTN hub leaders and the 62 teachers who opened their practice and their learning spaces, and welcomed us in. We are inspired by their love of math, passion for students, and desire to never stop improving.

Table of Contents

Figures

Building a Learning Organization

Designing for Educator Learning

Participating in the Network Influenced High School Math Teachers

BMTN Teachers Reported Increased Student Engagement in Algebra

The Better Math Teaching Network

From 2016 to 2021, the Better Math Teaching Network (BMTN) aimed to transform high school mathematics teaching in New England. Researchers and teachers worked together to make high school Algebra I classes more student centered. Launched by researchers at the American Institutes for Research (AIR), with support from the Nellie Mae Education Foundation (NMEF), the network was grounded in the following five core principles:

1. **Teachers are central to change.** Teachers shape students' learning experiences and beliefs about math. It is possible to create classrooms that are more strongly student centered—classrooms in which all students are actively and meaningfully engaged in learning math.
2. **Student-centered teaching is complex and almost impossible to do in isolation.** Teaching to maximize student engagement and understanding is complex. One way to deal with this complexity is for teachers to participate in structured, collaborative learning with other teachers and researchers.
3. **Teaching can be continuously improved.** Teaching is a craft to continuously hone. Teachers use practices daily that lend themselves to ongoing, incremental improvement. Continuous improvement methods from industry and healthcare hold promise for education.
4. **Quick-cycle improvement methods provide opportunities to study and improve teaching.** Many of the practices teachers want to improve on can be studied with quick-cycle research and development methods. Teachers can test and refine strategies within and across lessons, realizing improvements every few weeks, rather than waiting until summer break.
5. **Research and practice should be seamlessly integrated.** Too often, research and practice fail to inform each other. The BMTN included researchers and practitioners who worked arm-in-arm to test and refine improvement strategies in real classroom settings. Mutual respect fueled the work.

Network leaders organized the BMTN as a networked improvement community (NIC) to address a common problem of practice using improvement science. They drew on research to define three principles for Deep Engagement in Algebra (DEA), which anchored teachers' work as they strove to make their practice more student centered:

Connect: Make connections among mathematical procedures, concepts, and application to real-world contexts, where appropriate.

Justify: Communicate and justify mathematical thinking as well as critique the reasoning of others.

Solve: Make sense of and solve challenging problems that extend beyond rote application of procedures.

The BMTN was piloted with a group of nine teachers during the 2015–2016 school year and added teachers the following three years. In all, a total of 63 teachers engaged in the BMTN. Selected from a pool of volunteers that applied to join the network, participating teachers worked in urban, suburban, and rural contexts and taught at least one Algebra I course to 9th grade students. They engaged collaboratively to continuously improve their teaching, enhancing learning for thousands of high school math students throughout New England.

Unique Challenges of Instructionally Focused NICs

Research has shown that changing classroom instruction is a high-leverage opportunity for improving education at scale. For this reason, educators across the United States are engaged in networks that aim to improve teaching and learning. In NICs, educators work collectively to improve learning opportunities for students using improvement science methods (Bryk, Gomez, Grunow & LeMahieu, 2015; Gomez, Russell, Bryk, LeMahieu, & Mejia, 2016; Russell, Bryk, Dolle, Gomez, LeMahieu, & Grunow, 2017; Russell, Bryk, Peurach, Sherer, LeMahieu, Khachatryan, Sherer, & Hannan, 2021).

NICs go beyond the typical workshop-based professional development to support collective learning in which educators:

- Commit to a shared goal that is tied to a measurable outcome
- Use disciplined inquiry methods anchored in concrete data to enact high-leverage instructional routines
- Experiment to find which practices work under which conditions

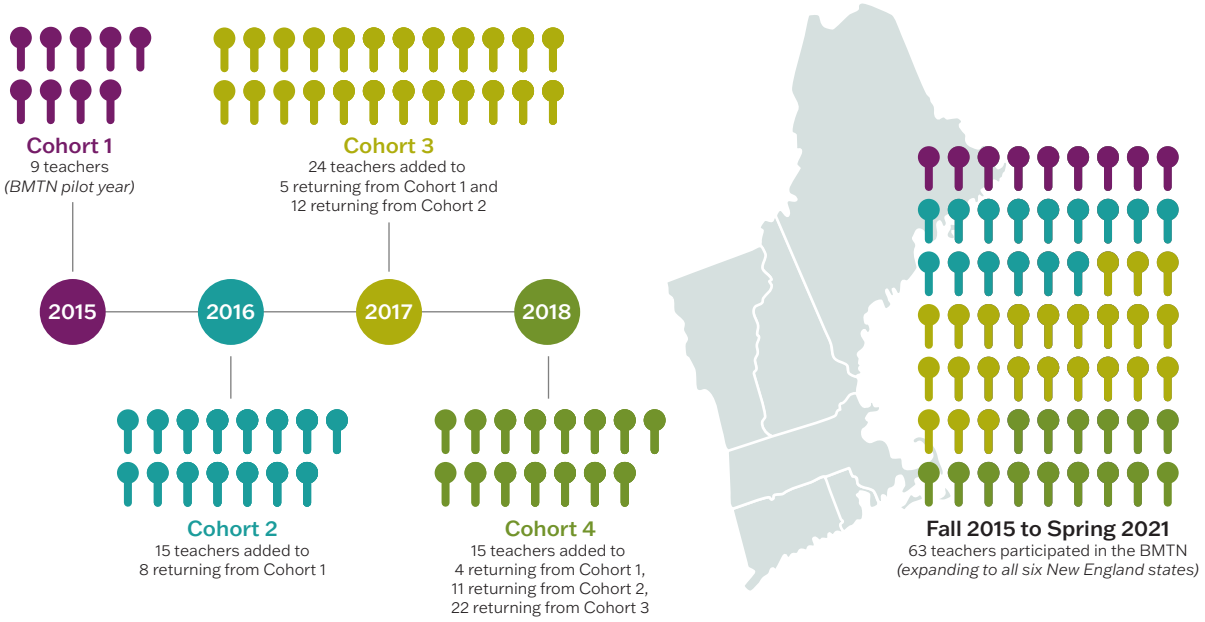
The NIC model for improvement in education has been in use for a little more than a decade. Instructionally focused NICs are temporary organizations seeking to improve instructional practices and student outcomes. The field's understanding of this process is still emergent. As an instructionally focused NIC, the BMTN provides a powerful case to explore approaches to changing instructional practice. Lessons learned from this case can be instructive to other NICs seeking to improve instruction.

Although the NIC model came from outside the field of education, there are many opportunities associated with NICs that are aimed at improving teaching and learning. There is considerable knowledge in the education field about what good, rigorous instruction looks like. The challenge is to get this knowledge into practice on a large scale. Improving instruction is a systems problem. It is not enough to provide professional development to teachers—instructional guidance systems and routines to support continuous improvement are also needed. Improvement networks can be used to support the uptake of best instructional practices. This is consistent with the notion of networked improvement science that is at the heart of the NIC model.

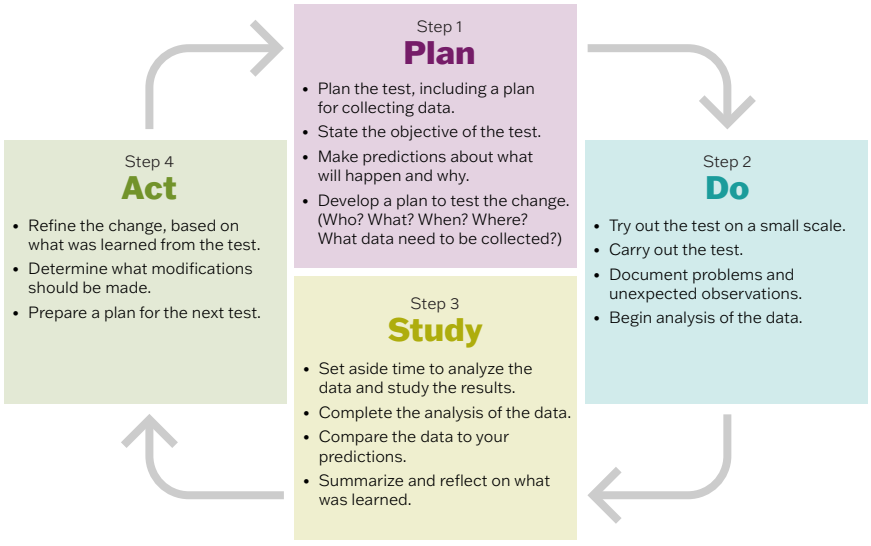
There are many reasons to organize networks to support instructional improvement in schools and districts, but the education field is still learning how to operationalize the NIC concept. With support from the Nellie Mae Education Foundation, researchers at the AIR launched the BMTN to test out the networked improvement community concept: How might an instructionally focused NIC transform high school Algebra I instruction in New England?

Designing an Instructionally Focused NIC

In 2015, the BMTN hub[1] launched the pilot year of the BMTN, engaging nine New England high school teachers to begin work on a common problem of practice: low and inequitable student engagement in mathematics. These teachers comprised Cohort 1. In the summer of 2016, 15 teachers (Cohort 2) joined eight returning teachers. These 23 teachers from five New England states participated in the first official year of the BMTN's operation. The network added Cohort 3 in 2017 (24 teachers) and Cohort 4 in 2018 (15 teachers), expanded to all six New England states, and continued until the pandemic disruption in March 2020. In the time we studied the network (fall 2016 to spring 2021),[2] a total of 62 teachers participated in the BMTN.



Each year, teachers were selected from a pool of volunteers who applied to be part of the initiative. Participating teachers worked in urban, suburban, and rural contexts and taught at least one Algebra I course to 9th grade students.[3] BMTN teachers committed to work collaboratively to make their teaching more student centered using the improvement science approach. The BMTN was organized as a NIC with three key design features: working toward a shared goal, using **Plan-Do-Study-Act cycles**, and testing in a range of contexts.



Modified from Institute for Healthcare Improvement
http://www.ihi.org/resources/Pages/HowtoImprove/ScienceofImprovementTestingChanges.aspx

1 The BMTN was led by two researchers from AIR, Toni Smith and Kirk Walters. While some supporting staff changed over time, they were primarily supported by a project manager, a math/adult learning expert, and a communications person.

2 The network officially ended its work in spring 2020; we collected a final data set in spring 2021. Since one teacher did not continue after the pilot year, we studied 62 BMTN teachers.

3 Occasionally, teaching assignments change, and in several cases, teachers returning to BMTN did not teach Algebra I sections after their first year in the network.

BMTN teachers shared the goal of improving student engagement in algebra

In NICs, educators commit to a shared goal tied to a measurable outcome. The BMTN hub drew on research, including their own prior work,[4] to articulate a definition of student-centered mathematics learning, referred to as **Deep Engagement in Algebra (DEA)**.

Connect

Making connections among mathematical algorithms, concepts, and application to real-world contexts, where appropriate.

Justify

Communicating and justifying mathematical thinking as well as critiquing the reasoning of others.

Solve

Making sense and solving challenging problems that extend beyond rote application of algorithms.

They defined the BMTN aim as follows: *By 2020, the BMTN aims to increase the number of New England students who connect, justify, and solve with depth by 2,020.*

BMTN teachers used Plan-Do-Study-Act cycles to change practice

One tool of improvement science is the Plan-Do-Study-Act (PDSA) cycle. Practitioners begin by designing a small, specific change tied to a working hypothesis of what will achieve an improved outcome. They then implement the change in the classroom, study evidence to assess whether the change produced the sought-after improvement, and decide—in light of what they have learned—what action to take next. BMTN teachers used PDSA cycles to test changes in their practice that deeply engaged their students in algebra. The BMTN hub designed tools and routines to support this work, including a variety of participation structures (whole network meetings, continuous improvement team meetings, study groups), access to hub expertise, inquiry cycle templates, and rubrics to support practical measurement.

4 In 2014, AIR conducted a study, with support from the Nellie Mae Education Foundation, called An Up-Close Look at Student-Centered Math Teaching: A Study of Highly Regarded High School Teachers and Their Students. The study broke down the concept of student-centered learning into key practices: allowing for heavy student contribution, encouraging active student exploration, using problems that require students to think critically and communicate their thinking, and asking students to explain the "why" of their answers.

BMTN teachers tested new routines in a range of contexts

Within NICs, educators explicitly experiment to find which practices work under different conditions. BMTN teachers taught a wide range of learners, including multilingual learners, recent immigrants, students in special education programs, adults in night school settings, and vocational/technical students. They also taught in a variety of geographic settings (rural, suburban, urban, state charter schools) from all six New England states.

The development of an instructionally focused NIC presents a number of design challenges that network leaders must address. These include building a learning organization, designing for educator learning, and optimizing systems. Whether and in what ways network leaders meet these challenges contributes to the efficacy of the NIC.

In the remainder of this report, we describe these three design challenges and offer summary-level data and findings about how the BMTN hub addressed these challenges. Ultimately, the purpose of instructionally focused NICs is to improve teaching practice in order to expand and deepen student learning opportunities. Therefore, we conclude with a brief examination of how participation in the BMTN influenced the participating teachers' practice and the classroom experiences of their students.

Design Challenge #1: Building a Learning Organization

How do hub leaders build an organization that supports collective learning?

In successful NICs, network members cohere as a learning organization. This is different from most education collaboratives in that the connection is more than just educators sharing ideas with each other—in NICs, network members learn from the variation in and results of the testing of change ideas other teachers enacted. In this way, learning is accelerated. The challenge, then, is for a network hub to build an organization that supports collective learning. Hub leaders must design participation structures, tools, and routines that support meaningful connection and shared learning opportunities for NIC members.

To meet this challenge, the BMTN hub organized members in activities designed to build trust, support member growth, and provide opportunities to learn from each other as they improved their own practice.

The BMTN hub achieved its goal of building a learning organization in six ways:

1. Designing routines to support teacher collaboration
2. Leveraging instructional expertise
3. Managing network membership intentionally
4. Maximizing access to research and practice knowledge
5. Managing knowledge and consolidating learning
6. Fostering an evidence-based culture

We briefly examine these below.

Designing routines to support teacher collaboration

The BMTN hub designed three routines to support teacher collaboration: whole network meetings, PDSA meetings, and study groups.

When asked about what aspects of the BMTN had the most influence over their growth as a teacher, 90% of teachers rated whole group meetings as the first or second most influential aspect.

Whole network meetings

The BMTN hub designed whole network meetings to build common language, common understanding of deep engagement in algebra, and common knowledge of how to carry out iterative improvement cycles (PDSAs). Whole group meetings also provided opportunities to consolidate individual learning. Teachers met four or five times each school year for in-person, multi-day meetings. The whole network meetings provided a forum for teachers to share what they were learning through their inquiry cycles, enabling the BMTN hub to access individual teacher learning.

> *The ability to network with like-minded teachers was profound. The fact that every teacher there was ok with failing at something, confident enough to ask for help, and willing to try new things made for an environment of trust and support. Being "trapped" in our rooms all day makes building those relationships difficult, so having dedicated time to be together as a network was pivotal in our success.*
>
> *– BMTN teacher*

PDSA meetings

75% of teachers identified PDSA meetings as one of the three most influential aspects of the network that helped them grow as a teacher.

PDSA meetings provided access to deep and sustained learning opportunities. Quarterly small-group PDSA meetings were run by a BMTN hub member and designed around the DEA framework. In these meetings, groups of three to five teachers discussed their inquiry cycles. Hub members scaffolded teacher learning related to rigorous inquiry cycle methodology, student-centered teaching practice, and accountability. Over the years, teachers found these small groups supported problem solving, exposed them to ideas that influenced their teaching practice, and operated as spaces where they learned new knowledge and skills from both hub members and other BMTN teachers.

> *I think about how powerful the collaboration is. Even when we're not able to meet in person, but to have the smaller groups and the designated time to really focus on practice . . . having like-minded people to talk to, people who are passionate about student learning, and people focused on being student centered is really powerful.*
>
> *– BMTN teacher*

Study groups

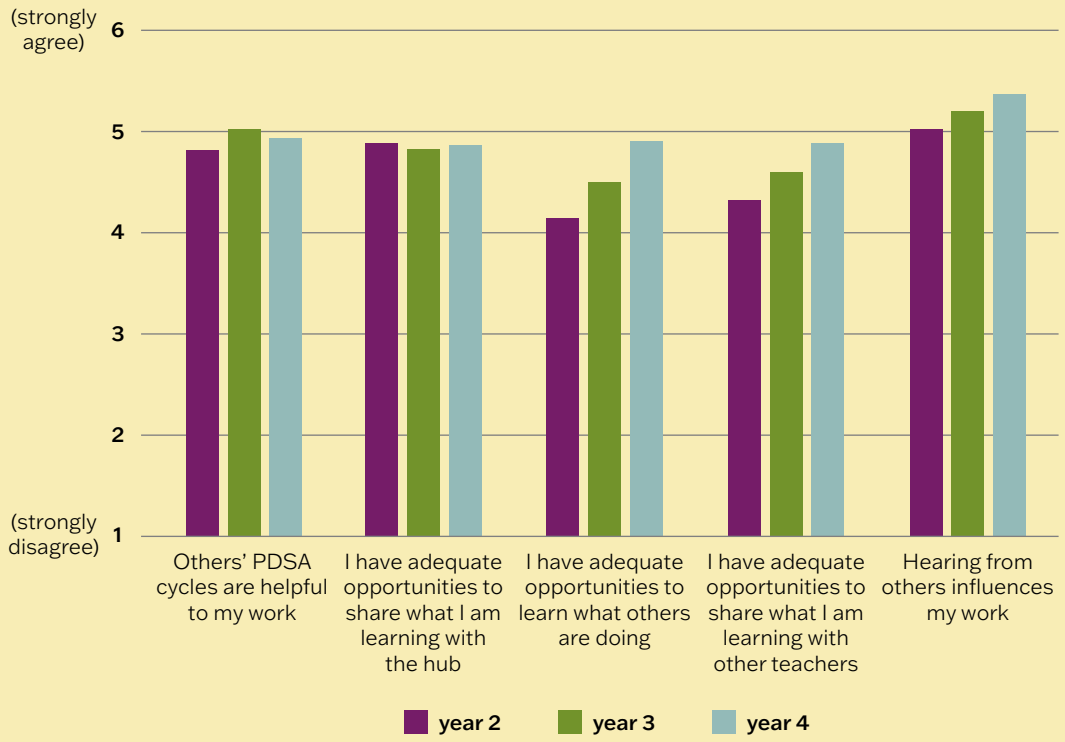
59% of network teachers opted into a voluntary study group.

91% of participating network teachers said they put into practice something they learned in their study group.

In the second year of the network, the BMTN hub introduced an option for teachers to engage in virtual study groups focused on specific math content. The BMTN hub selected texts, designed a protocol, and created groups of three to four teachers clustered around a teacher's choice of text and scheduling availability. Twenty-four BMTN teachers chose to join a study group, which met approximately every two weeks from January through May. Teachers reported many benefits of these study groups, among them a sense of belonging to a mathematics community, building teacher knowledge, and acquiring new resources.

Taken together, whole network meetings, PDSA meetings, and study groups allowed teachers to build trusting relationships with colleagues that facilitated learning from one another. As reflected in **Figure 1**, BMTN teachers' enthusiasm for the opportunities they had to share what they were learning with others increased over time, as did their enthusiasm to learn from teachers in other schools and districts. Teachers also reported that hearing what other teachers were doing influenced their own teaching practices, which grew over time.

Figure 1. Teachers shared with and learned from each other



Leveraging instructional expertise

Instructionally focused NICs require that hubs have deep expertise in teaching and learning, as well as knowledge of improvement science methods and data analytics. The BMTN leads Toni Smith and Kirk Walters were former teachers and established math education researchers, and understood improvement science methodologies. A third hub member, Melinda Griffin, had math teaching experience and expertise in designing adult learning experiences.

BMTN teachers had access to this expertise through the routines described above as well as individual coaching from the BMTN hub. Deep hub expertise and accessibility to the hub contributed to high levels of trust in network leaders. Across all four years of our study, the majority of BMTN teachers had high levels of trust in the expertise the hub leaders brought to the work.

Managing network membership intentionally

Managing network membership is a critical aspect of building a NIC as a learning organization. In the early stages of a NIC, the hub makes decisions about how to bring in members with diverse expertise. The hub also determines when and how to onboard new members. As networks grow, maintaining momentum and continuing to build trust are both important and increasingly challenging. Another challenge is figuring out how to help new members learn what they need to learn without slowing down returning members.

The BMTN hub managed network membership in purposeful and strategic ways. The hub invited new teachers into the network via an application and interview process, and selected teachers who represented:

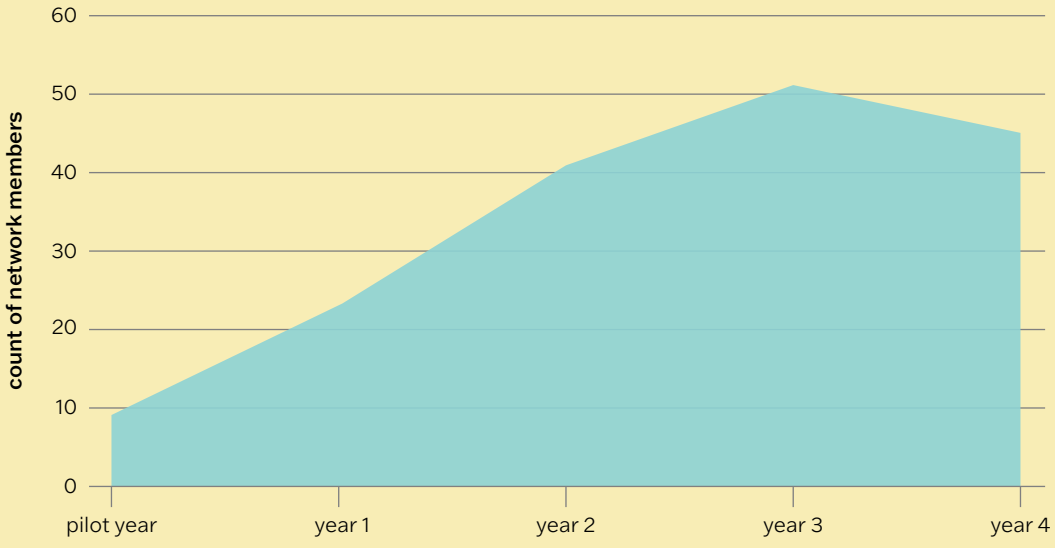
- Various states, student populations, and localities
- A range of teaching experience (from two years to more than 25 years)
- A range of self-identified student centeredness (from being very student centered to very traditional)

The BMTN hub carefully designed which educators were invited into the network, how many teachers joined each year, how those teachers were onboarded, and when to stop adding new members.

The BMTN hub added network members each year for the first three years. No new members were onboarded in the final year of the network.

Year by year, attrition was generally low, ranging from one to six teachers per year.

Figure 2. Network growth over time

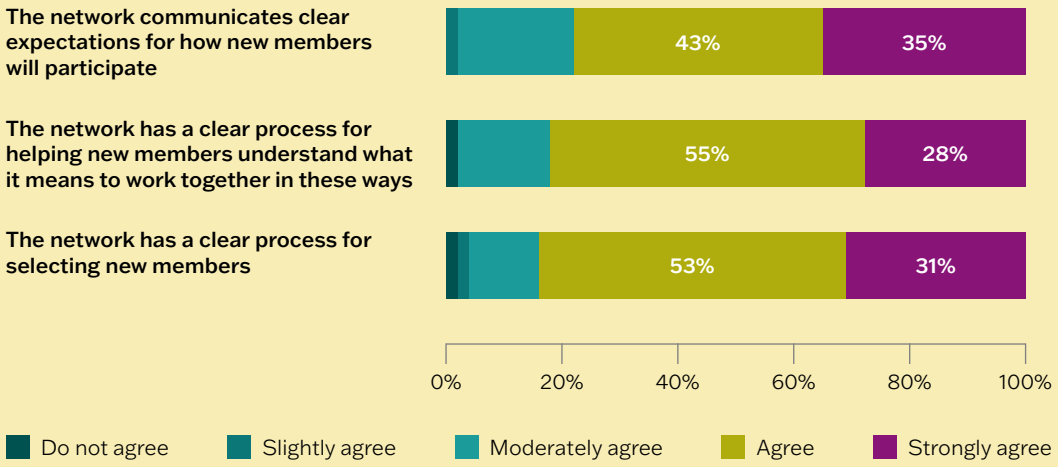


The BMTN hub also worked to balance the needs of existing teachers while designing network activities to support the onboarding of new teachers through the following activities:

- In-person summer meeting for new teachers (one day), prior to the three-day whole network meeting
- Intentionally integrating returning members with new members in PDSA groups and table assignments at whole network meetings
- Individual coaching for new teachers prior to implementing their first inquiry cycle

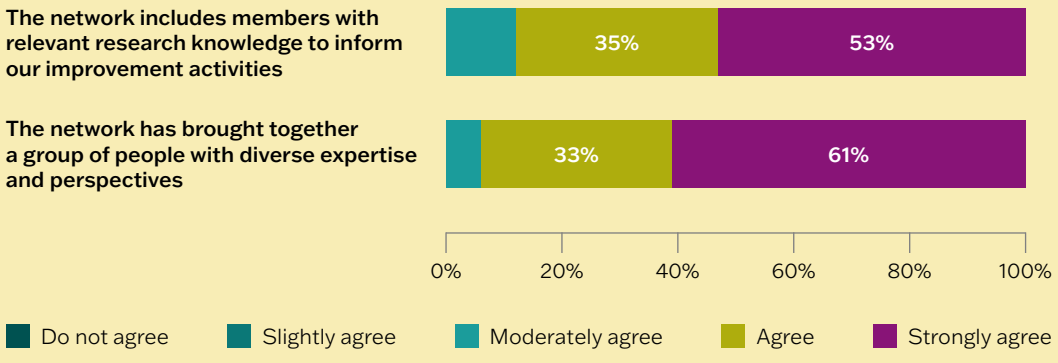
Most BMTN teachers agreed that they were onboarded successfully, as shown in **Figure 3**.

Figure 3. Teachers agreed that they were onboarded successfully



In general, BMTN teachers also agreed that the network had the diversity, skills, and knowledge it needed to increase student engagement in high school algebra. See **Figure 4** below.

Figure 4. Teachers agreed that the BMTN had diversity in membership



Maximizing access to research and practice knowledge

NICs are specifically designed to leverage network connections in order to create access to research and practical knowledge. NICs provide a space to bring together this vast knowledge base—both on the research side and the practice side.

The BMTN hub integrated practical knowledge and research knowledge into the network in a variety of ways:

- They used national models of math teaching excellence to frame their definitions of student-centered mathematics teaching.
- They co-constructed definitions of what it meant to deeply engage students in algebra, and they used those DEA definitions to frame the work.
- They tapped into the range of expertise the network members brought to the work.
- They supported network members to test their new student-centered teaching practices in a wide range of contexts.

One tension that emerged in the BMTN was how to balance the desire to honor a teacher-guided inquiry process with what the field already knows about best practice. Rather than directly guide teachers to research-based strategies, the BMTN hub allowed teachers to design and/or identify routines to test. This raises the question of whether it would have been more efficient if the hub introduced research-based changes from the outset.

Managing knowledge and consolidating learning

The ultimate power of NICs lies in learning from the variation tested within the network and sharing it broadly. As networks mature, hubs must find meaningful ways to capture what the network members are learning and package it in useful artifacts.

The BMTN hub took a number of strategic actions to consolidate what members learned in order to share it within and beyond the network. The hub used multiple approaches to synthesize what the teachers had learned to push the network's learning forward.

Each year the BMTN hub:

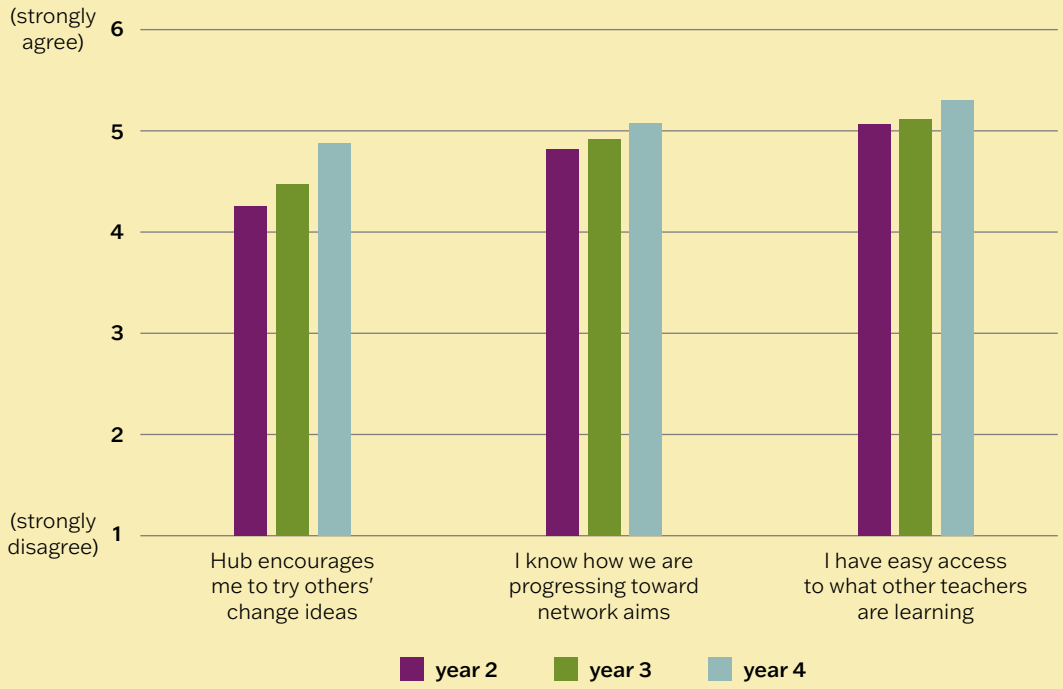
- Produced a change idea summary book that represented each teacher's recommendation for a high-leverage student-centered routine
- Revised rubrics that represented the best thinking about how to measure student progress
- Iteratively revised a PDSA template that allowed teachers to better implement and document their inquiry cycle process and learning

In addition, the BMTN hub also:

- Helped network members compile a task library of high-quality mathematics tasks
- Designed a tool for teachers to self-assess their level of student-centeredness
- Supported opportunities for network members to present at local and national conferences
- Packaged key learning from network members' testing after year 2, which were then used to establish professional learning communities in two Rhode Island school districts

Knowledge management tends to be an aspect of network leadership that builds over time. Survey data shows this to be true in the BMTN, as reflected in **Figure 5**. In spring 2020, as the network's funding was ending, the teachers rated aspects of knowledge management fairly high, reflecting teachers' positive endorsement of the BMTN hub's work in this area.

Figure 5. Knowledge management grew over time



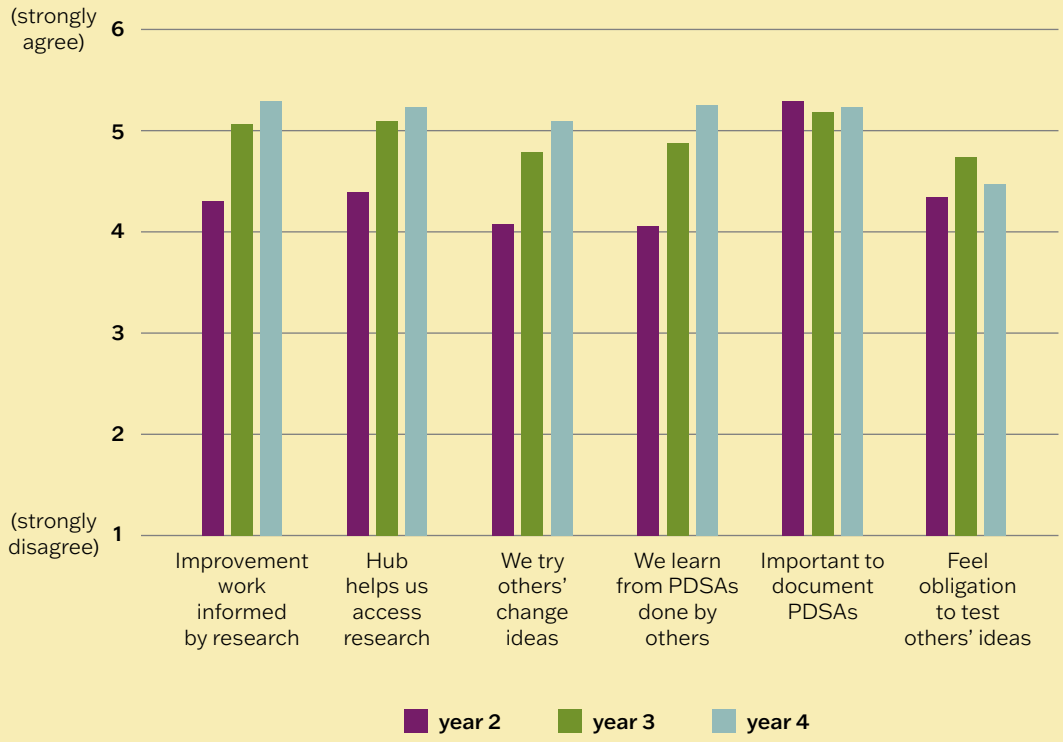
Teacher learning about how to deeply engage students in algebra was supported by their testing of student-centered instructional routines. The routines teachers tested in the BMTN focused on engagement with math processes. The depth in student engagement came from the quality of the tasks that teachers used within those routines. Examples of these routines and tasks can be found on the network's website.

Had the network continued, the next phase of knowledge management might have included the consolidation of the testing across various contexts in order to learn more about how different changes need to be adapted to different contexts.

Fostering an evidence-based culture

NICs are different from other networks in that they use evidence and disciplined inquiry approaches to accelerate learning. The work of NICs involves participation in collaborative inquiry and is promoted through engagement in inquiry cycles, documenting the inquiry work, testing each other's ideas, and sharing lessons learned. This promotes network-wide learning and typically grows over time. **Figure 6** shows the growth of an evidence-based culture in the BMTN as more teachers reported learning from each other's testing, trying each other's ideas, and their increased use of research.

Figure 6. Teachers recognized a growing evidence-based culture



Building a learning organization is a fundamental challenge for instructionally focused NICs. The BMTN hub built a learning organization by leveraging their own expertise and the expertise of carefully selected network members, engaging those teachers in collaborative routines and iterative testing cycles where they infused practical knowledge with research knowledge to test student-centered practices. The hub consolidated what was learned in the BMTN each year, shared it within and beyond the network, and built an evidence-based culture.

Design Challenge #2: Designing for Educator Learning

How do hub leaders simultaneously build educator capacity to enact rigorous instruction and use improvement methods to support continuous instructional improvement?

Engaging in a NIC requires educators to learn how to utilize improvement science methodology. An instructionally focused NIC adds a second requirement, learning to enact new instructional practices. NIC hubs must be intentional as they design for the integration of these learning needs.

Many teachers routinely reflect on their instructional approaches but engaging in formal inquiry with PDSA cycles requires teachers to collect data and analyze it, make sense of that analysis, and act on what they had learned. Learning how to engage in PDSA cycles in this way takes time. Teachers often experience a steep learning curve if they are simultaneously introduced to improvement science and new instructional practices. Hub leaders must build capacity in teachers to enact rigorous instruction while also learning how to use improvement methods to support continuous instructional improvement. Designing learning opportunities to support these different types of learning is a challenge, as is integrating them into a cohesive professional learning experience. On top of that, hubs must design this learning so that it can fit into the busy lives of educators.

The BMTN hub addressed these challenges by supporting teachers to rigorously engage in inquiry work with a deep focus on mathematics teaching practice. The hub did four key things to support BMTN teachers in their use of student-centered routines with depth:

1. They built tools that scaffolded the PDSA work.
2. They supported practical measurement.
3. They enacted iterative routines that supported the PDSA work.
4. They emphasized rigor.

In these ways, the BMTN hub designed for educator learning of inquiry methods in service of mathematics teaching and learning improvement. We briefly examine these strategies on the following pages.

> *I think [the PDSA cycle has] taught me to be much, much more intentional about studying what I'm doing and showing that it's working.*
>
> *– BMTN teacher*

Designing tools to support rigorous testing and shared learning

Sharing resources was an important part of building the learning community. For each phase of their inquiry cycle, BMTN teachers had tools to support their engagement, to test with rigor, and to share their learning. Rubrics, checklists, and data tracking tools designed by other network members were often shared informally during meetings. The BMTN hub built several tools that they improved over time, including the PDSA template and the format of the change idea summaries. The hub also supported the development of a task library and co-constructed shared rubrics with BMTN teachers.

BMTN teachers had access to each other's work in Google Drive folders and the BMTN crowd-sourced task library. They often used each other's tools.

PDSA template

The BMTN hub designed a PDSA template for teachers to track data and their own reflections, improving it each year to better support teacher testing, data collection, and sensemaking processes. The template served as a roadmap through the PDSA process, as well as an accountability tool, and was the backbone of teachers' rigorous inquiry work. Documenting inquiry work supports teacher reflection and allows the work to be shared across the network.

Change idea summaries

Each spring, teachers would write up at least one summary of what they had learned about a new student-centered routine they had tested. The BMTN hub compiled these summaries into a change idea summary booklet that was distributed each July as the new year launched. The change idea summaries served as a menu of student-centered routines tested by BMTN colleagues. Teachers could implement or adapt them to their own context.

Task library

Two teachers designed a crowd-sourced task library to support student-centered mathematics. They automated the process of uploading math tasks and scored each task to ensure the addition of only high-quality tasks. Because finding rich tasks is a time-consuming component to designing deeply engaging lessons, many BMTN teachers found this resource very useful.

Shared rubrics

The BMTN hub worked with network members to build a robust vision of student-centered teaching. This vision was articulated in their rubrics. The hub co-constructed (with network members) rubrics to measure what it looks like for students to connect, solve, and justify with depth in algebra. These co-constructed rubrics were instrumental in supporting educators to effectively utilize practical measurement.

Supporting practical measurement with shared rubrics

Because BMTN teachers tended to test their own change ideas, they had to design the practical measures they would use in their PDSA cycles. Teachers had to decide what data they would collect to understand if their changes led to improvement, and they had to quickly make sense of that data to decide if they would adopt, adapt, or abandon their change idea. Integrating this practice into the busy day-to-day lives of classroom teachers is a significant challenge. Supporting practical measurement is one of the most difficult aspects network leaders face when engaging educators in inquiry cycles.

> *I think that we've gotten better at being more common with how we're measuring things and the commonalities among the rubrics.*
>
> *– BMTN teacher*

Two BMTN teachers shared the following thoughts on why practical measurement was the most challenging aspect of the work for them:

> **Developing practical data collection routines:** *Data collection was always the most challenging aspect of the PDSA cycle for me. Finding relevant data that is easy to collect and analyze with everything else going on in teaching was always the thing I played around with the most.*
>
> **Collecting repeated measures:** *Identifying quantifiable data was so difficult for me, unless the change idea was related to assessment. The other component that made it challenging was that my student groups changed so much that I wasn't always able to collect quality data from the same student multiple times.*

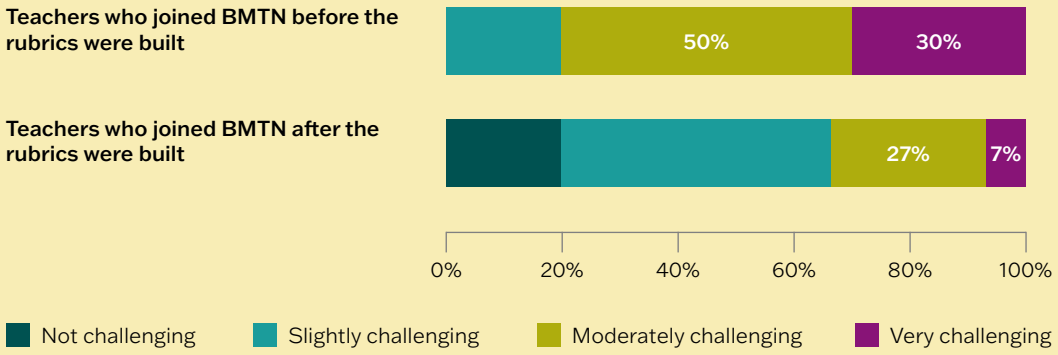
Over time, BMTN teachers tried a wide range of data collection methods:

- Teachers built their own rubrics, student surveys, checklists, and exit tickets.
- Teachers recorded audio or video of small group work, classroom discussions, and pair sharing.
- Teachers collected peer assessments, student writing, and student solutions to math problems.

In light of the practical measurement challenges teachers faced, the BMTN hub took steps to introduce tools to scaffold the measurement process. In the summer of year 3, the hub shared common rubrics to measure the DEA elements. In its development process, the hub borrowed from rubric development and measurement work from Cohort 1 and Cohort 2 teachers. Each year, the BMTN hub revised the rubrics, based on what teachers learned from using them. In this way, the rubrics were also a way to consolidate network learning.

Shared rubrics changed the measurement experience for teachers who entered the network in later years. When asked what they found challenging about the PDSA process, teachers who joined the BMTN after the shared rubrics were introduced were less likely to report identifying practical measures that measured the change idea as a challenge, as reflected in **Figure 7**.

Figure 7. Teachers who joined the BMTN later reported fewer measurement challenges



Designing routines to support consistent engagement in inquiry cycles

The BMTN hub designed routines that supported teachers and held them accountable as they enacted rigorous inquiry cycle work. These routines supported teacher capacity to incorporate student-centered math practices into their teaching through PDSA cycles.

In their efforts to support teachers' inquiry work, the BMTN hub:

- Crafted the meeting schedule to allow for regular teacher exchanges that supported learning and independent work. These meetings provided opportunities for teachers to:
  - Engage with each other
  - Define what deep engagement would look like with their students
  - Solve math problems together
  - Share ideas, teaching tools, lesson plans, and tasks
  - Build and revise rubrics
- Supported those teachers new to the network in their PDSA design
- Encouraged regular teacher engagement in the inquiry process
- Provided ongoing individual coaching support from themselves as well as from network teachers
- Collected final PDSA documentation after each PDSA meeting, providing teachers with the opportunity to get support before they "finalized" a PDSA cycle

Three BMTN teachers shared how they benefited from the PDSA cycle:

> *I think that a lot of times teachers plan, do, and act, but we don't have time to study. If somebody were to come to my classroom and ask me why I do that, well, here's the data showing why I do that. I think [the PDSA cycle has] taught me to be much, much more intentional about studying what I'm doing and showing that it's working.*

> *The PDSA cycle makes me more reflective of my work because I can do all these things and be like, 'Great, I did it,' and then fall back to my traditional teaching that I'm comfortable in. But the PDSA cycle makes me reflect and say, 'You did it. What's next? Is this enough to show that my students are learning?'*

> *I think that a lot of times in my class before, I would just fly by the seat of my pants, like, 'Oh, I noticed this without collecting any real data and so I'm going to make all these other changes.' The PDSA has slowed down my thought process to really analyze what I'm doing, how I'm doing it, and where it needs to be changed in order to see the best improvement or the improvement that I'm looking for.*

Emphasizing rigor in the implementation of PDSA cycles

The BMTN hub expected teachers to be rigorous in their testing. Scheduling network meetings roughly every three months, the hub expected teachers to complete one cycle in between each network meeting for a total of four cycles before May. **Our analysis of PDSA cycles and reflective interviews suggests that engaging deeply in four cycles of iterative testing each year helped teachers begin to use data to drive decisions, rather than rely on intuition.**

However, completing four cycles each year was rigorous, and not always possible. In year 3 (the full year prior to the COVID-19 disruption), 47% of BMTN teachers completed four cycles. With the exception of their first year in the network, teachers who completed the most cycles and/or the most trials per year did not consistently report higher confidence in using inquiry cycles, nor did they report higher utility derived from their PDSA cycles. **These results were unexpected, and may suggest that after the first year, four PDSA cycles may not be the "sweet spot" for which to aim.**

Teachers whose PDSA documentation reflected the highest quality did not report the highest confidence or the highest utility. Years in the network appears to be the biggest predictor of teachers who reported higher confidence in using inquiry cycles to test practice changes. **Teachers who found the PDSA cycles most useful were:**

- **Rural teachers**
- **Those teachers who reported that they planned to continue using inquiry cycles even after the network stopped meeting**
- **Teachers who were actively spreading BMTN work within their local contexts**

Design Challenge #3: Optimizing Systems for Instructional Change

How do hub leaders manage the complexity of changing instruction in complex systems?

System features such as instructional leadership, curriculum, professional community, and professional development opportunities work together to form infrastructure that serves as a resource or barrier to teachers' instructional practices. NICs that seek to make instructional change are often designed as school-based or district-based organizations. Local leaders are typically engaged in the work so they can remove barriers, integrate the improvement work into existing workflows, and redesign aspects of the instructional infrastructure within schools and districts to enable deep, widespread, and sustained changes in teaching and learning.

The BMTN design resulted in limitations in the extent to which the network could optimize systems for instructional change. The network brought together individual teachers from six states, 36 districts, and 44 different schools. The leaders of the schools in which BMTN teachers worked were not involved in the improvement work, making it less certain that BMTN teachers would have the support and resources they might need to engage in the work, sustain the work, and spread what they were learning within their local contexts.

Accordingly, the BMTN hub created three alternative strategies to try to optimize the system:

1. They provided time for teachers to deeply engage.
2. They created school-based support.
3. They supported spread beyond the network in a variety of ways.

We briefly examine these strategies below.

Providing time for teachers to deeply engage

The BMTN hub created space for teachers to invest in instructional change efforts by designing participation structures and paying teachers for their time. This enabled teachers to deeply engage in the improvement work, mitigating what is typically the biggest challenge educators face in instructionally focused networks—making time for the work. Additionally, by participating in the network, teachers had access to regular learning opportunities and collegial support.

Creating school-based support

The BMTN hub created school-based support and agency by seeding pairs of teachers in a single building. Nearly half of BMTN teachers (29 of 62) had a school-based colleague in the network. Shared experiences led to the development of strong partnerships and school-based teams. Proximity and easy access to school-based colleagues contributed to the exchange of ideas, tasks, and routines, and results achieved through PDSA testing cycles.

> *When I had another person in my building and something didn't go well, I had immediate feedback. It was my first line of defense. We shared a classroom door, so I'd literally just pop open the door and say, 'My cycle testing went terribly,' and he'd say, 'Okay. Let's talk about it.' It was really constructive. It wasn't judgmental because we were both in the same boat of, 'Let's do some research, let's try something, and let's see how it goes.' It took away those ideas of someone's going to judge you for how you teach because he was right there.*
>
> *– BMTN teacher*

Supporting spread beyond the network

The hub explicitly supported BMTN teachers to spread what they were learning in a variety of ways. As the network matured, BMTN members engaged in different types of spread. We examine three spread strategies below and discuss them in more depth in *Beyond the Networked Improvement Community: Lessons on Spreading Insights from the Better Math Teaching Network.* [5]

Informally sharing ideas with school colleagues

BMTN teachers voluntarily and informally shared what they were learning with their school colleagues who were not in the network. They typically shared math tasks, lessons, and resources afforded by their participation in the network. Teachers appreciated having home-based BMTN peers to help them spread innovative change ideas to their non-BMTN colleagues, and to navigate departmental and school-wide barriers that constricted pedagogical improvements.

Sharing at conferences

As teachers enjoyed success in the student-centered practices they were testing, the BMTN hub encouraged and financially supported BMTN teachers to present their work at local and national math conferences and at the Carnegie Foundation's Summit on Improvement. The hub also compiled promising routines and packaged them to share within the network (change idea summary booklets), more broadly via their website, and in two professional learning communities the BMTN hub launched and led in year 2.

In spring 2020, **86% of network teachers** reported that they were moving what they learned in the BMTN beyond their own classrooms by sharing it with school, district, and/or state colleagues.

Building professional learning experiences in their local contexts

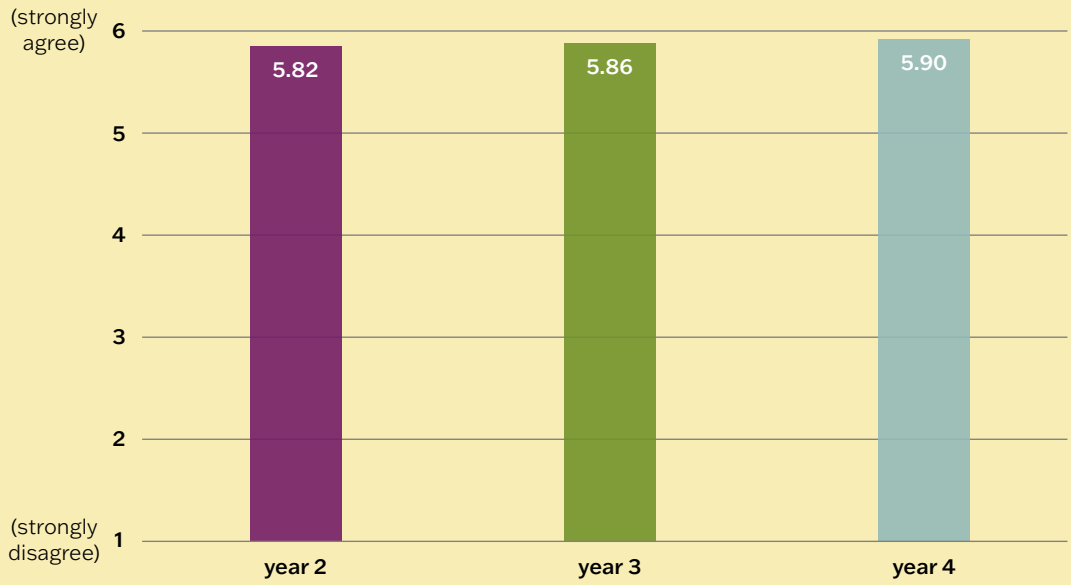
In year 3, some BMTN teachers piloted local spread efforts within their math departments or in district-wide professional development structures. In year 4, the BMTN hub formally introduced and supported the idea of BMTN teachers leading professional learning experiences in their local contexts to spread the work of the network. Several BMTN teachers agreed to design and implement these experiences within their own local contexts, sharing promising math practices and/or teaching colleagues how to engage in PDSA cycles using BMTN's tools and routines. Because these were BMTN teacher-led, they required very modest hub support to enact. Thus, the BMTN was able to consolidate its learning and spread that to educators beyond network members in sustainable ways, even though the network was not structured to align and spread within local contexts.

5 This PNI report can be found on the Nellie Mae Education Foundation's website.

Participating in the Network Influenced High School Math Teachers

For many secondary math teachers, professional development opportunities focused on mathematics content and pedagogy are few and far between. Coming together to collaborate and share with other high school math teachers from across the region was a rare, but highly beneficial, opportunity for BMTN teachers. Teachers highly valued the opportunity to be in the network, and that value was sustained over time. Each year, BMTN teachers responded to a value measure on the network health survey.[6] **Figure 8** reflects how high the value means of those responses were each year.

Figure 8. Teachers consistently valued the network

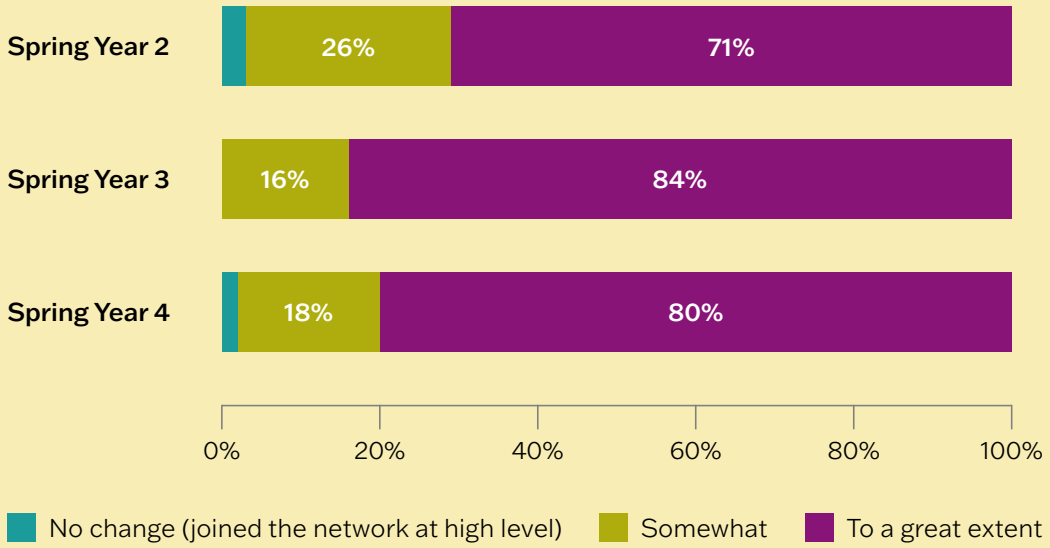


6 The value measures represent combined means of three questions: I value the opportunity to be part of BMTN; BMTN is worth the time it takes; Being part of BMTN feels special.

Teachers attributed change in their student-centered practice to the network

In final interviews, all BMTN teachers identified changes in their practice as a result of their engagement in the network. At the end of years 2, 3, and 4, we asked teachers to rate their student-centered practice at two timepoints: when they joined the network and at the time of the survey. We then asked: *To what extent do you attribute the changes in your student-centered practice to BMTN?* In the spring of all three years, every teacher except two[7] responded somewhat or to a great extent, as reflected in **Figure 9**.

Figure 9. Teachers attributed changes in student-centered practice to the network



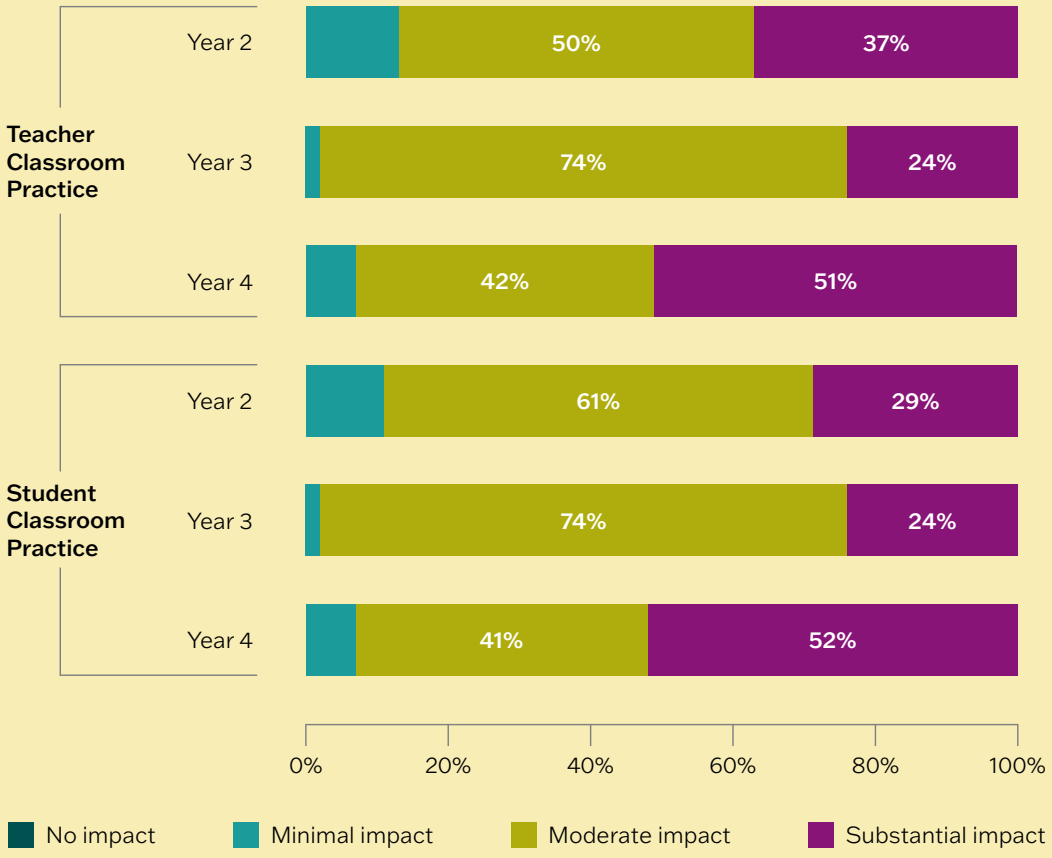
One teacher who was very student centered when she entered the network shared this reflection:

> *I work at being more deliberate about expectations and the means to getting there. I think more about connections because of the different ways that students learn. I think that BMTN helped a lot with this—even just with the time given to the full network meetings and the small group virtual meetings.*
>
> *– BMTN teacher*

7 The two teachers who selected different answer choices rated themselves high in student-centered teaching when they joined the network and stayed at that same high level (so they had no change to attribute to the network).

Consistently over time, a large portion of BMTN teachers responded that their engagement in the network had a great impact on what they did in their classrooms and what students did in their classrooms, as reflected in **Figure 10**.

Figure 10. Teachers reported impact on what they did and what students did in their classrooms



Changes in practice were varied, but three patterns stand out:

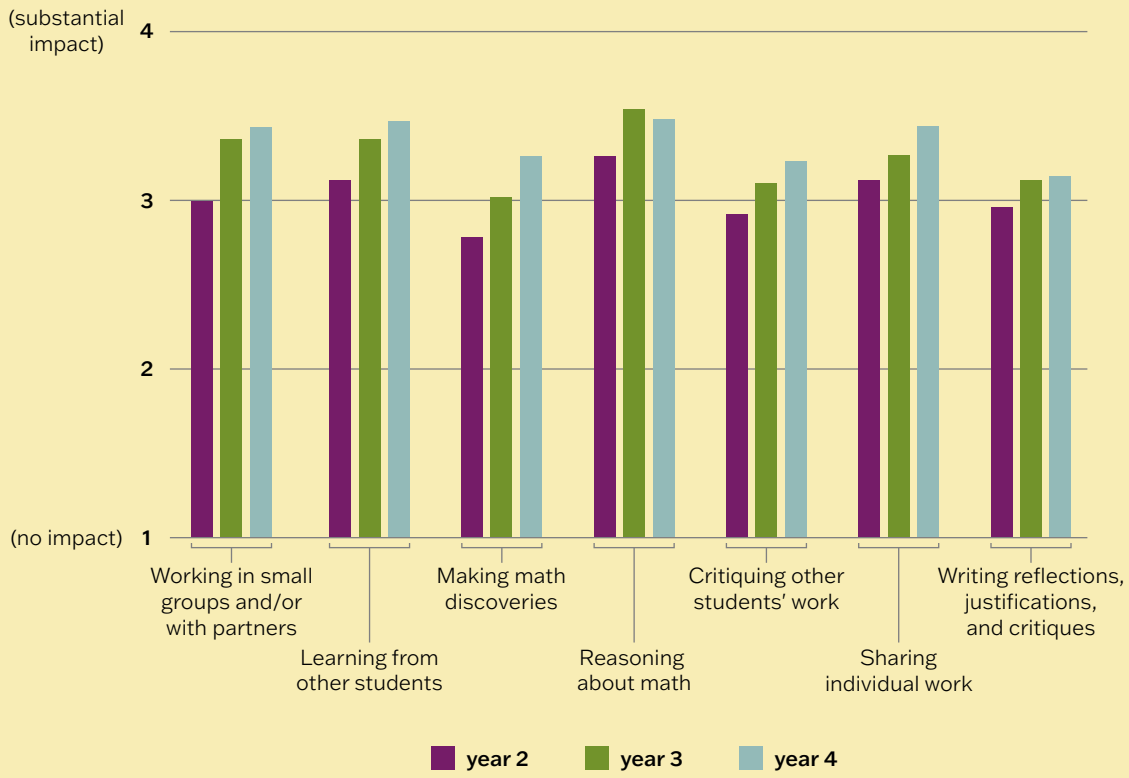
1. BMTN teachers implemented new strategies and routines.
2. They placed great importance on the tasks they used in their lessons.
3. Their planning became more intentional.

Teachers implemented new strategies and routines

As the funding was ending, we asked BMTN teachers to identify the two most significant impacts of the network on their teaching practice. Nearly half (20 of 43) of the teachers noted an increased use of student-centered routines as one of the network's two significant impacts on their teaching practice.

Figure 11 illustrates the growth over time BMTN teachers identified in specific student-centered instructional practices in which the network had an influence. Reasoning about math, learning from other students, and sharing individual work were the practices that teachers noted the network had the most impact on their practice. Making math discoveries was the practice that built the most over time.

Figure 11. Participation in the network supported student-centered teaching



In interviews, a majority of BMTN teachers reflected on how they had new strategies and routines as a direct result of their participation in the network. Many appreciated having a bank of evidence-based instructional techniques to draw on; others valued learning new instructional practices via the collaboration and mentorship afforded through their network peers. Still others pointed to the cyclical testing cycles inherent to improvement science that enhanced and refined existing practices and techniques.

Teachers focused on the tasks they chose to engage students

The quality of the task matters. You as a teacher have the right and almost the responsibility to edit a task and create prompts around a task to fit your students and where you want them, where they are and where you want them to get to.

– BMTN teacher

One significant network learning that BMTN teachers frequently noted is "the task matters." Teachers placed emphasis on using tasks that provided sufficient opportunity for key learning outcomes.

The importance of a task that allows for depth for students. That's always been really important, as well as the need to scaffold through these things. The deep solving is not going to happen the first time that you give them a task that provides an opportunity.

Finding good tasks can be very difficult, as one teacher noted.

The hardest part for me is finding good tasks and problems. So many available resources are surface-level tasks, so I often adopted or made my own tasks. That can be very time consuming although beneficial to the work.

58% of network teachers contributed to the task library at least once.

91% of network teachers used the task library at least once.

Two network members led the effort to build a task library, populated by network members, to serve as a resource to support this critical aspect of student-centered teaching. BMTN teachers found the task library to be very useful. Prior to the pandemic, more than half of BMTN teachers contributed tasks to the library and almost all BMTN teachers used it.

Ten teachers continued to use the task library during the height of the pandemic, and 24 planned to use it when their classrooms were "back to normal."

Teachers planned with a focus on student engagement

Using improvement science in the classroom led BMTN teachers to be more intentional in their planning. Deliberate consideration of the role students assume in the classroom—including anticipating and visualizing what students will be doing and how they will be engaging—moved to the forefront of teachers' planning efforts.

Three BMTN teachers shared their thoughts on this:

> *I think the way that the instruction is designed is really important—the task you're using, what the teacher is doing, what the students are doing, how learning looks in the classroom. And then providing opportunities for students to engage in math.*
>
> *It has really caused me to think intentionally about what I want from my students—what I want their response or their work to look like—instead of focusing on what I'm doing. The work that we've been doing through BMTN has really made me stop and think about what I really want my students to be doing during this time.*
>
> *When I come up with a new task or assignment or some type of group activity, I think, "What is this trying to achieve and how is this going to help student learning?" I think it definitely helps with how I design any type of problem-solving task for students.*

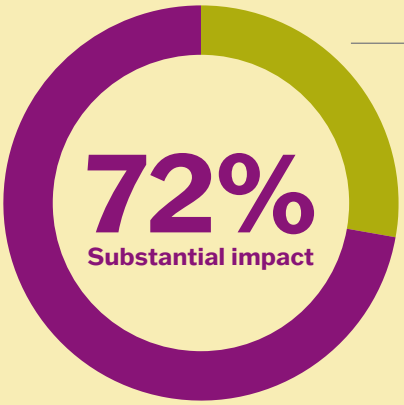
As BMTN teachers became more student centered in their practice, tried out new routines and strategies from the network, identified meaningful tasks to use, and planned more intentionally, they reported that more students were engaged, more deeply, in algebra.

BMTN Teachers Reported Increased Student Engagement in Algebra

Teachers expanded the students they engaged in their classrooms

Throughout the network's tenure, teachers reported impacts among their students directly resulting from their BMTN work. Teachers observed and gathered evidence on engaging more students and different types of students, including students who did not perceive themselves as "good at math," learners who were not motivated in school, multilingual learners, and students in special education programs.

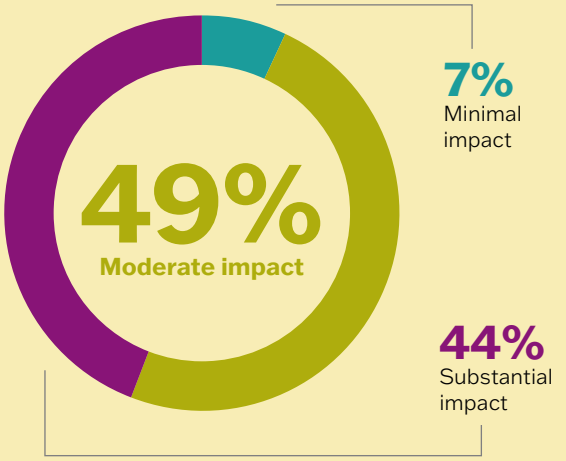
Figure 12. The BMTN influenced teachers' ability to engage more students



I always design a series of problems with multiple entry points, and everyone feels like they can do something. They can access the topic at some point. That's why almost all of my students are engaged in the class.

– BMTN teacher

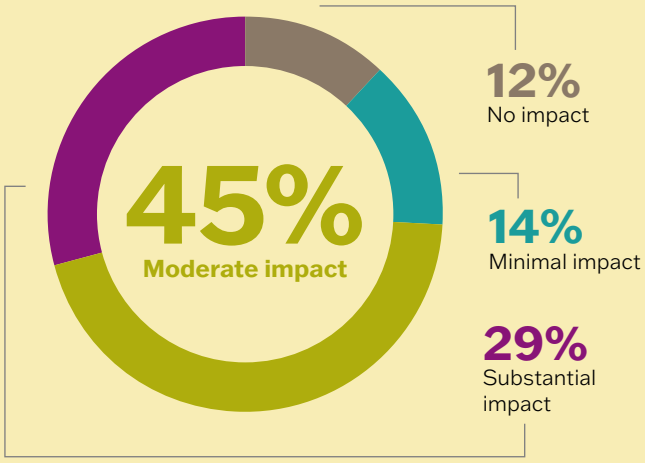
Figure 13. The BMTN influenced teachers' ability to engage different students



When you start making [students] think about how they got the answer and what the process is, at first there's that resistance because they're not used to it and they don't want to do it. But now, it builds in with my group work because they're learning to explain their ideas more. I have a lot of English language learners, so it's also helping with their English, which was some other resistance, too. But on top of that, they like to explain their ideas because they find out that some of their friends and peers are doing it in different ways that might also benefit them and might be easier than the way they're doing it. It's opening them up to see that.

– BMTN teacher

Figure 14. The BMTN influenced teachers' ability to engage marginalized students



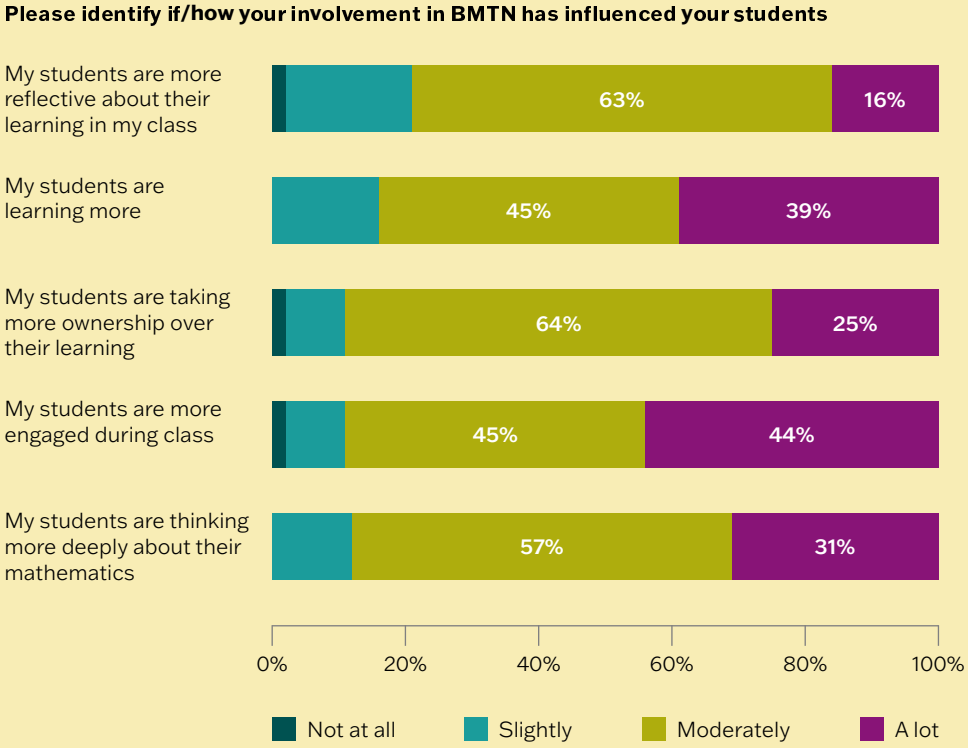
They just don't care because they have not had success for so many years, and they don't want to engage in math whatsoever. And I see kids that for years don't want to do anything and just shut down. And now they're at least trying. They're willing to try and get it wrong and then try again, whereas before, they'll try once and say, 'I'm not gonna do it again.'

– BMTN teacher

Students showed increased agency in their own learning

In interviews, BMTN teachers pointed to evidence of students assuming new roles within their classrooms, especially as these teachers intentionally focused on becoming more student centered in their practices. Some students stopped relying on the teacher as the only source of knowledge in the classroom. **Figure 15** shows BMTN teachers' summative reflection on the influence of the network on their classroom practices that expanded student engagement and agency.

Figure 15. Teachers identified the network's influence on their students



In interviews, BMTN teachers observed and described how they documented greater student engagement and agency, greater math discourse and dialogue in their classrooms, and the development of key life skills, including critical thinking and perseverance. Some teachers noted a greater willingness or resiliency among students to persist in their learning.

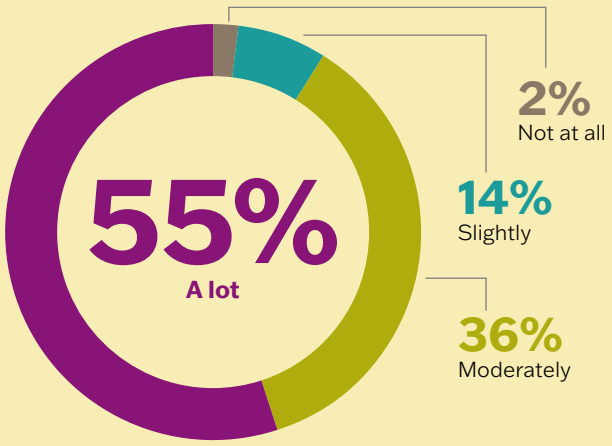
> *I stop and say, 'Okay, now, let's take two minutes to work with your Turn and Talk partner to see if you can make sense of this problem.' I think it's those tiny little teaching practices that really, really benefit the kids, because it's going to promote more responsibility and attention in that moment. They know that they're going to be held accountable for that little discovery. The kids' mentality in the classroom has changed: 'Now, I'm going to have to work a little bit more rather than the teacher working up at the board and I'm just copying down notes.'*
>
> *– BMTN teacher*

Across these observed outcomes are the overarching themes of students shouldering greater responsibility and ownership for their learning and the emergence and cultivation of a strong and powerful student voice within the learning environments created by BMTN teachers. In providing students with greater autonomy to explore mathematical ideas, some teachers found students more apt to make meaningful connections between and among big ideas. BMTN teachers described how their students had input into lesson design and implementation, examined ideas more closely, and were more comfortable "wrestling" through problems to generate solutions.

Students engaged in more peer collaboration

More than half of BMTN teachers reported that their involvement in the network substantially influenced their students' collaboration, as reflected in **Figure 16**.

Figure 16. Teachers reported students were working more collaboratively



BMTN teachers described students as engaging in more collaborative learning, more student discourse and group problem solving, and more reliance on peers to wrestle with mathematical ideas. Teachers also reported that students were less reluctant or intimidated to share their thinking and their work with their peers and teachers.

Two BMTN teachers shared their observations of their students:

> *They start to learn how to talk about math and how to actually help each other and use the vocabulary. The use of vocabulary has increased. The collaboration has increased just because, hey, I'm not afraid to talk about my math anymore. So now you can actually express to somebody else, a peer, what you're struggling with.*

> *My students are in groups. They are collaborating. They are thinking. They are figuring things out. We do individual, small group, whole group, partners. I give them choice. There is something different every day to keep them on their toes and improving. It is alive, noisy—well not too noisy—but a dynamic classroom again, and there's learning with depth as opposed to that cursory procedural-type learning.*

Teachers' changed practice reflects the network's focus on deep engagement

By defining deep engagement in algebra in very specific ways (connect, solve, justify), the network supported teachers to build more opportunities to deeply engage in mathematics.

Connect

Definition: Make connections among mathematical procedures, concepts, and applications to real-world contexts, where appropriate.

How students in BMTN teachers' classrooms changed: Students made more and deeper connections (e.g., across big ideas, within and across their math learning, with the world outside of school).

> *Having students explore more independently has shifted learning more to them and I am more of a facilitator as opposed to just a purveyor of information . . . oftentimes they can explore something that is meaningful to them and then we try and link it back to the big topic of algebra class. So as far as their experience goes, it seems more meaningful. They're developing more connections because they're seeing more application and they're seeing how one topic lends itself to another.*

> *I think it has provided a sense of consistency for them. They know that they're always going to be asked, 'Will this always work? Why do they believe this is the particular process they should be using? What's similar, different?' They're making connections between the different topics that we're studying. And in the past, it would have probably felt kind of like a pingpong ball.*

Justify

Definition: Communicate and justify mathematical thinking as well as critique the reasoning of others.

How students in BMTN teachers' classrooms changed: Students solved problems with more depth and engagement.

I think that students become more engaged because they're being asked to really think about what it is they're doing in a way that is different. I think in our brains that language piece builds understanding, but it also builds engagement. As we're finding out right now, we're very social people—and we're missing that social connection—but I think that even holds in the classroom. When kids are able to talk about what they're doing, it adds that social aspect for them to be more engaged. It also increases their understanding as they're able to talk about and articulate their ideas about the math.

When I first came into BMTN, I was really interested in working on the justify domain. I thought it was really important to not just see answers from students, but to hear their processes and explanations of how they know the math. Through my work in BMTN, I have developed strategies to support this that I don't think I would have necessarily adopted without it. One of them is using Flipgrid to have students make videos explaining how they solved math problems.

Solve

Definition: Make sense of and solve challenging problems that extend beyond rote application of procedures.

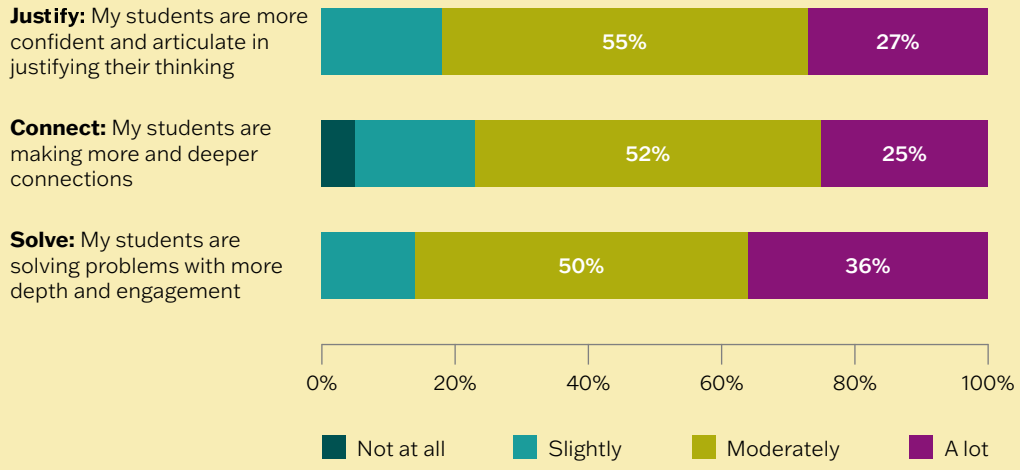
How students in BMTN teachers' classrooms changed: Students became more confident and articulate in justifying their thinking.

It has helped me to think of ways to help my students become better problem solvers. I always found that my students had a hard time tackling non-routine problems, and now I have some options of ways to engage them in the process and work with them to become better at this.

I am putting students at the center of their learning and giving them more authority in the classroom. By using task-based instruction to introduce new ideas, I have put the emphasis on problem solving and reasoning rather than procedures and memorization. Although we use this problem solving and reasoning to build procedures, the procedure is not what comes first.

Many BMTN teachers reflected that their students were engaging more deeply in algebra, as reflected in **Figure 17**.

Figure 17. Teachers' involvement in the BMTN influenced their students' engagement in algebra



Conclusion

Over the six years of active network participation, the BMTN hub navigated three challenges that instructionally focused NICs face in order to improve student-centered math in high school algebra, a gateway to high school graduation.

They **built a learning organization** by designing and enacting participation structures that regularly and deeply connected network members, they leveraged the expertise in the network, they strategically managed network membership, they consolidated learning, and, over time, they built an evidence-based culture. They were still working to solve the problem of how a network can learn from testing in a variety of contexts and quickly disseminate that learning.

They **designed for educator learning**, understanding the time demands of high school math teachers and finding ways to push for rigorous testing while using tools and routines to both support teachers and hold them accountable. They found ways to leverage their own experience and expertise, as well as that of participating teachers. Ongoing challenges included how best to support practical measurement and design individualized support across the wide range of change ideas tested by BMTN teachers.

Because the BMTN was designed to be a network that pulled individual teachers from all over New England, **optimizing the system** was a sticky challenge. The BMTN hub addressed this challenge by supporting the spread of ideas, strategies, and methodologies in a variety of ways. The network has left infrastructure and capacity behind in the form of tools and resources (e.g., change idea summaries that reflect tested routines, rubrics, the task library). Additionally, the BMTN hub built teacher capacity for improvement science, student-centered math, and running professional learning communities.

The BMTN formed a powerful NIC that used its social resources to strengthen student-centered mathematics teaching, which significantly and positively impacted teacher perceptions of student mathematics learning. The network was a highly valued professional experience. A year after the network stopped meeting (due, in large part, to the pandemic), teachers reflected on their experience. In their final words, many of them said BMTN was the best professional development opportunity of their career.

Three BMTN teachers shared their overall thoughts:

> *This is the best professional development I have been involved with, hands down. I am thinking about taking a new position within my school, and I will most certainly use improvement science in my work.*
>
> *I am grateful to have had the opportunity that I had and would absolutely go back and do it all again. It's been a joy to work with the network, but especially with Toni and Kirk. Their vision, leadership, and fearlessness to learn along with us made the experience really special.*
>
> *I was told I was a risk taker by my boss last year and that is because of BMTN. I have no problem trying out a new strategy in my classroom if I think it will improve engagement, and I am not afraid of failure. I am adaptable because of BMTN. Thank you.*

References

Bryk A., Gomez L., Grunow A., & LeMahieu P. (2015). *Learning to improve: How America's schools can get better at getting better.* Cambridge, MA: Harvard Education Publishing.

Gomez L. M., Russell J. L., Bryk A. S., LeMahieu P. G., & Mejia E. M. (2016). The right network for the right problem. *Phi Delta Kappan*, 98(3), 8–15.

Russell J. L., Bryk A. S., Dolle J., Gomez L. M., LeMahieu P. & Grunow A. (2017). A framework for initiation of networked improvement communities. *Teachers College Record, 119*(5), 1–36.

Russell J. L., Bryk A. S., Peurach D. J., Sherer D., LeMahieu P., Khachatryan E., Sherer J. Z., & Hannan M. (2021). The social structure of networked improvement communities: Cultivating the emergence of a scientific-professional learning community. *The Carnegie Foundation for the Advancement of Teaching.*

Appendix: Data Collection

This report draws from data collected across the four years we engaged in a developmental evaluation of the Better Math Teaching Network (fall 2016 – spring 2020). School year 2019–2020 was intended to be the final year of the network, but the pandemic shifted the work into the following school year. We administered a final survey in April 2021. The table below summarizes the data sources we draw upon for this report.

Data sources	Data collected
Hub interviews / self-assessments	Annually
Network health survey *The network health survey was given to all teachers in the network.*	Year 1: December 2016, June 2017 Year 2: December 2017, May 2018 Year 3: January 2019, June 2019 Year 4: February 2020, May 2020 Final reflection survey: April 2021
Teacher interviews	Year 1: December 2016 (23), June 2017 (22) Year 2: December 2017 (43), June 2018 (38) Year 3: December 2018 (14), March 2019 (39), May 2019 (30) Year 4: March 2020 (43)
PLE case studies (interviews, artifacts)	Years 3 + 4
PLE interviews	Year 3: BMTN teachers (6) Year 4: BMTN teachers (6), administrators (4), non-BMTN teachers (12)
Observations (field notes) and artifacts from network in-person meetings	Year 1: October, December, March, May Year 2: July, October, December, May Year 3: July, October, March, May Year 4: July, November, March
Small group, PDSA coaching meetings videos	N = 47
PDSA documentation	Up to four cycles, each year, all teachers
Change idea summaries	July 2017, 2018, 2019
Change idea summary presentations	July 2017, 2018, 2019
Study group meeting videos	N = 18 (video from 3 groups)
Study group meeting notes	N = 38 (notes from 7 groups)

Partners for Network Improvement

Research, Strategy, & Evaluation

University of Pittsburgh | Learning Research and Development Center

Murdoch Building
3420 Forbes Ave.
Pittsburgh, PA 15260
phone 412.624.7020
pni.pitt.edu
lrdc.pitt.edu

nellie mae EDUCATION FOUNDATION

1250 Hancock Street
Suite 205N
Quincy, MA 02169
toll-free 877.635.5436
fax 781.348.4299
nmefoundation.org