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Implementing California's Mathematics and Science Standards

Lessons Learned from Regional and County Collaboration

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Contents

The California Partnership for Math and Science Education

To launch the California Partnership for Math and Science Education, the California County Superintendents Educational Services Association (CCSESA) collaborated with the California Department of Education and the California State Board of Education. A joint steering committee worked for six months to align the interests of stakeholders across the state and coordinate diverse math-science standards implementation efforts.

The result was the formation of two statewide Communities of Practice (CPs); and establishment of a grant opportunity to develop local collaboration and initial, year-long capacity-building projects.

With support from the S.D. Bechtel, Jr. Foundation, the steering committee partnered with multiple content experts to help inform the planning and activities of the new CPs. Partners included the Lawrence Hall of Science; the Exploratorium; alliances such as the NGSS Collaborative and K–12 Alliance; and organizations such as Children Now and the California Action Network for Mathematics Excellence and Equity (which joined later).

Given this extensive level of collaboration and support, the Partnership intends for its work to provide a model for math and science standards implementation, potentially replicable in other content areas.

Introduction

The last ten years have brought sweeping changes to math and science education in California. Challenging new standards for both subjects now guide what students learn from kindergarten through grade 12 as well as how they learn it. With the standards in place, school districts across the state are engaged in implementation, a massive undertaking. Fundamental to success is capacity building — especially in terms of helping educators build the content knowledge and pedagogical skills they need to provide all students the high-quality math and science education required for many of today's desirable careers.

A key entity focused on helping the state meet the standards implementation challenge is the California County Superintendents Educational Services Association (CCSESA), a regionally structured organization of California's 58 county offices of education (COEs). Based on research and its own lengthy experience, CCSESA believes that accomplishing statewide implementation goals calls for educators across regions and counties to work collaboratively rather than in isolation — to connect with each other and mutually build math and science capacity by disseminating knowledge and sharing expertise.

To help educators statewide establish implementation efforts to strengthen math and science teaching and learning, the California Partnership for Math and Science Standards (formerly the Math/Science Standards Implementation Project or Communities of Practice) launched in 2016. (See box.) The Partnership grew out of a shared commitment by CCSESA, the California Department of Education, and the State Board of Education to develop a tiered approach to deepen statewide standards implementation support and coordination across all content areas.

California's Math and Science Standards

Along with most other states, California transitioned to the Common Core State Standards for mathematics in 2010. In 2013, the State Board of Education adopted a math framework to help teachers transition to the new standards. But even with the framework's guidance, implementation is complex. The approach to math has been fundamentally changed. Students are expected to apply and defend their ideas about math concepts, focus more deeply on a smaller number of grade-specific and complementary topics, and build on procedural skills across grade levels.

In 2013, along with nearly half the states, California adopted the Next Generation Science Standards (NGSS). The NGSS emphasize science and engineering practices and strongly emphasize student inquiry, disciplinary core ideas (i.e., ideas that are necessary for understanding a science discipline), and cross-cutting concepts — concepts that resonate across scientific disciplines and bridge the gap between science and engineering.

Note: NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states.* Washington, DC: The National Academies Press.

With support from the S.D. Bechtel, Jr. Foundation, the Partnership initiated two flagship efforts. The first was to establish two statewide Communities of Practice (CPs), giving COEs and other targeted groups of educators a formal place to gather and share ideas and expertise.

The second — arising from the CPs — was the establishment of 22 grant-funded collaboratives to promote the creation of more localized CPs or other local capacity-building projects across the state. Sixteen of the collaboratives are regionwide; six are countywide. About half focus on building capacity in one subject, math or science. The other half seek to develop capacity in both subjects together, an approach CCSESA encouraged to promote integration of math and science where content overlaps.

The grant funding, which was first offered in 2017, provided the new collaboratives an opportunity to work towards developing regional CPs or addressing identified capacity-building needs. COE math and science leaders were able to use time at CP meetings to meet as teams and plan their grant proposals. The proposals they developed each centered on a regional or countywide project, involving numerous different strategies to build local capacity for standards implementation.

These initial projects have generally involved mounting a professional learning event or series of events. The events differed in focus and structure, depending on each region's strengths and context.

Some were designed to improve teachers' classroom practice; others also included district and site administrators and COE staff. Several collaboratives strategically focused on building leaders — teachers, administrators, and COE staff — who could support math and science standards implementation within their regions and counties. A number of projects particularly focused on equity — that is, on helping educators understand what is required to ensure that students of every ethnic, racial, and socioeconomic background have the needed access and opportunities for learning high-quality math and science.

To produce these projects, educators from different counties and districts had to create effective ways of working together, across sometimes vast geographic areas, and despite uneven resources and differing regional traditions in terms of how COEs and districts interact. The short-term goal was a successful round of math-science capacity-building efforts statewide. Long term, the goal is to have an ongoing, statewide collaborative structure for building the capacity in every region for educational excellence.

Aware of the stakes and the challenges, WestEd documented the collaboratives' evolution and captured lessons being learned. This report conveys WestEd's findings from the first 14 months of tracking the work. Our case study approach is intended to capture a snapshot of how these efforts are building collaboration, capacity, and — ultimately — sustainability for math and science standards implementation.

This report focuses on 13 of the collaboratives, a representative sample selected by WestEd and the Partnership to include a mix of content-area foci (e.g., math, science, and converged math and science); rural, urban, and suburban areas across California; and capacity-building approaches. The sample includes: nine regional collaboratives, about half with projects in either math or science, and half with projects that fostered convergence of math and science; and four countywide collaboratives that organized projects in a single subject area. (The box on p. 4 provides a brief summary of the 13 collaboratives; the section beginning on p. 30 offers fuller profiles of each.) The information in this report may not be generalizable to the efforts of the collaboratives not included.

To understand how the 13 collaboratives developed the structures and systems needed to implement their projects, WestEd's team conducted focus groups with project leaders and participants, documented regional events as participant observers, and conversed with leaders and participants. The hope in sharing this information is to enable relevant stakeholders to understand systemic factors that aid or challenge standards implementation across the state.

The sections that follow report nine key lessons being learned from these regional collaboration efforts as well as key challenges they are working to surmount.

Overview of Featured Regional Projects

Below is a brief description of each collaborative. For detailed descriptions, see Project Profiles, p. 30.

Region 2 (Math and Science): Nine rural counties in northeastern California. Project: Focused on increasing K–12 teachers' capacity to facilitate student discourse in science and math classes, Region 2 organized a symposium where educators gathered in eight county offices and connected via video-conferencing to hear a keynote speech on mathematics learning and participate in a shared science exploration activity. Participants discussed the day's learning as a whole group and in local county office groups.

Region 3 (Math and Science): 10 central counties, including Sacramento. Project: Region 3 created a regional community of practice, with two separate two-day convenings where COE leaders partnered with local "influencers" (e.g., teacher leaders, coaches) to build capacity around equitable math and science practices and strategies. Events included speakers, activities, and shared tools to develop influencers' knowledge and focus their attention on inequities in math and science standards implementation.

Region 4 (Math): Six Bay Area counties. Project: Region 4 Math worked with elementary and middle school teachers to develop Math in Science Talks (MiSTs), wherein teachers adapt "math talks" — a familiar instructional routine — into "science talks" that integrate math content. The goal is for teachers to facilitate student opportunities to make connections between math and science to deepen learning.

Region 4 (Science): Six Bay Area counties. Project: Region 4 Science convened elementary administrators for a symposium designed to improve their understanding of science education and the NGSS. Offered twice, the event focused on teaching science to English learners, identifying and removing barriers to elementary science instruction at school sites, and exploring a science phenomenon that administrators could share with their teachers.

Marin County (Math): Located in Region 4. Collaborative leaders used the Teaching for Robust Understanding (TRU) Framework as a lens for examining and improving their math and science instruction. TRU is a tool designed to promote equitable classroom experiences and develop students into powerful thinkers.[1] Marin County created a series of Professional Learning Communities (PLCs) whose participants used the framework to plan lessons together, film themselves teaching their lessons, and give one another feedback. The PLCs came together for three countywide meetings, where project leaders provided coaching and information.

Region 5 (Math): Four counties, South Bay coast. Project: Region 5 convened teams of teachers, coaches, and administrators to form two local cohorts that collaborated, co-planned, and showcased a lesson or unit responding to social justice and equity in mathematics education for different student populations. The leadership team also led two large conferences with expert speakers and breakout sessions to develop social justice and equity understanding.

[1] For more on the TRU Framework, see https://truframework.org/

Monterey County (Math): Located in Region 5. Project: Monterey County conducted a series of four workshops to support district administrators' and teacher leaders' understanding of social justice and equity in mathematics. Featuring the Executive Director of the California Math Project, the sessions provided an overview and discussion of social justice in mathematics, the belief systems involved, curriculum and instruction, and family and community engagement. The sessions also provided hands-on learning experiences to illustrate social justice issues and encourage personal and group reflections.

Region 6 (Math and Science): Five central counties. Project: Region 6 conducted a series of events with grade 3–5 teachers to foster leadership skills and math and science knowledge. Teachers first came to a three-day summer retreat to develop math and science knowledge through presentations and hands-on experiments and exploration. They were then tasked with developing math and/or science lessons or units that would incorporate lessons learned at the summer institute, piloting and sharing them locally, and reconvening in the winter to share their work with colleagues from the summer retreat.

Region 8 (Science): Four counties in Central-Southern California. Project: Region 8 focused on building leadership capacity for NGSS implementation through multiple planning meetings and professional development activities. This included convening an NGSS Leadership Committee with county leaders for two core face-to-face meetings, supplemented with additional videoconferencing (Zoom) sessions; a three-day training and follow-up sessions with the Exploratorium for county leaders and teachers on NGSS three-dimensional learning; and a regional administrator training event for 70 administrators.

San Luis Obispo County (Science): Located in Region 8. Project: To build NGSS capacity across the county, San Luis Obispo coalesced leadership and partnerships across districts, the county office of education, and higher education to support professional learning for a cross-district cohort of 24 teachers. The cohort consisted of grade-level teacher teams who attended a five-day science institute co-hosted by California Polytechnic Institute and met periodically during the year to plan and implement an NGSS-informed lesson using a lesson study approach.

Region 9 (Science): Three counties in Southern California. To share ideas and resources, form a common vision of high-quality science instruction, advocate for science education, and build local NGSS knowledge, Region 9 created a think tank of county leaders. It included the three COEs, who formed networks of science leaders, representing K–12, higher education, and community partners. Think tank members received support from grant leaders on day-to-day science instruction. The group met for a two-day event, where they explored NGSS content and participated in team-building activities.

San Diego County (Science): Located in Region 9; includes 42 school districts. Region 9's project had two goals: to redesign the county's online NGSS Resource Center with new resources and capabilities and to develop materials that would facilitate use of the California Science Framework. In an update of their original plan, San Diego also hosted a work group for practitioner-leaders from across the county who worked together to solve problems of practice and review content for the Resource Center.

Region 11 (Math and Science): Eighty-one school districts in Los Angeles County. Project: Region 11's converged math and science project featured two symposia, held several months apart and focused on deepening administrator knowledge. The symposia offered math and science keynote speakers, opportunities for conversation with colleagues across the region, and a resource room where participants could browse materials.

Key Lessons about Regional Collaboration to Support Standards Implementation

Nine overall lessons emerged from observations of project activities and focus group discussions with diverse project leaders and participants:

- Relationship building is the foundation of successful collaboration.
- Partnering with key external collaborators can strengthen efforts and leverage resources
- Articulating a shared project vision creates team focus, cohesion, and commitment.
- Regional collaboration helps spotlight and address inequities in student access to high-quality science and math education.
- Collaboration can harness and accelerate leadership development at all levels.
- Collaboration can accelerate math/science knowledge and skill building at all levels — COEs, districts, and school sites.
- Collaboration helps surmount the resource limitations of smaller counties.
- Technology helps overcome the problems of geographic sprawl.
- Approaches used lay the groundwork for sustainability.

The sections that follow elaborate on these lessons and offer examples from the collaboratives to illustrate the experiences in which the lessons are grounded.

Relationship building is the foundation of successful collaboration

The importance of relationship building is clear across the collaboratives. Relationships lead to trust, camaraderie, and a sense of commitment and responsibility — to each other and to the work the collaborative is striving to accomplish. Relationships, in short, create the necessary bridge from interest to concerted action.

Most of the collaboratives did not have to start from scratch. They were able to build on and strengthen pre-existing relationships — between and among COEs, school districts, and other entities. Besides drawing on established trust and prior mutual learning, they could tap into the math and science

expertise of multiple education stakeholders. Not surprisingly, those with the strongest networks of within-region relationships tended to be able to accomplish the most in the initiative's first year.

But across the state, leaders said that achieving the scale of capacity building demanded by new math and science standards requires more than simply convening a knowledgeable team of planners. It's also crucial to think strategically about the kinds of additional relationships that the team needs to build so that it can deeply implement those plans, strengthen math and science capacity throughout the state's school systems, and lay the groundwork for the sustainability of these efforts.

> *"The only reason this collaboration was possible was because of the relationship building that happened for at least 20 years.*
>
> *With our superintendents, there's trust and support at all levels. When we came together, we were very respectful and very trusting, no need to determine whether someone was going to have a different agenda than what we all did."*
>
> — Region 6 Leader

Specifically, the regional and county collaboratives need to get the right people at the table and intentionally foster working relationships that can spur progress toward the goals.

Getting the right people at the table. Collaborative leaders reported that strategically creating the right collaborative relationships means identifying stakeholders who can both shape and share the work they accomplish together. Who might help the team do a thorough scan of the region's math and science efforts and determine educators' greatest needs? Who would be the most influential change agents — at the district level? At school sites? Approaches to addressing such questions varied by region and county.

The Monterey County leadership team, for example, worked up front with various experts to understand the landscape of math and science education efforts in the county. Partners included a professor at CSU Monterey Bay who conducted "asset mapping." The team also reached out to an administrator induction program for feedback on administrator needs for professional development.

In Region 3 (central counties, including Sacramento), the leadership team had decided at the outset that they would enlist the participation of groups of "influencers." This target group would be educators who could carry implementation efforts into districts and schools to build the region's capacity to ensure equity and to integrate math and science. Prior to starting the work, however, the team sought to define who, at what level, and from what role groups these influencers may be. Their first task, then, was to address those questions by reaching out to a range of education stakeholders, asking who exactly might

effectuate math and science change. Based on that input, the final influencer groups included district-level people who could reach school sites, teachers who could mentor other teachers or reach classrooms, and teachers on special assignment who could provide coaching and support.

> *"To really make systemic change, you need to address it from the teachers, and the classroom, even parents, people at the district level, and everything in between so you have a multi-pronged approach. Find those voices within the district who care…and use their influence to make it happen."*
>
> — Region 3 Leader

Intentionally fostering working relationships that can spur progress toward goals. Collaboratives with a joint focus on math and science standards intentionally included both math and science experts to encourage cross-collaboration and mutual support. The working relationships that developed are helping build regional capacity by ensuring that every participating COE can tap into the entire region's math and science expertise. COEs can then share the benefits of those connections — the knowledge, skills, lessons learned — with all the school districts within their sphere of influence.

Fostering collaboration across math and science experts is particularly helpful in providing support for NGSS implementation. Because the state's math standards pre-dated those for science, math educators can share lessons learned from their implementation work. The Region 2 project, in largely rural northeast California, is an impressive example of intentionally enlisting cross-subject leaders across counties to help teachers learn instructional strategies integral to both math and science. Region 2 working teams developed a cross-county teacher professional development videoconference on discourse strategies — for both math and science pedagogy — that they later described as "wildly successful."

Leadership teams in several regions are updating plans to incorporate more voices in future work as a means of leveraging local expertise and wide representation to spread knowledge. Region 2, for example — which already includes such key players as the Exploratorium — may target a broader range of partners, including the California Math and Science Projects, which have a strong history of deepening educators' content expertise. Region 5, in the South Bay area, discussed incorporating more teachers, administrators, and district office staff in their efforts to create greater capacity across different roles.

Critical relationships the collaboratives are fostering are those among teachers and administrators who participated in the projects' professional development. Through Region 2's hybrid in-person/online event, for example, teachers across the region were able to collaborate with colleagues locally and also engage in discussion with peers across the region. The event created connections across grade levels

and districts that have the potential to foster ongoing collaboration. Region 11's symposium convened administrators across the region and brought them together for breakout discussions that allowed them to share knowledge.

Partnering with key external collaborators can strengthen efforts and leverage resources

The grant funding for regional or countywide collaboration on math and science capacity building allowed project leaders to take fuller advantage of relationships beyond the K–12 world, thus benefitting from different perspectives on math-science education as well as gaining new ways to leverage regional resources.

Besides the Exploratorium and the California Math and Science Projects, partnerships included institutions of higher education, whose faculty members shared their knowledge about topics including social justice, teacher education, and math and science content. In the South Bay's Region 5, for example, academic experts spoke about the multiple ways that unequal student treatment in education undermines learning and shared strategies to promote equity and social justice for students. Similarly, Monterey County collaborated with a subject matter expert to facilitate its four sessions on social justice in mathematics workshops.

Several regions partnered with the Exploratorium, which was not only able to provide hands-on demonstrations to make NGSS come to life — for teachers, administrators, and COE staff — but in some cases, under its own program funding. For example, the Exploratorium brought Region 8's participants into its own three-day training, which freed up Region 8 resources for additional professional development opportunities.

In San Luis Obispo County, a university partner — the California Polytechnic Institute — not only helped leverage existing resources but did so in a way that models a next-step level of collaboration and innovation. The collaborative has hired a member of its leadership team — a teacher on special assignment — for a one-year role supporting and infusing science expertise across the collaborative's partners and the county. California Polytechnic Institute is paying for half of the new position, with the COE and a district equally funding the rest.

A number of external partners and COE leaders have expressed interest in ongoing collaboration beyond the life of the regional grant-funded projects — an interest that bodes well for the sustainability of math-science implementation efforts.

Articulating a shared project vision creates team focus, cohesion, and commitment

A number of collaboratives struggled initially to get cohesion among the partners. (See also "Challenges," below.) Science and math experts may not share common ways of talking about their

disciplines, and even individuals in different roles supporting the same subject may not always share the same language. Participating COEs may differ in strengths, available resources, and ways of doing business. University faculty or staff from educational institutions like research centers may operate with different mindsets and terminology from those common among K–12 system educators.

Leaders reported that the one thing team members tended to share was a passion for the work — a strong commitment to equitable math and science education under the standards. These leaders found that they could draw on that passion to enable the group to come together around articulating a common vision for their standards implementation work. That vision, defined among collaborative members, then guides strategies and priorities, helps project teams align stakeholders, and focuses capacity-building efforts.

> *"[We] thought it would be cool if we had this science collaborative. We'd all do this together instead of isolated. We talked about [how] at every level it's so easy to silo, and there was that desire to make [collaboration] happen."*
>
> — San Luis Obispo Leader

Leaders across the state spoke of the benefits of articulating a shared vision. For example, Region 8 (in central/southern California) articulated its mission and purpose — "To build regional capacity by developing leaders who will support the implementation of NGSS for all students." That agreed-upon vision served as the lodestar, guiding project leaders as they adapted and tailored professional learning plans to their own contexts and needs. As one Region 8 leader reported, a key take-away was that the groups did not necessarily have the same experiences, but the collaboratively determined focus gave their disparate efforts regionwide coherence and impact. This contrasted with the typically limited impact of working in isolated silos, a norm educators frequently lament.

In Region 3 (10 central counties, including Sacramento), leaders reported that at first the differing needs and compositions of their counties and districts inhibited alignment of vision and direction, especially around their work on equity. Cohesion improved, however, after they invited the Education Trust West to lead participants through data reviews and an assignment analysis guide aimed at exploring equity issues in mathematics and science. This discussion on a tangible aspect of sometimes nebulous or ambiguous concepts — access and equity — promoted a shared understanding and way of thinking. That allowed for the emergence of a common language and direction, in turn enabling pre-existing math-science partnerships among the participating COEs to strengthen their work on issues of cross-subject integration and equity.

Regional collaboration helps spotlight and address inequities in student access to high-quality science and math education

Achievement data from state math assessments show that despite several years' work implementing the new math standards, the state's longstanding racial and socioeconomic achievement gap, in math as well as other subjects, continues to persist. Educators are concerned that similar or greater gaps are likely to emerge with the NGSS, as teachers move through a learning curve in beginning to teach with new standards.

Recognizing that these achievement results reflect system, rather than student, failure, the Partnership highlights the urgency to emphasize equity — meaning ensuring that all students have access, in every sense, to quality math and science instruction.

For that to happen, educators need to understand the equity issues inherent in math and science education — knowledge they may not have gained from their training or prior experience. Equity encompasses multiple facets of structures and practices. For example, students from all backgrounds need access to quality math and science courses. But beyond ensuring that those courses are offered to all students, schools also need to provide students and families with needed information — for example, about which courses students require at each academic level to prepare them for college and career. Further, math and science pathways in middle and high schools need to use recruiting practices that reach out to traditionally underserved students.

Access also means ensuring that all students have well-qualified teachers who know math and science content and believe in students' abilities to learn math and science. Teachers need to understand and be able to effectively use instructional practices — e.g., culturally relevant pedagogy — that allow all students to relate to what's being taught and, thus, gain cognitive access to the content.

Several regional and county teams took advantage of the opportunity to use grant resources to focus on equity. Recognizing that the starting place for equitable student outcomes is heightening educator awareness of the issues involved, several collaboratives worked with external experts in equity and social justice to develop equity-focused math-science professional development. Sessions included presentations, then centered on dialogues that promoted deep thinking and digestion of knowledge about equity.

Region 4 Math's (six Bay Area counties) training in Math in Science Talks (MiST) included a presentation and conversation on the ways that social justice intersects with math, giving teachers a broader understanding of how powerfully a high-quality math education — or lack of one — affects students' educational opportunities and professional options. Region 4 Science brought in an expert to speak about best practices for teaching math to English language learners, allowing participants to update their knowledge of the best ways to teach science content while developing science vocabulary.

Monterey County also uses social justice as the lens through which the team is approaching their math work. Its project offered workshops that provided an overview of social justice in mathematics, the

belief systems involved, equitable approaches to curriculum and instruction, and family and community engagement. The work has resulted in growing connections and interest around key social justice in mathematics issues. Team leaders reported that session participants' increased awareness has led them to question practices in their schools or districts. For example, one participant flagged equity concerns about pathway structures at one of her district's high schools. The teacher voiced her concern to the superintendent, resulting in a county-facilitated convening of countywide secondary staff.

> *"One of our participants took what she learned [about structural barriers to equity] back to her leadership. Now the site administrator and district office administrators are looking to make changes. Potentially over 100 students will have more access to grade level standards and a grade level appropriate math class. That's pretty huge for Monterey County."*
>
> – Monterey County Leader

Collaboration can harness and accelerate leadership development at all levels — COEs, districts, and school sites

The new math and science standards require comprehensive structural and instructional changes. Building the capacity needed to institute those changes requires strong leadership at every level. To build leadership skills, collaborative leaders sought to support math-science champions — educators passionate about making change happen — among COE and district central office staff, school site administrators, teacher leaders, and instructional coaches.

A starting place was including these change agents in the collaborative's leadership, intentionally bringing their knowledge to bear and creating relationships with and among them. Those relationships then allow the teams to mentor emerging math or science leaders, more deeply distribute responsibilities, and galvanize networks in support of the goals.

Several regions tapped pre-existing relationships to identify potential leaders. For example, some participants in Region 11's math efforts had been working together for years, by way of the California Algebra Forum, the California Math Project, and — most recently — the newly formed math and science CPs. Science team members had also shared prior experiences and had a common knowledge base. Because these educators lacked experience working across subjects, Region 11 made the most of their relationship history by appointing them to separate math and science teams to support symposium planning and activities.

Region 8, the science collaborative in central/southern California, made leadership development a key focus of its project. Region 8 created an NGSS Leadership Committee (NLC) consisting of county-level leaders who had in-person and virtual meetings to plan and reflect on each county's science implementation strengths and needs. The NLC created a unified vision and priorities among county leaders, with an emphasis on leaders' responsibility not only to build their own capacity but to help scale the standards implementation work by building leadership capacity at all levels — including COEs, district offices, sites, and classrooms.

As part of its effort to foster such distributed leadership, the NLC included teacher leaders and higher education partners in its Exploratorium professional training — people expressly selected for their influence among peers. The goal, in part, was to impart knowledge within different spheres of influence. But there was also an explicit expectation that these educators would take on shared ownership for advancing standards implementation by way of their respective roles. The Region 8 project, along with those in several other regions, also included training for school and district administrators — positional leaders whose decisions can create or remove barriers to standards implementation efforts.

> *"This is about increasing the number of leaders we can draw from. People have taken that to heart. We're recruiting people with the same mindset. We're not just looking at titles to know who to invite."*
>
> — Region 8 Leader

Experiences across collaboratives suggest that both district and site administrators are important to include, and having them participate as part of a district team can be especially effective, since their roles and decisions are often interdependent. Region 9, for example, asked teams to invite both site and district administrators as part of district teams and found that doing so promoted greater commitment and more effective action planning. Some participants whose teams lacked either a district administrator or principal reported feeling frustrated over the sense that stakeholders whose buy-in is essential were missing from the conversations and learning.

> *"We recommended that teams came with the administrator, but not all of our teams actually did it . Some had just the site administrator, and not a district administrator. Those districts that came with the district administrator are moving forward at a higher rate of progress."*
>
> — Region 9 Leader

Other collaboratives reported that leadership development became a by-product of their work. Region 9 (three southernmost counties) also created a "think tank" of science leaders from each county who came together to jointly address problems of practice. The group developed a collective vision for high-quality science instruction and an inclusive decision-making process that ensured that all members understood reasons behind collective actions and next steps. By sharing resources and best practices, they strengthened each other's expertise and ability to guide and inform local science implementation efforts.

The Bay Area's Region 4 had separate collaboratives and, thus, separate projects, for math and science. That resulted in giving more COE staff and regional partners the opportunity to get involved in the work. Moreover, because the Region 4 Science project included both established and emerging leaders from multiple COEs, its experienced senior leader was able to mentor a number of rising COE science leaders. The emerging leaders gained the experience of working on a large-scale project that might otherwise have been reserved for more senior staff.

The Central Valley's Region 6 also used its project as an opportunity to include and support emerging leaders. In the training the region developed, grade 3–5 teachers not only designed a new instructional segment that integrated math and science but were also asked to share it locally, thereby positioning themselves as leaders with their colleagues. Teachers reported developing greater leadership skills as a result.

Collaboration can accelerate math/science knowledge and skill building at all levels — COEs, districts, and school sites

Besides developing leadership at all levels throughout the system, the collaboratives used several other key strategies to address the identified professional development needs of educators in their region or county. The strategies they chose varied according to the kinds of knowledge or skills their needs assessments targeted, but generally the approaches fit into one of five categories:

- Adapting and sharing existing approaches and resources to instill best practices regionwide.
- Emphasizing active, hands-on learning experiences and opportunities to reflect on learning.
- Ensuring knowledge diffusion, to broaden the reach of what's being learned.
- Highlighting math and science convergences to enhance content knowledge.
- Emphasizing a single subject to enable deeper instructional support.

Adapting and sharing existing approaches and resources to instill best practices regionwide.

A central idea of the Partnership is that useful approaches to math and science standards implementation are being developed across the state and should be shared broadly. As each region identified its capacity-building needs and priorities, leaders were able to tap into and leverage professional development on the new standards already being offered by other experts.

Adapting professional learning experiences. Several regional collaboratives had the opportunity to participate in the Exploratorium's three-day professional development experience focused on NGSS three-dimensional learning, which emphasizes a combination of science practices, core ideas, and crosscutting concepts connected to the NGSS. Funded by the Exploratorium through one of its own program grants, the training included not only face-to-face workshops, but also online follow-up sessions.

Collaboratives could channel this pre-existing high-quality science training into their project plans, tailoring its impact in their region by strategically selecting which regional educators would participate. For example, when the Region 4 Science team offered Exploratorium training to elementary school administrators, they required that participants attend as district teams. The goal was to catalyze science planning and create a shared understanding of approaches to local science implementation issues and best practices.

To help administrators understand what the NGSS looks like in practice, the training included a demonstration of a science phenomenon, or example of a naturally occurring scientific event. One principal who attended reported that the ideas had taken root: on the ride home together, she and her colleagues continued to discuss and build on the work they had begun at the event.

Adapting existing tools and practices. Several project teams chose to adapt or further develop existing tools and practices to create resources more tightly aligned with local math and science instruction needs. To do so, project teams had to dig in deeply to understand the resources and determine how they could be best tailored and contextualized for their stakeholder groups. Those efforts developed the knowledge and capacity of the project leaders, who could then share that learning with others.

Broadening Impact Beyond Math and Science

Several project teams deliberately focused their professional development on strategies that build math-science knowledge and skills by way of equity-based frameworks applicable to all subjects. This approach helps broaden and deepen the benefits of implementing the math and science standards.

For example, Region 5 and Monterey County strove to build an understanding of access and equity issues in math and science by addressing the umbrella issue of social justice, which applies to many facets of education. Expert speakers raised teachers' awareness of how pervasive such issues as deficit thinking about students or gender bias are among teachers across subjects, not just math and science. Similarly, in Region 8's Exploratorium training, an expert speaker outlined strategies that engage English language learners,

conveying knowledge that educators could then use to increase outreach to students and broaden educational access across subjects.

In Marin County, the TRU Framework used for math professional development promotes equitable instruction across the board. The framework's five pillars provide educators with tools to evaluate whether classroom practices feature the content, cognitive demand, agency, and assessments that embody a rigorous educational experience. Marin County used the framework to help teachers draw connections across their districts' multiple professional development initiatives, thus increasing their investment in their professional learning.

San Diego County, for example, focused on redesigning the county's existing online NGSS resource center and developing new resources to support county leaders and educators in implementing the NGSS. Project leaders further asked local educators what would make the resource center more useful and usable for science instruction support at the Region 9 CP, then incorporated educators' feedback into the redesign accordingly. This kind of data collection from local educators — e.g., conducting "empathy interviews" — is a key part of design thinking.[2] Resulting changes included adding search functions teachers could use, a database on science phenomena or events to explain subject concepts, and links to relevant external resources.

In Marin County, project leaders created their own classroom observation protocol to align with the Teaching for Robust Understanding (TRU) Framework, which the COE adopted as the lens to examine math and science initiatives. While the TRU Framework was well-aligned with the county's current initiatives and priorities, project leaders felt they needed to more clearly draw out its connections to ongoing work to make it palatable and useful for teachers. Their adaptation required careful examination of and reflection on the framework's strengths and weaknesses. The protocol created allowed teachers to work together to analyze lesson components objectively, which helped them understand their instructional strengths and weaknesses and provide targeted feedback to colleagues.

Other project teams also relied on or adapted established tools and practices. San Luis Obispo, which focused on building cross-district understanding of NGSS instructional shifts through a lesson study model, incorporated a lesson template from the K–12 Alliance to guide teacher teams through the lesson study process and draw connections to the science standards.[3] Similarly, Region 8's county leads took materials from their trainings with the Exploratorium and other resources they encountered to present or adjust them in response to county resource needs, such as creating NGSS lesson kits that schools in Ventura County could use.

[2] For more info on design thinking, see https://webdesign.tutsplus.com/articles/techniques-of-empathy-interviews-in-design-thinking--cms-31219

[3] Lesson study is a technique used by groups of teachers to develop professionally. Teachers will teach a lesson, ask a colleague to observe and provide feedback, discuss the lesson with colleagues, and refine the lesson. For more info see https://www.aft.org/sites/default/files/pd_whatislessonstudy_2004.pdf.

> *"To come home with a prepared bag of tricks to incorporate into professional learning was super powerful for me and for my team. We all now have these activities and can co-present on them. It was just invaluable."*
>
> — Region 8 Leader

Emphasizing active, hands-on learning experiences and opportunities to reflect on learning.

Most projects provided training where educators became students, experiencing and reflecting on learning over multiple sessions. For both math and science projects, this approach responded to educators' desire to "see" and understand how the standards should look in instruction.

In Region 5, for example, where the focus was building capacity for socially just and equitable mathematics teaching and learning, the project's two conferences combined expert speakers with breakout sessions for discussion and sampling of resources or materials. But cohort teams of teachers and administrators also created lessons and units together, for in-depth, hands-on learning.

> *"What I like about this [PD] is there are presentations and direct information, but we stop and participate. It's true for kids, it's true for adults — we learn through social constructs and need time to interact."*
>
> — Monterey Leader

Marin County similarly varied their professional development format to sustain their learning efforts over the course of a year and enable teachers to go more deeply into what they were working on together. Teachers formed 14 Professional Learning Communities (PLCs) where members met with one another and with coaches to discuss progress toward their goals. They also convened for three countywide workshops.

> *"The teachers are really appreciative of the time to sit down and reflect on their practice — time to just pull out one small piece, and really delve into it deeply. Being able to look at their target students, and how these*

> *different strategies are really impacting them, has been beneficial. Some of them have been sharing it with other teammates outside of our TRU groups, as well."*
>
> — Marin Leader

In other words, the work happened on three levels: individual educators preparing their own lessons; PLCs providing feedback and advancing understanding; and county-level workshops where educators could watch and discuss the same lessons as a group, receive shared information, and continue conversations from the PLCs. These shared activities enabled educators at all levels to learn from each other about specific elements of math or science instruction, thus building countywide knowledge and capacity.

Ensuring knowledge diffusion, to broaden the reach of what's being learned.

Project teams adopted several strategies to increase the likelihood that key knowledge would reach all levels of stakeholders, from instructors to administrators. One, discussed above, is grooming leaders and champions to carry the work forward. Others included requiring participants to accept responsibility for sharing what they learned, creating repositories to make the most informative, useful, and standards-aligned resources widely available, and tracking how resources spread, to inform dissemination strategies.

Requiring participants to share what they learned. Marin County set up a system for teacher teams to share and reflect on how they were bringing the TRU Framework back to their classrooms. After reflecting on and tailoring instruction during their PLC meetings, teachers filmed how they then implemented instructional shifts at their sites. They shared their video clips by posting them on a private community of practice set up for them on the Teaching Channel where they could view, analyze, and make decisions on how to continue to develop efforts.

In Region 3 (central California, including Sacramento), which emphasized equity, symposia participants from large and smaller counties were asked to take home the classroom lesson analysis tool they had learned about and introduce it to their local colleagues, thus infusing research-based knowledge about math and science equity issues throughout the region's classrooms.

Creating repositories to make resources widely available. Many project teams and participants noted a need for repositories to provide a one-stop resource to standards-aligned lesson plans or templates. Amid the flood of "exciting" new content, tools, and practices educators are constantly encountering, they need repositories that can help identify the best and most useful resources, help organize materials that are context specific, and support access for educators in remote locations.

San Diego County's redesigned NGSS Resource Center, discussed above, has successfully addressed this need and is held up as a model by educators who have used it. The San Diego team gathered available resources and convened local practitioners to vet, approve, and help logically organize the resources before including them on the website.

Tracking how resources spread. By tracking the spread of resources, teams gain information that helps guide their ongoing dissemination efforts. The San Diego team, for example, monitors its resource center's reach, using website analytics to see the number of users who had consulted the site. Doing so gives them a sense of how widely the website is used and whether learning is being broadly shared. Similarly, after Region 8 (central coast) intentionally shared resources from its Exploratorium training locally (see "Adapting professional learning experiences," above), team leaders tracked whether and how the resources spread. They found that their strategy was highly effective; demand grew so great for repeat training sessions in some counties that some districts began collaborating to provide sufficient resources and learning events to accommodate all the requests.

Highlighting math and science convergences to enhance content knowledge.

Since the NGSS were released more recently than the math standards, one challenge to converged math and science implementation is that educators' knowledge of NGSS lags behind that for the math standards. The Partnership encouraged joint projects partly to help close that gap. But pairing math and science in one project meant that project leaders needed to be up to speed on both sets of standards, as well as on the status of implementation across their region in both subjects, to design a project that met teachers where they were.

Region 4 (six Bay Area counties) submitted separate math and science grants, but the Region 4 Math project actually focused on converged math and science. To support this work, math staff at each participating COE needed to learn about NGSS and how the science standards intersect with and overlap with the math standards. At the leadership team level, two team members took the lead in learning more about science, which helped them gain a deeper understanding of how science and math can work together in the classroom.

Though the team found it challenging to develop new science knowledge, they believe the effort enriched their project, which focused on helping teachers adapt "math talks" — a familiar instructional routine — into "science talks" that integrate math content. Team members also feel that their understanding of the NGSS enhanced their ability to support elementary teachers in both subjects, including teachers who want to integrate science into their math instruction.

> *"We said, 'let's start with what's comfortable.' We can take what people are good at, the number talk, and get it into science. We want people to see it doesn't just have to happen in a math classroom. They see how it can*

get the kids talking, and we can use that to make sense of the science and make sense of science in a math classroom."

— Region 4 Math Leader

Region 6 (five central California counties) helped project participants develop their knowledge and skills in both subjects by assigning teachers to design units focused on a single subject or on the convergence across the two subjects. Many participants created science lessons that incorporated relevant math concepts, which strengthened their understanding of the cross-subject connections. Moreover — using the diffusion strategy discussed above — the teachers were asked to share their new lessons locally, a dimension that expanded the impact of the project beyond its direct participants to school faculties throughout the region. It also positioned these teachers as leaders with their colleagues, establishing them as the go-to people at their schools for math and science.

Emphasizing a single subject to enable deeper instructional support.

Regional leaders of single-subject collaboratives felt this structure enabled them to go more deeply into building capacity for that subject. Region 4's science-focused collaborative (in six Bay Area counties) focused its project on elementary administrators, a group that has so far received little support for learning about the science standards and how to implement them, despite their critical role in making implementation happen. The professional development symposia presented in Region 4 helped administrators with a chance to understand how NGSS looks in practice. They participated in sessions with cross-district teams, designed to help them to share concrete implementation strategies with fellow administrators and to identify roadblocks to high-quality science instruction — such as pressure to allocate more instructional time to math and literacy.

Bolstering the work in both Region 4 collaboratives (one focused on science, the other on math) were strong subject-focused working groups that developed as a result of their project work. Addressing difficult challenges across participating counties created camaraderie and mutual knowledge sharing. Math and science COE staff across the region say their work has improved as a result; strong relationships with colleagues in other counties equip them with at-the-ready contacts for resources and advice.

Collaboration helps surmount the resource limitations of smaller counties

In many smaller or largely rural counties, the resources and capacity to support educators as they implement standards are more limited than those of larger counties. The regional and county collaboratives help overcome this challenge by establishing new regional infrastructures of shared support, information, and resources that all COEs and districts can access.

Importantly, collaborative leaders report that the changes in how COEs support each other go beyond surface-level logistics. The collaborative experiences in many regions — driven by mutual passion for the math and science implementation work — have created engaged and reciprocal working relationships. Team members report that they have developed a mutual sense of responsibility. "We're not gonna walk away from each other, it's too important," is how a leader from one of Region 2's larger counties put it.

> *"Our collection of resources around this [professional development] is pretty amazing. Because of the collaboration, we could call everyone at the different county offices and ask for more if we couldn't find what we wanted."*
>
> — Region 2 Leader

Leaders across the state agree that this connectedness and commitment has facilitated greater sharing of expertise, information, knowledge, and best practices, leading to broader standards implementation and, hopefully, higher quality learning and deeper impact. As one Region 2 leader reported, where once she would have worked alone to assist her county's districts with their implementation efforts, the support she now receives from fellow COEs via the collaborative helps upgrade the quality of the assistance — a collaborative mode she can count on going forward.

Technology helps overcome the problems of geographic sprawl

Vast geographic distances between educators in several regions posed challenges that collaborative teams often worked around by more pervasively using technology. Some regions maintained educator networks through ongoing virtual collaboration. Region 6 (five central counties), for example, connected its participants in a Google Classroom. Region 3 (10 central counties, including Sacramento) and Region 4 Science (six Bay Area counties) both used Padlet as a place where participants could ask and answer questions. Google Classroom and Padlet both also serve as a record of the knowledge that was shared.

For some collaborative teams, online engagement with remote and rural areas was an explicit goal, seeking to address the difficulty of traveling long distances to participate in professional development. This was the case for both Region 2 and the Central Valley's Region 6, which both used Zoom to support resource development. As the teacher participants in their projects worked to develop math and/or science units to pilot and share, they used a combination of Google Classroom and Zoom for support. Regional leaders posted reminders, due dates, and resources on Google Classroom and hosted Zoom

calls where participants could share their progress, offer suggestions to fellow teachers, and stay motivated.

While the current Partnership projects are funded and organized by CCSESA regions (e.g., California's 11 regions of geographically proximate COEs), it's clear that the use of technology for collaboration knows no regional boundaries; future collaborative efforts could readily involve a geographically broader array of locales wherein educators' priorities coincide. What holds true regardless, however, is that using tools like Zoom requires attention to how those tools are used. For example, Partnership projects have been mindful that participant involvement relies on skillful, technology-aware facilitation. A participant from Region 5 (central coast) shared that while she was among a group of cohort members who participated in meetings from afar, she felt included because the facilitator intentionally paused the conversation to interact with those on Zoom in ways that incorporated everyone's voices.

> *"If we're not there physically, we can't see who wants to speak when. But with every topic, [the meeting facilitator] would stop to see if those of us on Zoom wanted to add anything. She made sure to invite us, so that all voices were heard."*
>
> — Region 5 Participant

Approaches used lay the groundwork for sustainability

Collaborative leaders recognize that their initial project was just that — a beginning. The approaches they took to shape and carry out that project laid the groundwork for what math-science standards implementation requires: a deep and broad commitment among educators across the state to math and science excellence by way of long-term, ongoing capacity building.

With that in mind, it's clear that the more attention collaboratives have paid to sustainability in each aspect of their planning and early work, the better positioned they are to sustain and build on that work. As described in the lessons learned above, collaborative leaders consciously planted the seeds for sustainability by using the following approaches:

Strategic relationship building: Bringing the right people to the table included thinking through key questions with sustainability implications: Who are the region's key math-science change agents? Who are the region's committed math-science champions? How can we harness and build on our existing relationships to help make this collaborative work happen? Which external players — e.g., university faculty or community-based math-science educators — are important to partner with?

Collaborative vision and goal setting: Working together to articulate a vision strengthens relationships and commitment to each other and the work. Vision setting started with needs assessment — team

members jointly identifying and reflecting on strengths and weaknesses within their counties and districts. What content training was needed where, tailored how? That mutual reflection often strengthened relationships, trust, and commitment. A common vision for capacity building could then emerge, becoming the glue that holds efforts together going forward, even as individual players change. Moreover, as leaders recognize, education funding streams typically ebb more than they flow. Strong relationships built around a common vision and goals help ensure the flow of human and financial resources across regional boundaries to support collaborative projects beyond the funding period.

Strategic leadership building: Collaborative leaders recognized that developing broad and deep capacity for high-quality math-science education requires developing leadership at every level — COEs, districts, sites, and classrooms. Many projects tapped positional leaders, targeting trainings to principals and district administrators. These are the policy and decision makers whose understanding of standards-aligned instruction and buy in to its urgency is essential for enabling teacher professional development and support.

In addition, collaboratives recognized the need to include willing and at-the-ready change agents throughout the system, such as math-science specialists, teacher leaders, and instructional coaches. Bringing these educators together by establishing learning teams, cohorts, or localized communities of practice helped to create a corpus of math and science improvement champions, willing to share their learning with colleagues. In short, these activities are developing mentors and math-science leaders who will "carry the torch."

> *"We opened it up to all administrators, we figured they would be our early adopters. [We then] made connections across districts with people who are already interested and ready to start. Then we could start a second cohort and have these people be leaders or mentors. That's how we envisioned it in the future."*
>
> — Monterey County Leader

Strategic approaches to knowledge and skill building: Most collaboratives planned their initial projects in ways intended to create a cascading effect that would allow knowledge and skill building to reach deeply into the system. A number of projects required, for example, that participants in professional development events commit to building others' knowledge and skills back in the schools or districts. Additionally, many projects provided resources and tools that educators throughout the system could continue to use and share with others, even beyond the life of the project.

Several projects created professional training spaces such as communities of practice where educators can get to know each other and continue the collaboration begun at professional development events.

The relationships being fostered are helping to build energy and commitment among these educators to continue to work together around the common goal of fully implementing the standards.

Improving math-science knowledge and skills by way of an equity framework also promotes sustainability. Projects that used a social justice or equity framework such as TRU allow stakeholders across levels and subject areas to see the relevance of the math-science work to their own interests. Project teams report seeing a broad impact from math-science dialogue around seeking social justice for underserved populations or on ways to change math-science instruction to better engage such student populations as English language learners. These issues resonate across disciplines and have the power to draw the sustained attention, commitment, and advocacy of teachers and administrators at all levels throughout the region.

Key Challenges to Regional Collaboration

Building leadership structures to plan and carry out significant projects in a short period of time was a tall order for the new collaboratives. Collaborative leaders had to strategically organize teams, representative of all member COEs, that would incorporate the kinds of knowledge and skills needed for the project they intended to jointly undertake. With some COEs, they could draw from a staff of math and science specialists. Other COEs have just one person handling both math and science. The assembled team then had to figure out how to work together, as well as with external players from universities or math-science entities.

In some collaboratives, pre-existing working relationships made it easier to coalesce the new team. They could move readily to articulate a vision, goals, and priorities and begin establishing roles, responsibilities, and structures for getting the job done. Other collaboratives involved leaders not only unfamiliar with each other, but — especially in converged math-science projects — unaccustomed to working across disciplines.

Reflecting on their work over the first 14 months, regional and county leaders identified three key challenges:

- Collaboration requires bridging disparate mindsets, priorities, and ways of working;
- Collaboration takes time, an ingredient in short supply; and
- With much to be accomplished, success requires focus.

Collaboration requires bridging disparate mindsets, priorities, and ways of working

While all of the collaboratives recognize the need to develop a shared vision to ground their work, doing so can be difficult. Players across a region may have disparate perspectives on what success will look like and, thus, differing priorities or goals. Especially in converged math-science collaboratives, and particularly when partners from outside the K–12 world are involved, the team may lack a common language — a significant impediment to developing a cohesive vision and effective working relationships.

Some teams were able to surmount initial hurdles with cohesion by virtue of moving forward together on their project. In Region 4 Science (six Bay Area counties), for example, team leaders reported difficulties as COE staff and external partners accommodated each other's differing kinds of science expertise and approaches to science education. "We come at these things really differently," said one

external partner. As they planned and implemented their project, however, their trust in and commitment to one another grew.

In Region 4 Math, leaders initial worried that the size of the leadership team may be a hindrance to coherence. But the task of puzzling through unexpected dilemmas encountered with their MiSTs project helped them develop a close working relationship that allowed them to reflect, adapt, and strengthen their commitment to the work and to one another.

> *"We realized with [new math and science] standards we could stay divided or we could align with each other, have a common vision, and try to move the state forward. But when we're in the room with our [other subject] colleagues, it's not a big cohesive front yet. I found those initial goal-setting conversations frustrating, because I felt like we kept going in circles. We've been trying, everybody's been trying."*
>
> — Region 11 Leader

For converged math and science teams, math's several-years head start in standards implementation created a gulf between math educators and science educators, whose needs and priorities differed. In Region 11 (81 school districts in Los Angeles County), for example, leaders discovered that despite the county's strong history of supporting math and science separately, it was not easy to develop a working relationship among colleagues across those disciplines. Leaders noted that it took work to build collaboration and cohesiveness, though some common visioning had developed. As they continue to come together, the two groups are establishing increasingly better working relationships, though leaders report that cohesion is a work in progress.

Collaboration takes time, an ingredient in short supply

Successful collaboration requires routine convening and a commitment to roles and responsibilities for short- and long-term action. Apart from big picture visioning, enacting projects involves extensive joint planning and myriad logistical details. Given that all players have demanding jobs and significant workloads, it is not surprising that leaders cited time constraints as one of the biggest challenges encountered.

Simply finding the time and arranging dates to come together consistently can be hard. For teachers, especially, there are complicating factors. As one Region 3 teacher noted, teachers may be "more than willing" to serve on the team. But meeting schedules have to work around teachers' differing release days for professional development and, often, lack of substitutes to cover their classes.

Distance also creates time challenges. As noted above, technology is a key strategy in several regions for saving travel time by allowing people to convene virtually. Region 11 reported that online collaboration technologies helped make it possible for them to meet, despite busy schedules. Leaders in Region 2, however, emphasized that technology is a supplement, not a replacement, for face-to-face collaboration. Especially when people are getting to know each other and still developing trust and teamwork, there is no real substitute for face-to-face interaction.

A key time-demanding issue for each project is coordination — not just of meetings and agendas but of the ongoing work required to make the project happen and ensure that goals and timelines are met all along the way. Several collaboratives, including Regions 3 and 4, developed systems that distributed responsibility for specific aspects of the work to leadership subgroups. Even with such structures, someone needs to be the coordinating hub, staying on top of all the pieces and helping troubleshoot and mediate hurdles as they arise. Region 11 (LA County) reported encountering difficulties because too much of the workload ended up being handled by a single coordinator; they're working to remedy this structural problem going forward.

With much to be accomplished, success requires focus

Faced with the scope and scale of standards implementation, collaborative leaders recognize that they can't do everything at once. Effectiveness requires focus. Within their shared vision for math-science change, leaders' task was to determine the region's greatest math-science needs, set priorities, and focus on areas where capacity building is most urgent. That included deciding which educators to target — which educators have the greatest needs or are best positioned to change agents with broad or deep impact? They could then develop professional development accordingly.

Leaders in Region 4 Science, for example, determined a shared focus on the fact that science is not always prioritized in elementary school. They determined that the key group to target as change agents on this issue is elementary school administrators. The professional development event they then developed provided an opportunity to convince elementary school administrators of the importance of science.

One challenge is that within regions, educator capacity in math or science tends to vary considerably — by district and school as well as by experience level. For example, professional development that meets the needs of novice teachers in math may frustrate veterans already equipped with that knowledge base or skill set. This problem of uneven capacity, and how to provide events that differentiate professional development, is compounded for collaboratives focused on converged math and science instruction.

Several project leaders realized — especially in light of feedback from professional development participants — that their professional development designs may have been overly ambitious. It may have been more useful, for example, to focus on deepening either math or science knowledge or on teaching a new math-science instructional strategy or on advancing awareness of social justice issues in math and science, rather than trying to accomplish all of these in a single day's event.

Region 4 Math provides a model of one effective solution. Leaders there devised a professional development approach that offered events involving both introductory and more advanced sessions in math and science. Educators could attend sessions in one or both subjects that most suited their level of experience and knowledge.

Approaches used in other regions included hands-on activities relevant to practitioners with varied experience and pre-reading, which helped ensure that participants all arrive with a similar level of baseline knowledge.

Conclusion

The first 14 months of work by the Partnership's regional and countywide collaboratives suggest their powerful potential to foster broad and deep implementation of California's math and science standards. In a short time period and with limited resources, these featured collaboratives have built an infrastructure of connectedness and commitment across key players who otherwise may have worked in isolation. The sharing of expertise, information, knowledge, and best practices has already enabled professional development throughout the state with far greater, more cohesive, and more equitable impact on educators and students than isolated efforts are usually able to achieve.

Besides affirming how impressive the impact of joining forces can be, the collaboratives' early experiences also illustrate how difficult it is to build effective working relationships among professionals with differing mindsets, priorities, and ways of operating — even when everyone involved shares a similar passion for math and science education. Despite the difficulties, each collaborative successfully implemented a capacity-building project, learning much along the way about the complex work of making shifts to leading, practice, and learning in service to access and equity for all of California's educators and students. The lessons learned, documented here, can serve as guideposts and fodder for continued brainstorming and innovation as the collaboratives go forward.

Project Profiles

Region 2:
Increasing and Improving Math and Science Discourse in the Classroom

Description: Joint math and science collaborative (the North State Math and Science Community of Practice) among nine rural counties in northeast California (Siskiyou, Modoc, Trinity, Shasta, Lassen, Tehama, Plumas, Butte, and Glenn).

Leadership structure: Region 2 has a math lead and a science COE lead, but responsibilities and decision-making are spread among representatives from each county — a mix of COE staff and teacher leaders — as well as higher education representatives. The Exploratorium also partnered with the team. Region 2 leaders have had explicit conversations about how smaller counties in the region rely on their larger-county colleagues, and the leadership team is determined to work together and support one another beyond the duration of the grant.

Capacity-building project: A day-long symposium for the region's K–12 teachers, designed to develop teachers' understanding of and capacity for facilitating student discourse in math and science classes with students of all ages. The event featured an interactive talk on math pedagogy, an Exploratorium-led physics exploration activity, and regional discussions on student discourse. Rather than convening everyone from the vast region in one place, teams met in eight county offices and connected to one another and the speaker via Zoom videoconferencing, breaking off into within-county groups to engage in the science activity and hold local discussions. (One county's teachers were unavailable for the event, but a science expert from the county was fully involved in the symposium planning process.)

> *"I was able to realize discourse is a framework I can apply to any subject. Even if students are working on different subjects, I can say 'turn to the person next to you and explain what you've been doing for 30 seconds.' It's*

not about teaching someone else, it's about 'are you understanding this on a level where you can explain it properly?'"

— Teacher Participant

Participants learned discourse strategies from University of Washington mathematics education professor Dr. Elham Kazemi. The Region 2 team provided attendees with books designed to further their knowledge. The team developed a discourse tool that they debuted at the event, which is designed to help teachers select the right talk activity to use with students for a given lesson.

Participants also worked together to explore a science phenomenon — a naturally occurring event. Doing so helped them gain a greater understanding of relevant standards and an idea for a phenomenon they could replicate with their students. Each participating COE scheduled follow-up activities with their teachers, tailored to areas where they felt teachers needed additional support.

Outcomes: Teachers and leaders in rural, sprawling Region 2 rarely have opportunities to collaborate with peers. The collaborative, interactive event enabled all participants to simultaneously hear the same messages about strategies for classroom discourse and their importance without having to travel a great distance. It gave participants the opportunity to engage directly with the keynote speaker on Zoom as well as to develop new connections with colleagues in other counties. Similarly, working relationships among leadership team members have grown, and larger COEs have voiced a commitment to supporting their colleagues in less-resourced areas.

"One of our purposes was to really engage in some of our more rural areas. And that was wildly successful, with [Lassen County] — one of our smallest geographic areas — bringing the largest attendance."

— Region 2 Leader

Region 3:
Creating an Equitable Vision for Math and Science Education

Description: Joint math and science collaborative among 10 urban, suburban, and rural counties in central California (Sacramento, El Dorado, Yolo, Alpine, Placer, Nevada, Sierra, Yuba, Sutter, and Colusa).

Leadership structure: The leadership team was large and diffuse in the beginning, consisting of COE staff as well as district administrators and staff. Over time, a core group collaborated to achieve grant goals.

For example, one team member managed the grant deliverables; several others helped plan regional activities.

Capacity-building project: The Region 3 team focused on developing and disseminating a common vision for high-quality STEM education throughout the region. To accomplish this, they used a two-pronged approach. First, they identified "influencers" — roughly 50 COE staff from across the region's 10 counties who had local influence — and convened this group to develop the vision. The vision they articulated calls for ensuring that educators throughout the region have access to the best ideas, practices, and tools for standards implementation, with an emphasis on cross-subject integration and equity. Second, team leaders identified a group of people who could help the influencers disseminate the targeted ideas, practices, and tools. They then convened the combined group of disseminators and influencers to work together as a community of practice focused on bringing those practices to schools and teachers across the region.

> *"It's been helpful to have a project to center our collaboration around. It centers and focuses us and has created stronger partnerships for this effort of integration and equity."*
>
> — Region 3 Leader

Outcomes: Leaders reported initially struggling to develop a shared vision and direction. Things improved after they invited Education Trust West to lead participants through data reviews and an assignment analysis guide aimed at exploring equity issues in mathematics and science. This discussion on a tangible aspect of what can otherwise be nebulous concepts — access and equity — promoted a shared understanding and way of thinking about issues everyone considered crucial. That allowed for the emergence of a common language and direction, in turn enabling pre-existing math-science partnerships among the participating COEs to strengthen their work on cross-subject integration and equity.

The project had a significant impact across counties as schools took steps to integrate the focus on high-quality STEM education and equity into their instructional systems. They noted that it worked within and strengthened existing structures, thus creating impact with the potential to be long lasting.

Moreover, COE participants reported being energized by the opportunity to serve as thought leaders and ambassadors and said that their own understanding of tools to support equity grew.

Region 4 Math: Adapting a Math Talk Routine to Create "Math in Science Talks"

Description: A joint math- and science-focused collaborative among six Bay Area counties (Alameda, Contra Costa, San Mateo, Marin, San Francisco, Solano, and Napa), including three of the state's largest urban counties and three less populous counties.

Leadership structure: The leadership team consists of staff from several COEs in the region as well as other regional stakeholders (e.g., from the Lawrence Hall of Science). For this project, one COE staff member handled the majority of group facilitation and reporting activities, and all team members fully engaged in planning and implementing the teacher training session. Two team members spent time deepening their NGSS knowledge, then took the lead on planning and supporting the portions of the work related to the science standards. All team members led meetings in their districts.

Capacity-building project: The Region 4 Math team's work focuses on professional development designed to develop elementary and middle school teachers' knowledge of the NGSS and ability to integrate math into science instruction. To do so, they developed a training to support teachers to use a classroom strategy called Math in Science Talks (MiSTs), wherein teachers adapt "math talks" — a familiar instructional routine — into "science talks" that integrate math content.

A professor from the University of California-Berkeley worked closely with the leadership team to plan a MiST training day. The training focused on developing all of the skills necessary to hold successful MiSTs: academic talk facilitation, NGSS content knowledge, convergence between math and science standards, and teachers' understanding of equity and access as they relate to MiSTs and education more broadly. Included was a session on how access to math and science helps students understand the world and expand their opportunities in society.

> *"This [collaborative planning of the MiSTs] was an iterative process. It helped us understand it was okay to question each other. It helped us build our own knowledge and capacity and to be better working with our administrators and teachers."*
>
> — Region 4 Math Leader

After the initial training, leadership team members followed up with teachers from their respective counties and provided coaching support as teachers piloted MiSTs. Drawing on that experience, they then reconvened as a team to evaluate progress and make adjustments.

Outcomes: Leadership team members related initial concerns that having so many strong leaders on one team might make collaboration difficult. Those concerns were allayed as they worked well together through initial MiST planning, and their newfound strong bonds were cemented when they discovered, during the piloting, that teachers were not implementing MiSTs as intended. The dilemma leveraged the group's new, close working relationship. They were able to regroup, simplify their planning tool, and determine ways to offer more hands-on support to make sure MiSTs were working for teachers and their students. The team's ability to be reflective and adapt, as well as their commitment to working closely with teachers and one another, is promising for the longevity of the MiSTs.

Region 4 Science: Building NGSS Understanding Among Elementary School Administrators

Description: Science-focused collaborative among six Bay Area counties (Alameda, Contra Costa, San Mateo, Marin, San Francisco, Solano, and Napa), including three of the state's largest urban counties and three less populous counties.

Leadership structure: The leadership team consists of staff from several COEs in the region. The collaborative uses a distributed leadership structure; an experienced leader in the group worked to build the group's expertise and capacity. To ensure that all voices are heard, they adopted a structure in which all members were viewed as equals.

> *"We said that if the goal is to leverage and understand expertise and build capacity as a group, at this table, everyone should have the same positional authority and opportunities. Be a learner and a contributor."*
>
> — Region 4 Science Leader

Capacity-building project: Working closely with the Exploratorium and the Lawrence Hall of Science, the Region 4 Science team developed a symposium designed to educate elementary administrators about NGSS and to encourage them to focus on science instruction — not only because it is often minimized in favor of math and English but also because of its potential to develop English language skills. The symposium also aimed to help administrators understand how to support and evaluate their teachers in science instruction.

The day-long symposium was offered twice to broaden participation, and participants were asked to attend in school and/or district teams so they could set a vision together. A keynote address from Dr. Susan Gomez-Zwiep (CSU-Long Beach) focused on science and English language development. To

develop their understanding of how NGSS looks in practice, the administrators participated in a hands-on experiment involving scientific phenomenon (i.e., an event that occurs naturally, like a person receiving a sunburn from sun exposure, that can be explained or predicted with scientific knowledge). They participated in sessions with cross-district teams designed to help them identify roadblocks to high-quality science instruction — such as pressure to allocate more instructional time to math and literacy — and to share concrete implementation strategies with fellow administrators.

> *"For me, what came out most was how we can integrate NGSS into our other subject areas, so it's not just an isolated subject."*
>
> — Region 4 Science Symposium Participant

The leadership team administered a pre- and post-event survey, wherein participants were encouraged to identify science leads for their sites, note if there was anyone they hoped to collaborate with, and indicate whether they'd like to follow up with a member of the leadership team. This helped participants plan for the future and will help them connect with others who might extend their learning.

Outcomes: Survey results from the symposium suggest that the event met key objectives. Participants reported that it increased their knowledge of NGSS, sparked conversations within teams about how to increase and improve science instruction, and bolstered their understanding of the best research for teaching science to English learners. They also genuinely enjoyed participating in an NGSS phenomenon and gaining an understanding of what NGSS looks like in practice. They reported leaving the symposia excited and ready to make positive changes to the way they approach science instruction.

Meanwhile, the collaborative's leadership team members reported developing a strong working relationship as they planned the project together. Their trust in one another enabled honest feedback throughout the process. Growing mutual commitment allowed for efficiency in progressing through the project's multiple aspects — they felt they left each meeting with a clear understanding of next steps.

Marin County: CCSS-M and NGSS Implementation through the TRU Framework

Description: Math-focused collaborative consisting of 18 Marin County school districts. Although Marin is part of Region 4, it won its own separate collaborative grant.

Leadership structure: The leadership team consists of instructional coaches from across the county and one principal. The team leader is a former principal from a Marin district who brings enthusiasm, strong leadership, and experience.

> *"Allowing teachers time to come together in small groups to reflect and re-assess student needs — that is the crux [of the work]. Teachers come up with their driving question and their vision, work together to figure out how to implement it, gather data on that, reflect on it, and decide where they'll go with next steps."*
>
> – Marin County Leader

Capacity-building project: The team leader learned about the Teaching for Robust Understanding (TRU) Framework at a community of practice meeting and felt that it was the glue the county needed to made its various math and science initiatives cohere. TRU is a tool that guides instructional practices to help produce equitable classroom experiences and students who are powerful thinkers.

After adopting TRU as a lens, the leadership team formed a network of Professional Learning Communities (PLCs) of elementary teachers across the county who were interested in using TRU to examine and improve their math and science instructional practices, focusing on increasing rigor and access. Each PLC comprises teachers from a single district. The teachers met three times as a whole group during the first half of the 2018–19 school year, collaborating with colleagues across the county. In between meetings, teachers filmed their lessons and shared them with colleagues from their own and other PLCs, providing one another with feedback and using their observations to plan future lessons. The leadership team also trained administrators and coaches on the TRU Framework, so that all educators had a common lens and language to use in coaching and planning conversations.

The coaches on the leadership team provided support to PLC member teachers, some of whom do not otherwise have access to coaching support. The project also increased knowledge of equitable practices and instructional techniques across PLC members. The leadership team is still advancing the initiative by building a protocol that will allow teams to evaluate teaching clips without the support of a coach.

Outcomes: PLC members had the option of focusing on their math or science instruction to build capacity in the area of their choice. Teams were comprised of teachers at different grade levels and schools, but participants reported that the feedback was relevant and meaningful regardless of different grade-level expertise. Teachers also reported that the lessons they learned about improving student access can translate to other aspects of their instructional practice.

Region 5:
Social Justice and Culturally Relevant Pedagogies in Mathematics

Description: Math-focused collaborative that encompasses four counties (Santa Clara, Santa Cruz, San Benito, and Monterey) in the South Bay area.

Leadership structure: The leadership team consists of staff from several COEs in the region. Santa Clara initially took on primary leadership and oversight of the grant work, partnering with other counties to develop and deliver the professional development project. The region decided to split into two localized learning cohorts, with project logistics led by Santa Clara in the North Region Cohort and Monterey in the South Region Cohort. Regional subcommittees tackled distinct project pieces, making efforts to ensure that people across all four counties had a part to play. Partners outside of the COEs included Instructional Leadership Corps, the Silicon Valley Mathematics Initiative, and Texas Instruments.

Capacity-building project: Region 5's primary aim was to ensure educators' broad exposure to crucial social justice concepts and build the capacity of mathematics leaders, teachers, coaches, and administrators to engage with and implement social justice and culturally relevant pedagogies. Their approach was designed to achieve both breadth and depth in familiarizing participants with the language and frameworks underpinning social justice and culturally relevant pedagogies, as well as creating the space for them to interpret and apply what they learned to their respective spheres of influence.

The region hosted two connected conferences, in June and September, open to all teachers, coaches, and administrators in the region. These conferences prompted enthusiasm and helped drive recruitment for participation in the north and south learning cohorts. Once formed, each cohort included 20 teachers, 20 coaches, and 20 administrators. Cohort members participated in professional development that culminated in the creation, implementation, and curation of units and lessons oriented around social justice and culturally relevant pedagogies. Some members of these cohorts also participated in the *Creating Balance in an Unjust World: Conference on Mathematics Education and Social Justice!*

Outcomes: Principals and coaches applied what they learned with a schoolwide lens — for example, by having the whole site staff read materials shared at the conferences. Teachers, in some cases, changed instructional practices — e.g., they developed lesson plans that incorporated social justice and culturally relevant pedagogical principles. Other teachers applied social justice thinking to broader structural issues, such as revisiting the math pathways offered in one of their high schools or bringing together general education and special education teachers for the same math training.

> *"As committee members, we sat in on all these different conversations and listened to the ways in which [participants] took the learning. Everybody got the same readings, same messages, and same activities. Yet how they interpreted it for their classroom or for their students' needs or for their own needs looked so different."*
>
> — Region 5 Leader

In a standout feature of this project, the north and south learning cohorts each held a showcase where participants shared how they had integrated social justice into their work as teachers, coaches, or administrators. These presentations not only exposed participants to the variety of ways social justice could effect change in the lives of students, they also seemed to magnify the energy around collaborating and pushing the work forward.

Monterey County: Developing and Leading Social Justice and Equity in Mathematics

Description: Math-focused collaborative consisting of Monterey County's 24 school districts. Though part of Region 5, Monterey County also won its own separate collaborative grant.

Leadership structure: Monterey County's grant was led by the COE's Educational Administrator of Mathematics, who is dedicated to promoting equitable math education and practices. While the grant focus was on math, the planning team included the educational administrators for science and for assessment to provide subject and administrator perspectives and related insights and offer their support.

Capacity-building project: Drawing on the Region 5 focus on equity and social justice in mathematics, Monterey County conducted a series of four workshops, with optional individualized coaching in between, to support administrators' and teacher leaders' understanding of social justice and equity in math education. Collaborative leaders anticipated that these sessions would attract school leaders already interested in working on access and equity and connect them with like-minded leaders from other districts. These early adopters could then serve as mentors to successive cohorts of participants.

Kyndall Brown, the Executive Director of the California Math Project, facilitated the sessions, using action items created by the National Council of Teachers of Math (NCTM) and TODOS, an equity-focused math organization. These action items provided an overview of social justice in mathematics, the belief systems involved, curriculum and instruction, and family and community engagement. The sessions also

provided hands-on learning experiences to illustrate social justice-based activities, and space for leadership to reflect on personal and local-level learning.

The sessions provided tools and a variety of learning opportunities and reflections for math through a social justice lens. Session participants were provided access to reading materials, textbooks, and lessons and engaged in learning that modeled theory and student learning. Participants were also prompted to evaluate and reflect on questions related to their understanding, practices, and experiences with equitable math education. Reflections occurred in small groups and via a Google Form survey. The COE also provided individualized support.

Outcomes: The collaborative's leaders began to question the project's impact after experiencing challenges with recruitment and attendance, especially of administrators. Despite the pressures of competing priorities at school sites, they had expected administrators, rather than teacher leaders, to take the lead on equity, acting as site-level change agents.

> *"It's not PD — get them together, let them network, give them tools, share what they're up to. The connections I've seen people make that were not intentional are amazing."*
>
> — Monterey County Leader

A particular development, however, mitigated those concerns and prompted the collaborative's leaders to adjust their thinking. A teacher on special assignment who had attended the second cohort session followed up by seeking additional research on de-tracking and equity. After reflecting on pathway structures at her district's high schools, the teacher flagged equity concerns about a pathway at one of the schools. The teacher's concern led to conversations with the superintendent which resulted in a county-facilitated convening of staff representing all of the county's secondary districts. Collaborative leaders say they learned two lessons: leadership comes from all levels; and an event does not require hundreds of participants to result in meaningful change.

Team leaders expected that administrators would be the change agents at districts and sites. But it was a teacher who used what she learned to identify and question a structural inequity — resulting in countywide attention to the problem. Lesson learned: leadership comes from all levels.

Region 6:
Math and Science Teacher Leadership

Description: Joint math and science collaborative comprising five inland counties in central California (San Joaquin, Stanislaus, Tuolumne, Calaveras, and Amador). The region is rural and suburban, with some of the counties larger and better-resourced than others.

Leadership structure: The leadership team includes representatives from each of the region's five counties. The team includes three senior leaders with a wealth of experience, representing two of the more populous counties and one rural one; their colleagues report they have worked hard to develop junior leaders and support more rural counties.

Capacity-building project: Their project, a professional development series, targeted teachers of grades 3 to 5 and included several components: a full-day, in-person kickoff event, two subsequent in-person meetings — a three-day on-site retreat and a one-day follow-up convening — and collaborative remote work through Google Classroom and Zoom conferencing. The on-site retreat focused on team building and establishing supports for converged math and science teaching. At the end of the retreat, participants were given the task of creating a math and/or science resource, piloting it with their students and sharing it locally with colleagues. At the follow-up event, participants learned how to integrate computer science into their classrooms. They also made presentations about the lessons, units, or tools they created and had shared with colleagues locally.

> *"I wanted to provide support to confirm what teachers tend to want to do anyway — integrate what they're teaching. They don't want just math or science time, they want the connections to be brought out. They needed support and tools to make it happen."*
>
> — Region 6 Leader

The differing parts of the professional development series were designed to build different strengths. Participants relished the relationships they formed during the retreat, and these connections were still evident at the next in-person event. The assignments also built capacity; participants not only designed a new instructional segment, but were also asked to share it locally, thereby positioning themselves as leaders with their colleagues.

> *"The lasting impact for me was being able to see the value that other districts put on science coaches, and the effort they're putting into science. [I'm] taking away the confidence to go to my district and say, 'Hey, look, this is what's going on. This is important.'"*
>
> — Region 6 Participant

When participants presented their lessons at the second in-person event, it was clear that the lessons had improved as a result of being tested by the designers and their colleagues. Each teacher's presentation was collected and shared on Google Drive, so participants left the event with a host of new tools to try, complete with advice from the designers on areas for potential extension or pitfalls to avoid.

Outcomes: Participants reported that sharing their lessons and units with colleagues helped develop both their teaching and leadership abilities. A deeper knowledge of content and an expanded sense of what happens in other districts both mattered when they returned to their jobs. One participant who serves as an instructional coach said that the science knowledge she gained would improve her ability to coach science teachers on content, beyond providing general instructional advice. Another teacher said his greater understanding of "the value that other districts put on science coaches, and the effort they're putting into science" gave him the confidence to advocate for a greater focus on science within his district.

Region 8:
Supporting Regional and County Capacity for NGSS

Description: Science-focused collaborative comprising four counties in Central/Southern California (Ventura, Santa Barbara, San Luis Obispo, and Kern). The collaborative's goal is to support and build regional leaders' capacity to implement the NGSS to provide high-quality science education for all students.

Leadership structure: The leadership team is headed by the Ventura COE Science Coordinator who drew on the expertise of participating COEs and school districts — including teacher leaders representing differing grade levels — to create a distributed leadership structure. With an emphasis on shared visioning, the collaborative emphasized leaders' responsibility not only to build their own capacity but to help scale the effort by building leadership capacity at all levels — including staff at COE and district offices, teacher leaders, and instructional coaches.

Capacity-building project: The project tapped expertise and resources to coalesce relationships for NGSS implementation across the county. The project included three central efforts:

1. Convening a Region 8 Core NGSS Leadership Committee, consisting of 15 members selected for their knowledge of each county and their capacity to provide implementation support. Committee members came together for two face-to-face and several virtual meetings to discuss and conduct county asset maps, solidify goals, report on capacity-building efforts, and plan for continuous improvements and sustainability.
2. Collaborating with the Exploratorium to participate in a three-day professional experience around three-dimensional learning and inquiry (which emphasizes a combination of science practices, core ideas, and crosscutting concepts, focused on connections to the NGSS). The event included time for the 40 participants and NGSS Leadership Committee members to collaborate on county implementation planning.
3. Convening a regional administrator training event to build administrative knowledge and collaboration for science teaching and learning. The event focused on NGSS awareness, quality science instruction and learning, and assessments.

> *"We circle back to calibrating the work we're doing with building capacity, that's what the [Region 8] expectation is. We want to build capacity. There's a responsibility to scale that up."*
>
> — Region 8 Leader

Outcomes: As a result of its leadership-focused collaborative work toward a shared vision, Region 8 has expanded opportunities across its four counties to apply learning and share resources for NGSS implementation. At the administrator training, San Luis Obispo, Kern, and Santa Barbara counties joined Ventura County's earlier action to start local NGSS Leadership Networks to grow their own leadership capacity. County leads have been able to use resources from the Exploratorium and adapt professional development opportunities for their own districts through trainings, roadshows, or NGSS lesson kits. Several county leads noted districts' appreciation and eagerness to have professional development opportunities replicated.

San Luis Obispo County: NGSS Implementation, Collaboration, and Lesson Study

Description: Science-focused collaborative consisting of San Luis Obispo (SLO) County's 14 school districts, including charter schools. Though part of Region 8, SLO also won its own separate collaborative grant for NGSS implementation.

Leadership structure: A collaborative leadership structure leverages SLO's county, higher education, and district relationships. When the COE's Program Specialist was asked by Region 8's grant lead to form a leadership team to participate in the regional collaborative, relationships coalesced to create an SLO team of science leaders, who then decided to also seek a countywide grant. The SLO team includes teachers on special assignment (initially from San Luis Coastal Unified, Lucia Mar Unified, and Paso Robles Joint Unified school districts), the Director of Curriculum and Instruction for Atascadero Unified, and science faculty from the California Polytechnic Institute. One of the teachers has now been hired to be the convener and spokesperson for the collaborative (see "Outcomes," below).

Capacity-building project: Striving to build capacity for NGSS implementation across the county, SLO's project brought together cross-district teacher teams for professional learning, with a focus on the lesson study cycle. The approach included establishing a cohort of 24 teachers, grades K–8 (with the exception of 3rd grade), who participated in a five-day summer science institute hosted by the California Polytechnic Institute. The teachers formed grade-level teams that met in the fall to plan and later co-teach rounds of an NGSS-informed lesson using a lesson study approach (see Resource section). The cohort met in winter to reflect on learning and to share experiences with a different group of teachers.

> *"Having all these small districts come together with large districts to share learning is really huge. They're constantly telling us that they need what big districts have in their district offices. We [the COE] can't serve all of them in the same capacity, but because of this grant and pulling people together, they're serving each other."*
>
> — San Luis Obispo Leader

The institute provided NGSS professional development on instructional shifts, grade-specific content, lesson design, and assessments. Project leaders provided a lesson study template and other resources adapted from protocols of the K–12 Alliance at WestEd. Teachers developed cross-district, grade-level teams, participated in lesson planning, and co-taught for the lesson study. Leaders observed the teams during their lessons and debriefed.

> *"I had teachers in my district reaching out to me afterwards, saying, 'Can I go and watch other teachers do their lesson study?' It's really powerful to be able to observe other teachers, whether it's in the district or outside of the district."*
>
> — San Luis Obispo Leader

Outcomes: Leaders and participants reported that teachers gained NGSS knowledge and valued working together, sharing resources, and visiting classrooms. Leaders also said that principals stopped by classrooms to observe lessons, and other teachers asked to participate.

A notable outcome of the SLO collaborative has been the hiring of one of the teachers on special assignment in a year-long role as the convener and spokesperson of the collaborative. This represents a next-step level of collaboration and innovation, since the external partner, California Polytechnic Institute, is paying for half the position, with the county and a district equally funding the rest.

Region 9 — Science: NGSS Resources and Collaboration

Description: Science-focused collaborative consisting of three counties (San Diego, Orange, and Imperial) in the southernmost area of California.

Leadership structure: The leadership team consisted of representatives from each of the region's three COEs and representatives from external science organizations in the area. In planning the project, team members also worked closely with network members from their individual counties.

Capacity-building project: To share ideas and resources, form a common vision of high-quality science instruction, advocate for science education across the region, and build local NGSS knowledge, Region 9 created a think tank of county leaders. It included all three COEs, who formed networks of science leaders — grouped into district teams and representing K–12, higher education, and community programs — to support NGSS implementation.

Region 9 convened the think tank for a two-day event where participants explored NGSS content and engaged in team-building work. The cross-county relationships that flourished as a result helped advance the work of individual leadership networks, some of which partnered with the leadership team for technical assistance on day-to-day science instruction.

> *"Lots of people who are leading this work, like ourselves, haven't been in the classroom since NGSS became the classroom expectation. So as part of the two-day event, we led [think tank members] on an exploration of phenomena and had them do some community building activities related to building science content that they could take away and do back in their district. We are building this community of practice, thinking of ourselves as a community of scientists, not just a community of educators."*
>
> — Region 9 Leader

Outcomes: The leadership team reported that the project empowered local leaders by increasing their access to science resources and expertise. That, in turn, provided new opportunities for teachers and students across the region, helping improve NGSS implementation — notably in rural districts in all three counties. Imperial and Orange counties were able to benefit from the structure and expertise that already existed in San Diego's established leadership network. A leader from Imperial County reported, for example, that districts there were able to accelerate their NGSS rollout because of support from his fellow grant leaders.

> *"I would say that the community of practice offered something for everyone, no matter where they were in their journey, with the implementation and NGSS."*
>
> — Region 9 Participant

San Diego and Orange counties reported increased numbers of regular participants at county-level science network meetings — a goal of the project. Engagement in these meetings increased in all three counties, with Imperial also reporting more county-district interaction around science.

San Diego County — Science: NGSS Resources and Collaboration

Description: Science-focused collaborative consisting of 42 school districts, including San Diego Unified, the second-largest school district in California. Though part of Region 9, San Diego County also won its own separate collaborative grant for NGSS implementation.

Leadership structure: The leadership team consists of three coordinators, a teacher on special assignment, and the director of the local Science Project. The lead for the San Diego County team also serves on the Region 9 leadership team, so the two collaboratives are in close communication.

Capacity-building project: San Diego's project had two major goals: to redesign the county's online NGSS Resource Center and to develop resources that would support implementation of the California Science Framework. The project built out the NGSS Resource Center to include several new capabilities: a search function to let teachers search for performance expectations; a database of phenomena, or naturally occurring events that can be used to explain science concepts; a framework for science teaching and learning; and links to the California Science Framework. The project team also developed new resources, updating their initial plan by hosting a work group of practitioner-leaders who worked together to solve problems of practice and reviewed content for the Resource Center.

The leadership team also offered hands-on support to educators throughout the county, including holding a training to demonstrate the functionality of the updated resource center and offering one-on-one planning support to create science lessons.

> *"When we're at schools with our teachers, they ask, 'What are other districts doing?' It sounds really simple, but honestly a huge take-away every time from this work group is now I know and can talk about it."*
>
> — San Diego Participant

Outcomes: The San Diego project created a sustainable resource that can be used by educators across the county and beyond — teachers elsewhere in the state report using it. Participants who helped curate the center's resources reported that the opportunity to collaborate on science work provided a unique chance to network and find mentorship from county leaders. They said they relished the collaborative opportunity and found the work relevant to their day-to-day responsibilities. Similarly, San Diego County education leaders report satisfaction with the opportunity to meet colleagues at other districts and build their own capacity by learning more about exciting science developments across the county.

> *"As people move, how do we create systems that are sustainable both within our districts and between our districts? This [project] helps us to really develop those systems."*
>
> — Participant

Region 11: Two Symposia for Access and Equity in STEM

Description: Joint math and science collaborative consisting of the 81 school districts in Los Angeles county, a predominantly urban county that includes the largest district in the state, Los Angeles Unified. The collaborative's focus is access and equity in STEM education.

Leadership structure: The LA County STEM Coordinator leads the Region 11 team. Though the math and science leadership teams have the task of planning events, to date the lead coordinator has handled the bulk of the planning. Initially, the science team coalesced more readily than the math team, but as they continue to come together, the groups are establishing increasingly effective working relationships.

> *"The first [symposium] was really just to introduce the conversation of access and equity in math and science. The second symposium was about what action can we take. What are the tools that can be used to have the discussion going further? Now that we recognize that there is inequity, that there is not enough access, how do we ensure that these coaches, these districts, these schools continue to think about how to build [access and equity] into their systems?"*
>
> — Region 11 Leader

Capacity-building project: To develop understanding of access and equity in math and science, the county convened two symposia that built on one another. The events featured prominent speakers — Dr. Ken Wesson, education consultant, and Dr. Talithia Williams of Harvey Mudd College — and opportunities for rich discussion. The second symposium was designed as an opportunity to bring administrators and instructional leaders into contact with one another and with Los Angeles county partners as well as to expose participants to tools and strategies they could immediately take back and

incorporate into practice. The event featured a resource room, open to participants throughout the meeting, that was designed to promote the sharing and adoption of resources from across the region.

Outcomes: The Region 11 symposia both featured speakers that participants enjoyed, but participants reported that because the events treated math and science as separate subjects, they did not help them deepen their understanding of integrating instruction across disciplines. They enjoyed the keynoters, but felt that the speeches could only advance their knowledge so far. Leaders expect that as cohesion grows within and between the math and science teams, their capacity to plan and execute effective capacity-building events will also increase.

> *"I would like to see a greater focus on connecting math and science. The two can be very separate, but if I'm a math teacher, I'm not going to a science notebooking session, and as a science teacher, I'm not gonna go to one that's very math focused. In our district, especially, we're trying to find different ways to merge the two."*
>
> — Participant