WestEd
WestEd.org

Rural STEM Education

Promising Strategies from Several California Counties

Maria Salciccioli

December 2019

Suggested citation: Salciccioli, M. (2019). *Rural STEM education: Promising strategies from several California counties.* San Francisco, CA: WestEd.

WestEd is a nonpartisan, nonprofit research, development, and service agency that works with education and other communities throughout the United States and abroad to promote excellence, achieve equity, and improve learning for children, youth, and adults. WestEd has more than a dozen offices nationwide, from Massachusetts, Vermont, Georgia, and Washington, DC, to Arizona and California, with headquarters in San Francisco.

WestEd
WestEd.org

Contents

LIST OF FIGURES

Overview

In this brief, you will find:

- A brief overview of a statewide initiative designed to improve math and science teaching and learning
- Information on rural education concerns that are found across the state of California
- Examples of rural California counties' strategies for supporting math and science standards implementation
- Ideas for carrying out math and science initiatives in rural areas
- Potential ways that states and funders can support STEM education in rural districts and counties

Key takeaways include:

- While distance means that many rural regions have significant barriers to meaningful collaboration, technology and targeted investments in face time offer improved opportunities for teamwork.
- Some rural areas in California have been able to amplify their professional learning efforts by distributing leadership and responsibilities, and by thinking critically about ways that educators in different grade levels can learn from one another.
- Many of the promising strategies highlighted in this brief can be adapted and replicated at relatively low cost.

In addition to this report, the WestEd team has released two prior reports on the Partnership, both available on the WestEd website:

- *Perspectives on California's Statewide Math and Science Communities of Practice*
- *Implementing California's Mathematics and Science Standards: Lessons Learned from Regional and County Collaboration*

Three more reports on the Partnership are forthcoming and will address noteworthy practices across the state of California, lessons learned from budget decisions, and promising state-level math and science grants.

A Statewide Initiative to Support Math and Science Standards Implementation

Since 2015, WestEd has provided research capabilities, technical assistance, and evaluation support for the California Partnership for Math and Science Education (the Partnership), a statewide initiative designed to increase access to high-quality math and science teaching and learning. Through this ongoing work, conducted in partnership with the California County Superintendents Educational Services Association (CCSESA), the California Department of Education (CDE), and the California State Board of Education (SBE), WestEd has supported two communities of practice, one each for math and science, as well as work conducted by teams of education leaders collaborating to support math and science standards implementation and improve education and learning outcomes.

The Partnership has run its communities of practice since 2016, and they focus on helping educators provide high-quality math and science education for all California students. This standards implementation support work is carried out through professional learning that combines a focus on math and science standards with an emphasis on equity, implementation support, and communication.

Meanwhile, regional teams of education leaders have received two rounds of grant funding — one covering work from fall 2016 to winter 2018, and another from winter 2019 to spring 2020 — to plan and pilot standards implementation initiatives. These innovative micro-grants were designed to test the idea that local innovation could be stimulated with relatively modest investments. The funding has

offered teams an opportunity to collaborate deeply on regional and county needs related to standards implementation, fashion projects in response to local challenges, and continue to learn from and incorporate their learning to improve and sustain their efforts beyond the grant funding period. The impact of these regional projects on improving collaboration was particularly pronounced in rural areas, as funding allowed regions to form and solidify rare in-person connections among leaders and educators that could have long-lasting effects on their ability to continue to work together.

While the Partnership's work reached educators in regions across the entire state, including urban and suburban areas, this brief focuses on how the Partnership has influenced math and science education in rural areas. The brief focuses specifically on rural STEM education because rural educators report additional barriers to teaching math and science beyond those that their peers face, yet research and analysis on STEM education does not often focus on overcoming these challenges. Our goal is to showcase ideas observed in certain parts of California through our work with the Partnership[1] in order to help teachers, administrators, county leaders, and policymakers consider their broader applicability to other contexts.

Rural STEM Education

There is a documented history of rural districts and counties across the nation facing significant odds while working to provide a high-quality education. Researchers have found that students in rural classrooms may struggle to receive high-quality STEM instruction due to factors such as lack of technology, insufficient teacher training, and geographic distance from resources (Marksbury, 2017). These barriers affect many U.S. students — 6.5 million as of 2011 — who attend school in rural areas (Chen et al., 2012). The aforementioned rural issues are in addition to the already significant challenges that counties, districts, and schools nationwide face in implementing college- and career-ready math and science standards.

Rural Areas Involved in the Partnership

While all of the Partnership regions include some rural districts and counties, a few of the regions are predominantly or entirely composed of rural counties (these regions are labeled in Figure 1 as Regions 1, 2, 6, 7, and 10). Those regions are the focus of vignettes featured later in this brief. They have had to come together to leverage particular strengths and overcome certain challenges associated with being

[1] While WestEd followed projects throughout California, we did not follow all of the projects that were organized through the Partnership, so this brief does not represent all rural Partnership projects. It merely represents those that we followed closely and from which we learned important lessons.

rural. As a result, they have developed strategies that may be of interest to other rural areas looking to support math and science teaching and learning.

Figure 1: Map of California's 11 educational service regions

Source: CCSESA

What Makes a Region Rural?

Conceptions of the term "rural" vary greatly, but definitions from the U.S. Census Bureau and U.S. Department of Education (ED), which are adopted by CDE, can serve as a guide. ED defines rural districts as those where all of the schools have average daily attendance below 600 and where the population density is below 10 people every square mile (Ramirez, 2019). ED uses Census data to mark schools as rural if they are at least 5 miles from an urbanized area, or 2.5 miles from an urban cluster (i.e., a densely settled area) (NCES, n.d.).

Figure 2, a map from the USDA Economic Research Service that shows California's urban areas in green, provides a visual comparison to the Partnership's regional map. It shows that there are large swaths of the state — particularly in the north, center, and southeast — that lack urban centers.

Figure 2: Map of California's urban areas (in green)

Source: USDA Economic Research Service

Beyond ED's technical definition, educators from the Partnership's rural areas were asked what made their regions rural. Their responses included features such as the following:

- Distance from an urban center, cultural experiences, and basic services, such as grocery stores and reliable internet access
- Small communities in which schools need to rely on county offices for services because principals wear many hats and schools lack additional instructional support staff
- The need to educate multiple grade levels in one classroom, due to small size and a small supply of educators
- Educators and communities with relatively low exposure to and excitement about STEM

Shared Challenges Across Rural Regions

As WestEd followed the Partnership's work, some common themes emerged on the difficulties of effectively supporting math and science standards implementation in rural areas that are less populated, less resourced, and geographically larger than urban and suburban areas.

Difficulty collaborating across distances. One common challenge in California's rural areas is geographic distance. Because districts and schools are spread far apart, when rural educators want to collaborate across schools or districts, they typically need to invest significant effort and travel time, especially if they have limited access to airports, train stations, and other methods of rapid transportation.

Lack of STEM personnel and internal STEM capacity. Since rural counties have fewer students, they tend to have correspondingly smaller budgets, due to Average Daily Attendance funding formulas. Across California, rural county offices of education (COEs) may be unable to fund full-time county-level personnel who can dedicate time to providing teacher and administrator professional development in math and science. In some cases, counties have instead designated teachers or principals as county STEM leads. Smaller budgets also mean fewer resources to ensure high-quality, consistent STEM teaching practices across a county. County-level administrators are stretched thin everywhere, not just in rural areas. However, in WestEd's work with the Partnership, rural areas were the only places where we found counties without county-level STEM leaders.[2]

Lack of local STEM partners to support standards implementation. Urban areas in California are home to hosts of nonprofits, math and science projects, and other external organizations and resources. The relative dearth of local partners to support the work of rural COEs means that rural leaders have had to think more strategically about who might be able to help them advance their teaching and learning goals, and how to collaborate when those partners are far away. As one COE leader noted, "We do have some external partners. We wish we could have more. But right now, that's where we're at. We're really leaning heavily on each other."

Some rural COEs in the Partnership addressed this issue by teaming up with local higher education partners. For instance, some of the rural regions worked with math and science projects affiliated with the California Subject Matter Projects, based in their local California State University (CSU) or University

[2] The projects conducted through the Partnership were focused on math and/or science. Most projects integrated technology in multiple, creative ways, but engineering was not a primary focus of most Partnership projects. While STEM is an acronym that includes engineering, it is generally used in this brief to refer to math and/or science projects with technology components, or math and/or science teachers and leaders.

of California campus. Other regions leveraged the support of external organizations that were not local, and collaborated in creative ways to benefit from their expertise despite large geographic distances.

Each of the regions in the Partnership — rural and otherwise — made different choices about whether they would undertake projects that combined math and science or addressed them separately. The regions had autonomy in deciding how to spend their grant funds, which grade levels to focus on, and which math and/or science topics to address (e.g., discourse, developing STEM leadership skills). The vignettes that follow illustrate successes (as gauged by metrics such as increased engagement, knowledge, and/or skills) from regions that made very different choices from one another, which suggests that there are many promising approaches to improving rural STEM education.

Vignettes from the Field: Noteworthy Practices for Addressing Rural Education Issues

This section presents some of the ways that regional leaders in rural areas worked to support math and science education through their Partnership-funded projects. Each vignette focuses on noteworthy strategies and practices that may provide new food for thought for educators, administrators, and policymakers looking to support and improve rural STEM education.

Region 6 Vignette: Developing High-Quality Math and Science Units

Key Challenge: Difficulty Collaborating Across Distances

Region 6, located in central California, has a mixture of very rural and more populous counties, none of which are close to large urban centers. Some counties in the region face challenges discussed earlier in this brief, such as lack of STEM leaders at the COE level and distance from large urban areas and external partners, whereas other counties are relatively better resourced, with more staff and significant COE

STEM expertise. The Region 6 leadership team wanted to help teacherleaders understand how math and science are interrelated and can be integrated, so it decided to implement a joint math and science project.

The team worked with teachers in grades 3–5 to help them develop high-quality units for math and science, which those teachers were asked to pilot and share locally. In summer 2018, the team brought together the participating teachers for a three-day retreat, hoping that building relationships would help cohere the unit-building efforts going forward. During the retreat, they engaged in team building, resource sharing, and standards implementation work. Over the fall semester, as teachers built and tested lessons, the Region 6 leadership team kept in touch using Google Classroom to provide virtual support and reminders. The team concluded its work with a winter showcase in which teachers presented their units and debriefed on the piloting process, and regional leaders compiled and shared the new units with all of the participants.

Building on the Groundwork

The Region 6 team is continuing and extending their work on math and science units and relationship-building in 2019–20. Many of the teacher leaders who participated in the first phase of the project are serving as leaders for the new cohort, so they are further developing their leadership skills as they help provide professional learning to a new group of teachers.

Positive Outcomes

The Region 6 team developed content knowledge and leadership capacity in participants, as they worked to build, test, and share high-quality math and science units. They also helped participants build relationships with colleagues across the region and created a repository of units that have been tested and can be adapted by anyone in the region. Since rural educators may have fewer opportunities to learn from colleagues outside of their schools, the project spread knowledge more widely than would have otherwise been possible.

Hurdles to Clear

With their first project, the leadership team had to decide whether investing in an in-person meeting or providing teachers with substantial stipends would be the best use of funds. The team opted to pay for an in-person retreat with the first grant and, with the second grant, after some relationships had been formed, they invested in larger teacher stipends.

Useful Strategies

Investing in relationships. Although it was costly and time consuming to bring participants together, the Region 6 team decided to start and end its first project with in-person meetings. They felt that building relationships and providing an immersive experience would build investment. These in-person meetings helped keep participants engaged, despite not physically seeing one another for several months, which can be particularly meaningful in a rural context where schools are far apart and may be so small that

there is only one teacher per grade level. One participant reported gaining meaningful science content knowledge, but she also noted, "That was the best part…the networking and getting to know each other."

Bridging distance with technology. Once relationships were established, the Region 6 team used Google Classroom and Zoom to send out messages, hold virtual support meetings, share information with participants, and convene the leadership team. Google Classroom allowed people to share their progress, and it helped keep work moving without in-person engagement.

Building teacher capacity to reflect on instruction. As teachers developed their lessons, they were asked to share them with local colleagues, which meant that their learning traveled beyond their classrooms. The team is also deepening teacher capacity in the second grant cycle by integrating universal design for learning (UDL) principles and lesson study into their project. UDL helps make learning more accessible for all students, and lesson study helps teachers dive more deeply into instruction and strengthen their ability to collaborate. Giving teachers both of these new skills develops their STEM teaching and leadership abilities.

In the first grant cycle, one participant reported that by connecting with other teachers, he saw how other districts prioritize science, and it empowered him to advocate for more instructional time for science at his school. Investing in teacher knowledge has meant that the Region 6 team has more experts who can help develop STEM knowledge across the region.

Region 2 Vignette: Fostering Learning and Connections Through a Regional Symposium

Key Challenges: Lack of STEM Personnel and Internal STEM Capacity

Region 2 comprises nine counties in the rural northwest of California. The region faces some of the challenges described above — chiefly, some of the counties lack STEM staff at the county level and some counties are very small, with relatively limited resources.

The leadership team decided they wanted to improve student discourse in all grade levels across the region. So, with the first Partnership grant, Region 2 created a STEM community of practice that convened K–12 teachers for an all-day symposium focused on increasing and improving discourse in the classroom. The regional event featured a keynote speech on math pedagogy, a physics exploration activity led by staff from the Exploratorium,[3] a math activity led by a CSU Chico professor, and county-specific breakout discussions on student discourse. The keynote speaker was remote, and each county in the region hosted its own in-person breakout group, so the speaker and the county offices connected

[3] The Exploratorium is a hands-on science museum and education center in San Francisco. It has supported several Partnership regions at no cost, which has helped these regions stretch their budgets and impact. The Exploratorium and other external organizations have been key members of the Partnership since 2015. This engagement has developed relationships among the regions and key education stakeholders across the state.

to one another via videoconference. This format allowed for shared experiences during the keynote and the exploration activity, as well as intimate discussions attuned to more local concerns during the breakout discussions.

Building on the Groundwork

The Region 2 team reflected on its symposium and decided to hold another symposium in 2019, with intentional changes designed to support continuous engagement across the region and sessions that are targeted to specific grade bands.

Positive Outcomes

The symposium helped Region 2 boost engagement in STEM education and provided an exciting opportunity for people in the region's most rural areas who have limited access to professional learning. Symposium participants reported that they enjoyed the keynote speech and science exploration. As one participant noted, "I think the discussion of all the ways to have discourse was a go-to." When asked to what extent the symposium had shifted their beliefs in the importance of discourse in STEM instruction, over a quarter of participants reported it had a very significant impact, and over 90 percent indicated at least some shift in their beliefs.

By bringing participants together virtually across counties, the leadership team leveraged technology to develop and strengthen relationships among the leadership team and teachers. With another symposium planned for fall 2019, the region will continue to provide this sort of high-quality professional learning on STEM instruction to many of the region's teachers.

Hurdles to Clear

The symposium was well attended, but the leadership team struggled to engage participants in follow-up sessions at the county level. To support ongoing engagement in the second part of the project, the team pre-scheduled follow-ups, so teachers were provided the schedule with ample time to plan to attend. Regional leaders also budgeted for participant stipends, which are tied to participation in follow-up sessions.

Useful Strategies

The team pulled off an ambitious symposium through the use of some key strategies:

Finding leadership outside of COE staff. One small county in the region did not have STEM leadership at the county office, so Region 2 invited a master math teacher from that county onto the leadership team and into the Partnership community of practice. The teacher was not only able to represent her county, but she also provided a teacher perspective, which helped the planning team focus on teacher needs. The team also included faculty members from a nearby CSU and a local community college. These higher education representatives brought even more mathematics expertise, which proved helpful during the symposium, as the CSU professor facilitated a session.

Additionally, the symposium included a session led by Exploratorium staff and a keynote from a researcher at the University of Washington. Calling on external connections made through the Partnership helped the Region 2 team provide high-quality professional learning on the NGSS, the CCSS-M, and discourse.

Large counties helping small counties. Even though all of the counties in Region 2 are rural, some are larger and more well-resourced than others. Those with more personnel, existing high-quality materials, and in-house expertise were eager to help other counties work toward their shared improvement goals, both as they planned the symposium and as they continued to work together afterwards. As one COE leader from a larger county said, "We'll always support our friends in the smaller mountain counties...we know [a small county] is always up there needing our support as much as we can, so we try to look for ways to extend that work. We try to do regional things as much as we can and keep thinking this way — it benefits everybody."

Communication and distributed leadership. While the Region 2 planning team had two primary leaders, everyone on the team had opportunities to contribute and the next steps after each team meeting were distributed across the team and documented in Google Drive. The group met regularly via video conferencing (and in person when possible) and checked in with one another on deliverables, culminating in a "dress rehearsal" conducted on videoconference prior to the symposium. This dress rehearsal provided an opportunity for the team to address last-minute questions and concerns, and to get on the same page without needing to meet in person. To help the large, remote groups of symposium participants feel more connected to one another, the team spent a significant portion of its grant budget on technology to facilitate the event, including high-quality microphones and projectors.

As the team moves into the second phase of its regional work within the Partnership, the team members have designed their professional development to engage teachers even further. Their planned follow-up sessions will feature grade band-specific content, rather than a broad K–12 focus; a video-conferencing option; content that is responsive to teacher questions, rather than pre-planned; and stipends to show appreciation for consistent participation in the project.

Region 10 Vignette: Building a Network for Regional Science Collaboration

Key Challenges: Lack of STEM Personnel and Internal STEM Capacity

Region 10 comprises four counties that cover a large geographic area in the southeast of California. The region chose to split its Partnership-funded work into separate math and science projects. The science team members decided to prioritize science collaboration and inclusion, so they started their work by building a robust network for science collaboration across the region. The network focused on improving NGSS knowledge and teaching in high school biology, chemistry, and physics. Region 10 decided to expend grant funding to bring teachers from the most rural areas to in-person network meetings. The rationale was that face-to-face connections could further build capacity in these rural

teacher leaders, who could share what they learned with others in their districts via a train-the-trainer model, ultimately benefitting many more people.

To facilitate full participation from remote districts and counties, the network also featured satellite sites — remote gatherings that were separate from the main network meeting, located in rural counties, and technologically connected to the network. Through these sites, educators in far-away counties could gather together and participate in the network meetings without traveling a significant distance.

Through the network, Region 10 launched twice-yearly in-person high school science trainings for teachers, which offered opportunities for deep science learning and networking.

Building on the Groundwork

As the team moves into its second cycle of funding, it is broadening its focus beyond high school to include middle school teachers, which will ideally strengthen students' understanding of science at an earlier age. Rather than addressing specific high school science courses, regional trainings will now focus on disciplinary core ideas (DCIs), which are broad ideas that frame K–12 scientific concepts and units, such as "Earth and Human Activity" and "Matter and Its Interactions." Teachers will be encouraged to attend training sessions on the DCIs of their choosing. The region is also expanding its work to provide administrator training, including a leadership symposium and a book study, to help school leaders better understand NGSS across the curriculum.

Positive Outcomes

The Region 10 Science project created a regional network, worked together to identify the areas of greatest need in science instruction, and created professional development to address them. The team was able to use its grant budget to bring people together in person, which enabled it to foster relationships and provide targeted content support to educators across the region, including the most-rural teachers who had had limited access to high-quality NGSS professional learning. The collaboration and professional learning structures that team members put in place during the first grant cycle created a foundation for them to scale their work further to reach more educators and administrators as their work continues.

Hurdles to Clear

The team realized that creating satellite sites was not sufficient for helping remote counties. Some of these counties had little NGSS expertise and remote learning would not be enough to help the most rural teachers build science knowledge. To combat this issue, the team adjusted its budget to make sure that it could include some very remote teachers in its in-person sessions. By doing so, these teachers were able to learn useful information at in-person meetings, then return home and train their local colleagues.

Useful Strategies

The strategies highlighted below bolstered Region 10's success in the first year of grant funding:

Building relationships and consensus. Before starting to offer professional development, the science team built a strong network that included teachers, administrators, and COE leaders from across the region. After the network agreed upon an area of focus — high school science — the aligned focus and new relationships allowed network members to work together more efficiently than they may have otherwise.

Thoughtful groupings. After first focusing on high school science subjects, the team thought carefully about how best to include middle school teachers. Focusing on DCIs meant that its professional development would be relevant to middle and high school teachers alike, since the DCIs are seen across the curriculum. This required less additional work than it would take to hold separate, course-specific trainings for all of the middle school teachers in the region.

Scaling up over time. The team started its project by focusing on high school, the grade band that it felt demonstrated the most need. Once the team had established a network and held successful trainings, it decided to scale up the work. After feeling that its early efforts were successful, the team now feels that "science can be that foundational subject that all other subjects can run through," even as team members plan to partner with a larger group of educators.

Region 1 Vignette: Developing Science Identities

Key Challenge: Creating Mindset Change

Region 1 is in the northwestern corner of California. It mostly comprises rural counties, but some counties are more suburban, and some have more resources at their disposal than others. In the first phase of the Partnership's grant-funded work, the region worked together on a joint math and science project. In the second phase, the region decided to work on separate projects to focus more closely on individual subjects.

The team noted that society has preconceived notions of who can be a scientist, and people in rural areas may be less likely to personally know STEM professionals. Accordingly, for its first project, Region 1 focused on developing math and science identities. The science team is continuing this work by tasking each of the five counties in the region with testing a different change idea to develop science identities[4] in order to dispel potentially harmful preconceptions.

Building on the Groundwork

As county teams continue the region's work on science identities, they are taking their change ideas through modified Plan-Do-Study-Act (PDSA) cycles. These cycles are an improvement-science approach in which teams develop a plan, test it, study how it worked, and make necessary changes. The teams' change ideas range from focusing on science discourse as a means for developing science identities to

[4] A "science identity" is the way that science is part of an individual's sense of self. For more information on what a science identity looks like, please see: https://www.xsci.org/research-2/science-identity/

building a local science collaborative to empower science educators. Each county is collecting survey data from teachers to understand the impact of its work. As the team goes through its modified PDSA cycles at the county level, team members are also working together to share their successes and challenges and to help one another refine their plans between cycles.

Positive Outcomes

The Region 1 science team has been able to maximize its time and effort through targeted change ideas, close collaboration, and partnership with an experienced nonprofit. Last year, in partnership with the Region 1 math team, it laid the groundwork for building math and science identities by working with districts to provide professional development, learning about teachers' and students' misconceptions about their STEM identities and abilities, and learning about how it could provide support on standards implementation. This year, regional leaders are working with the Exploratorium to continue building science knowledge and identities.

Hurdles to Clear

While the regional math and science teams were focused on similar issues and worked well together in the 2017–19 project cycle, the science team realized that a unique focus on science identities was necessary and was not getting enough attention in a joint project. The decision to split the math and science teams in 2019–20 has meant that the math and science leaders have had to work hard to coordinate with one another, but it also permits a deeper focus on science.

Useful Strategies

The team's work featured various strategies that contributed to positive outcomes:

Incorporating a well-resourced partner. Since the Region 1 area has relatively few local science organizations, the team connected with the Exploratorium for support. While the Exploratorium is not located near many of the counties in the region, it is an organization with significant human and financial resources, and it funded Region 1 to bring teachers to San Francisco for training. It may not be ideal to ask rural educators to travel to an urban area, but in this case, regional leaders reported that the hands-on training provided by the Exploratorium energized educators, which made the trip worthwhile.

Using PDSA cycles. Improvement science, while labor-intensive, can be incredibly rewarding. It has the potential to provide a wealth of information from different counties on a common regional challenge, helping regional leaders better understand steps that can be taken toward improvement. By engaging in modified PDSA cycles, which are an improvement science strategy, the relatively small Region 1 team is learning a lot of information very quickly. Testing five different change ideas, and collecting data on their impact, means that the team has gained knowledge on five different tactics for building science identities, and it can move forward with those that have the greatest impact in its region. The modified PDSA cycles also enable counties that are far apart to use local evidence to collaborate on a shared regional problem.

Advancing Rural STEM Education Work Further — Extending and Replicating the Work

In California, COEs and districts receive significant support from the CDE, which has established a tiered system of support as part of an accountability and continuous improvement system (Barrales, 2019). However, the system is still developing (Plank et al., 2018) and there is additional work to be done to establish a more comprehensive system of professional learning throughout the state (Furger et al., 2019). The work of the Partnership could serve as a guide for how targeted funding can catalyze support and professional learning opportunities for rural science and math educators. Funders should also take note of the meaningful results that regional funding can deliver when provided to teams of educators who are working at different levels and across systems. The efforts and accomplishments of rural COEs throughout the state are an important piece of what has made these Partnership-funded projects effective, and the strategies that participants have deemed successful might be worth emphasizing further at the state level. The strategies detailed throughout the report represent ideas for counties, districts, and schools to take up as they attempt to improve rural STEM education. In addition, states and funders can support and fund these efforts, which can help coalesce them into state-level approaches.

Sometimes, geographic distance can mean that rural educators are left out of important conversations, yet organizers of the Partnership's regional grant-funded projects worked to ensure that rural leaders had a seat at the table.[5] Through Partnership projects, regional teams were empowered to focus on the areas of greatest need and provide support that sometimes looked different than the standard fee-for-service relationship between COEs and their districts. Continued funding from an interested funder could help increase and spread the impact of this work. Notably, regions spent their money in very different ways, so flexible funds that allow regions to innovate would likely carry the greatest weight.

Replicating Rural Regions' Promising Strategies

The vignettes in this paper provide an in-depth look at the strategies that four rural regions used. These vignettes are intended to help education leaders understand what it looks like to design and execute an

[5] The Partnership provided travel funding for rural educators, created a rural subcommittee to discuss and prioritize rural issues, involved rural leaders in leadership conversations, held phone and videoconferencing meetings to support inclusion, and invited rural educators to present about successful strategies they employed.

initiative designed to improve rural STEM education. Rural areas seeking to replicate the success of these regions do not necessarily need to design large-scale standards implementation projects like some of those featured here, which might prove daunting. Rather, interested rural educators can identify the elements and the scale that will work best for them — they can replicate regions' entire strategies, try individual pieces of these regions' work, or mix together pieces from multiple regions' improvement efforts.

The following strategies that were leveraged by rural regions in the Partnership may be particularly well suited for use by other rural educators hoping to provide meaningful support for STEM teaching and learning. We hope that looking across these examples, county-level educators might find strategies that could fit into their contexts and funding structures.

Improvement Science Approaches

Engaging in cycles of planning, doing, studying, and acting can be helpful for teachers and leaders alike as they work to understand whether and how techniques are improving student learning, or where processes designed to support teaching and learning are breaking down (Bryk et al., 2015). Bringing teachers into PDSA cycles helps them take ownership of their practice. It is a low-cost way for teachers to test instructional practices and assess the effectiveness and impact of their efforts. Teachers at all levels of expertise can benefit from engaging in local experiments. They can work remotely to help one another examine artifacts or lesson clips through virtual conversations via video or electronic messages.

PDSA cycles can also be used beyond the teacher level as a tool to help schools, districts, and counties understand which teaching and learning practices are working and which ones need to be refined. Data gathered from these cycles can be used to improve education across systems, and PDSA cycles can be a way to start engaging with data and working effectively toward continuous improvement.

Digital Connections

Many rural regions in the Partnership successfully leveraged digital technology in order to meet without traveling. Leadership teams met on Zoom or Skype, which helped them share documents during meetings and have a more personal connection. Google Classroom allowed Region 6's leadership to communicate and collect assignments. These resources keep teachers and leaders connected, and they can be obtained for free or at a low cost.[6]

Cross-Grade Topics

Focusing professional development on topics that cut across a variety of grade levels — such as discourse, in Region 2, or broad science concepts, in Region 10 — can help rural regions bring more people together to engage in shared conversations about improving math and science. Teachers across the state report that it is valuable for them to collaborate with colleagues outside of their schools

[6] For more information on digital connections in the Partnership, please see another WestEd resource, *Implementing California's mathematics and science standards: Lessons learned from regional and county collaboration*.

(Salciccioli & Perry, 2019), but rural areas may have very few teachers in a given grade level. Finding subjects for professional development that would benefit many teachers, then scaffolding the professional development to make it relevant across grade levels, can help create professional learning that is both widely useful and specific.

Administrators can also benefit from professional learning that addresses broad topics but is scaffolded, as their knowledge of STEM subjects may vary greatly and building administrators' understanding of STEM education helps build system coherence across subjects and grade levels. Several members of the Partnership — rural and urban alike — are turning their attention in the 2019–20 grant period toward scaffolded administrator professional development in the STEM subjects.

Over time, as capacity builds, professional developers may consider narrowing their training further or providing a greater number of targeted sessions. Teacher leaders may be able to help increase a region's ability to offer more narrow trainings over time, as they learn from county leaders and then provide training for their colleagues.

References

Barrales, K. (2019). *California's system of support*. California Department of Education.

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

Chen, C., Sable, J., Mitchell, L., & Liu, F. (2012). *Documentation to the NCES Common Core of Data Public Elementary/Secondary School Universe Survey: School year 2009–10* (NCES 2011-348rev). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Furger, R., Hernandez, L., & Darling-Hammond, L. (2019). *The California way: The golden state's quest to build an equitable and excellent education system*. Learning Policy Institute.

Le Fevre, L., Salciccioli, M., Gutierrez, P., & Perry, R. (2019*). Implementing California's mathematics and science standards: Lessons learned from regional and county collaboration*. San Francisco, CA: WestEd.

Marksbury, N. (2017). Monitoring the pipeline: STEM education in rural U.S. *Forum on Public Policy Online,* 2017(2).

National Center for Education Statistics. (n.d.). *Rural education in America*. Retrieved from https://nces.ed.gov/surveys/ruraled/definitions.asp

Plank, D., O'Day, J., & Cottingham, B. (2018). *Getting down to facts II: Building a system of support for school improvement*.

Ramirez, P. (2019). *Title V, Part B Rural Education Initiative*. California Department of Education.

Salciccioli, M., & Perry, R. (2019). *Perspectives on California's statewide math and science communities of practice*. San Francisco, CA: WestEd.

Appendix A: Methodology

At the formation of the Partnership, WestEd was selected by the S.D. Bechtel, Jr. Foundation to provide support, analysis, and observations of the initiative. WestEd staff have attended every Partnership convening and have also attended regional calls and events focused on local standards implementation, including in-person and online attendance at events held by rural regions. Furthermore, WestEd has served as a thought partner to regions throughout the state, some rural and some not, to help with strategy development, data analysis, and assessment.

For this brief focused on rural education, WestEd staff gathered additional information by conducting interviews with each regional team; joining a Partnership subcommittee where rural COE staff and leaders from science organizations across the state gather to learn about rural challenges and share strategies; and reviewing each regional team's budget to understand how funding was used to support standards implementation, as well as how rural spending differed from suburban and urban spending. WestEd also conducted a literature review on education issues affecting rural areas in order to understand the bigger picture.

The projects highlighted in this brief were chosen because their approaches to math and science education focused on necessary improvements in STEM education, while also addressing the unique challenges faced by rural areas, using techniques that could be replicated in other rural areas.