

The Future of California Science

A Story of Leadership, Collaboration, and Legacy

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Preface

“This is the first time in California where I have seen consistent messaging from every major professional development player in the science education world. Having all these folks from different organizations coming together about NGSS with one singular vision, voice, and message has been an incredible change. It’s really shaping what science education is looking like now.”

Anthony Quan, STEM Coordinator at the Los Angeles County Office of Education

Something unprecedented is happening in California education today, and it provides genuine hope for the future of science learning — and young people — in the state.

That’s the premise of this narrative, told through the perspectives of 23 champions¹ for implementation of the Next Generation Science Standards (NGSS). They are part of an ever-expanding cadre of leaders who are crossing significant conventional boundaries to earnestly collaborate on aligning efforts and bringing forward the promise of high-quality science learning for all California students.

The vision, tenacity, and creativity of these leaders — who represent districts, counties, the state, and a range of science-focused organizations — are making a difference in science teaching and learning. Setting aside parochial agendas in favor of unified action, their organizations are fueling early NGSS implementation successes, orchestrating innovative statewide professional learning for teachers and administrators, shaping structures that allow adoption of the NGSS at scale, and bringing visibility to science as a needed core subject in the country’s most populous and diverse state. However, while NGSS implementation is happening in every region of the state, there is still much more to do to fully reach all districts, teachers and administrators, and students.

Many of these leaders came of age professionally in the 1990s, a time when sweeping reforms illuminated the power of effective science learning. They became lifelong advocates for high-quality science instruction as a means to benefit all students, helping youths from all backgrounds grow into adults who can participate fully in civic life and the 21st-century economy. These established champions are, in turn, inspiring — and supporting — an emerging cohort of teacher leaders and administrators

¹ Appendix A lists the interviewees for this paper.

who are advancing vibrant implementation of the NGSS in classrooms, schools, districts, counties, and state policy settings.

As leaders of the teams that implemented and evaluated a six-year statewide effort known as the California NGSS Early Implementers Initiative, the coauthors of this paper have had a front-row seat for implementation of the California NGSS since their adoption in 2013. Coauthor Kathy DiRanna was also strongly involved in the new collaborations formed among science organizations that will be described in this piece. We document this story to attempt to capture the spirit and strategies behind the remarkable collaboration that is bringing forward a new era in state science education practice. We hope this account informs and encourages educational leaders, policymakers, funders, and all who are doing the hard but crucial work of advancing the NGSS and the Common Core.

IN THEIR VOICES

Many of the leaders cited in this paper are featured in a companion video on “The Future of California Science,” available at <https://vimeo.com/437327825>.

NGSS Changes the Game for Students, Schools, and Districts

The NGSS emphasize big shifts that empower all students to learn science. These standards embed what science education experts have long sought: having kids and their teachers learn in the same ways that scientists work. Interviewees gave vivid descriptions of the profound shift from teacher-centered science instruction to student-centered science investigations, an approach recommended by experts and supported by research for decades. Principal Ron Rammer in Galt Joint Union Elementary School District, an early implementation site, described this new instruction brought about by the NGSS:

Our administrators saw our kids, instead of being students, as being scientists. It really moved them when you have a group of students come up and present whatever phenomena they’re working on and present some kind of research or a model or something. They really own it. Things just look different, kids’ conversation is different, how they go about solving a problem is different, the information they’re given is different. The format and the days of lecture, and then prove the teacher correct by doing a demo or a lab — those days are long gone.

Biology professor David Polcyn, of California State University at San Bernardino, spoke to the significance of this change:

Once I delved into the NGSS, I thought, “Wow, this is what we do, both private-sector and university scientists.” I always struggled with, how do we take these ways that we

scientists think about and view the world and translate them into something for a second grader, a fifth grader, or an eighth grader? The NGSS do this.

As the NGSS are implemented, children's science learning often becomes more powerful, exciting, and equitable. While implementation projects in any school subject typically seek to reach *all* students, the NGSS are particularly effective in pursuing that often underattained goal. Many interviewees related testimonials from teachers along the lines of "I've seen students participating who never participated in science the old ways," or "I know now that we don't give enough credit to all students being able to do the kinds of thinking and investigation that I've been seeing."

NGSS teaching has a natural synergy with the Common Core and other school subjects. English language arts (ELA) is a subject with which science has been extensively integrated. For example, non-science educators can readily glean how the following NGSS Science and Engineering Practices (particularly the bolded portions) connect with the core areas of ELA:

- **Asking questions** and defining problems,
- **Constructing explanations** and designing solutions,
- **Engaging in argument** from evidence, and
- Obtaining, evaluating, and **communicating information**.²

Especially at the outset of NGSS implementation, many district leaders carried a traditional stance for the elementary grades — holding that science and ELA should be kept cleanly separate, and that science should not intrude on or compromise the high-stakes focus and accountability on ELA.

Over the last six years, however, many district leaders have come to see the integration of science and ELA as a win-win. Assistant Superintendent Matthew Steitz in the Vista Unified School District felt that integration of science with other school subjects will be one of the major legacies of the district's involvement with other early implementers of the NGSS:

Where we're at now is that administrators' eyes are open to the integration piece. That's been the big "aha" for them — that I can get more bang for my buck by pushing science than I can by just pushing reading and math and English. They're seeing the ways that integration should happen among a variety of subjects, not just with science.

Dave Tupper, the NGSS early implementation project director for the Lakeside Union School District, offered a concurring perspective:

I think we have successfully impressed everybody with "This is how you should teach and learn in all of your content areas." The NGSS science is beyond just science being

² *The Synergy of Science and English Language Arts*, from the evaluation of the NGSS Early Implementers Initiative, provides more detail: <https://www.wested.org/resources/synergy-of-science-and-english-language-arts/>.

fun. This is how we should purposefully plan for understanding, and consider all populations of kids.

Field Leaders Chose Collaboration Over Competition

Productive implementation of the NGSS was far from a given when the new standards were adopted by California in 2013. The Executive Director of the California Science Project (CSP), Maria Simani, remarked, “It required many conversations among us to really understand what the NGSS mean for students, and then what they mean for teachers.”

Susan Gomez-Zwiep, a Regional Director in the K–12 Alliance at WestEd, echoed that sentiment: “Even nationally, nobody really knew what the NGSS looked like in implementation yet.” Indeed, Matthew Krehbiel, Director for Science at Achieve, the national organization that spearheaded creation of the NGSS, saw California as being in the vanguard of strongly implementing the NGSS.

The state’s progress to date can largely be attributed to leaders who set aside historic concerns and challenges that drove their organizations’ individual, siloed efforts, opting instead for a unified approach to implementation. These leaders recognized that collaboration among their organizations was crucial to any prospect of reaching a day when all California students could realize the full potential of the NGSS.

The organizations in this story have, for the most part, independently provided science professional learning to clients. Report coauthor Kathy DiRanna, Director of the K–12 Alliance, described past efforts this way: “We were very interested and concerned about the state of science education in California, but we were like a group of toddlers doing parallel play. We all did nice work, but organizational collaboration was not part of our strength.”

FAST START: GENESIS OF THE NGSS EARLY IMPLEMENTERS INITIATIVE

As the California State Board of Education adopted the NGSS in 2013, the implementation challenge loomed large. As expressed by one Board member, Trish Williams:

We all knew that just because the state adopted the standards didn’t mean that suddenly all the teachers of the state could magically move their instruction to this very new teaching. There was a lot to figure out, beginning with how this NGSS teaching could be done, and then going on to how you help teachers learn this. I heard teachers’ initial reactions and thought, “This is going to take a long time.” But maybe there was a way for us to fast start it.

Williams, along with Phil LaFontaine from the California Department of Education, K–12 Alliance Director Kathy DiRanna, and others, had discussions with the S. D. Bechtel, Jr. Foundation that led to eight districts being selected to serve as test sites for implementation. Williams also garnered support from the Hastings/Quillin Fund to involve two charter management organizations. The Initiative created professional learning about the NGSS and provided that professional learning, as well as leadership development and implementation support, to both teachers and administrators.

The NGSS prompted new partnership structures and stances. DiRanna went on to say that when the NGSS came about, science education leaders immediately had a different reaction:

We realized the complexity of the NGSS and the challenges of figuring out how to accomplish NGSS teaching, and then the enormity of bringing all California teachers to understand and implement this. We started to recognize that we really did need each other — that we couldn't do this all alone.

Leaders self-organized to form two entities that have proven vital to aligning and amplifying the activities of their respective organizations:

- Five high-visibility organizations created the **California NGSS Collaborative**: the California County Superintendents Educational Services Association (CCSESA), the California Department of Education, the CSP, the California Science Teachers Association (CSTA), and the K–12 Alliance at WestEd. Leaders from these organizations met regularly and forged the major efforts described in this report.³
- These five organizations also participated in another entity composed of an even larger set of California stakeholders in science education, the **Science Community of Practice**, which is now part of the **California Partnership for Math-Science Education**. This collaboration includes research organizations, private foundations, advocacy groups, and several well-regarded informal science education centers in the state (e.g., science museums, zoos, and aquariums).⁴

The NGSS Early Implementers Initiative supported these entities by sharing lessons learned, approaches, and tools developed and tested by the K–12 Alliance and school districts. Further, some teacher leaders in the Initiative participated within the NGSS Collaborative and the Science Community of Practice by helping create professional learning opportunities or resources and/or delivering professional learning sessions throughout the state.

Leaders burst through classic barriers to collaboration. California providers of professional learning⁵ for science teachers have typically viewed one another, at least in part, as competitors. Staff at county offices of education want to provide as much of the professional learning needs in their districts as possible, although not all county offices have a deep bench of professionals to do so in science. Meanwhile, the university-based CSP and the nonprofit K–12 Alliance at WestEd at times vie against

³ Appendix B provides brief descriptions of the key organizations in this story. The interviewees for this paper listed in Appendix A include leaders from each of these organizations.

⁴ Members of the informal science community also have worked more collaboratively than in the past to understand their role with schools for implementing the NGSS; in southern California, they even have created a group called the Science Educators of Southern California.

⁵ Providing opportunities to help teachers develop knowledge and skills has often been called professional development. In recent years, however, that field has moved to calling such work the provision of professional learning opportunities; this paper adopts that term throughout.

each other to provide services directly to school districts, and often work independently of the county offices of education.

Faced with the demands of implementing the NGSS, many of the professional learning providers looked past these economic and turf concerns. The amount of effort required to reach all teachers in the state meant there was enough work, and business, for everyone. Further, the complexity of figuring out how to implement teaching of these very different new standards made a synergy of the intellectual capital among organizations appealing.

The ability to move beyond decades of parochial concerns to work together is truly noteworthy. While many organizations were quick to buy into the idea of formally collaborating, in early meetings of the Science Community of Practice they still had to overcome concerns and relationship dynamics that had thwarted joint efforts in the past. Valerie Chrisman, Facilitator for the Mathematics and Science Communities of Practice, related:

The science work started in a little bit of a rocky place, with both county offices and science organizations feeling that their roles weren't being appropriately valued by the other. However, partnerships and feelings of trust have been developed. And it goes across all the lines — public, private, philanthropic, etc. You have county offices and organizations not in competition with one another, at least in science. They work as a team to provide services in a way that they never have before.

For most, participation sat on top of their day job. Another factor that makes this collaborative work remarkable is that participants' time in joint-planning meetings, as well as in developing professional learning events and products, was unpaid — that is, they contributed “out of hide.” The considerable expense of getting together in person to diagnose, design, and plan was typically covered by outside funders. However, because participants' labor time was not paid, they had to fit it around their already full day jobs, shouldering it alongside the substantive responsibilities and time commitments that came with their respective job titles.

These leaders avoided the lure of quick actions that would not endure. In the policy world, it is difficult to execute long-term initiatives. The players in this story have stuck with this arduous effort to implement the NGSS for eight years to date (2013–2020), not only surviving but thriving in their relationships and endeavors. For example, the NGSS Collaborative organizations forged Roll Outs — statewide professional learning events about NGSS instruction — across six years.

As another example, the S. D. Bechtel, Jr. Foundation funded the NGSS Early Implementers Initiative for a total of six years, expanding midcourse after an original commitment of four years. While Initiative participants were making great strides, it became clear that the substantial changes envisioned in the NGSS required additional time in order for new instructional approaches to be crafted. And districts needed more time to spread implementation from core teacher leaders in the Initiative to all district teachers of science. Helen Quinn, the chair of the California Science Framework committee and someone familiar with NGSS endeavors in the state, spoke to this point:

What's different about the [NGSS Early Implementers] Initiative from what you normally see, which quite impressed me, is that Bechtel went ahead and added a fifth and sixth year, recognizing false rapid change versus substantial change taking time. People think, "Oh, that's a long time." But look at what it takes to do what is being asked for here and what resources need to be created to support it! And I mean resources in terms of professional development but also instructional materials and the state testing. All those things take time to move.

Collective Action: A Focus on Professional Learning

Collaboration yielded significant new professional learning opportunities for science teachers, administrators, and others in roles that mattered to the in-classroom success of the NGSS. This part of the story highlights the following major efforts:

- **The NGSS Collaborative** created and led implementation of:
 - A series of five two-day Roll Outs for NGSS implementation that have reached more than 8,000 science teachers across K–12
 - Three-day trainings on the use of a Toolkit for Instructional Materials Evaluation (TIME), to elevate the abilities of districts to critically examine instructional materials for use in their respective contexts
- **The Science Community of Practice** created and led dissemination of:
 - Three fundamental implementation modules for use by districts or counties. The modules addressed developing or choosing assessments consistent with the NGSS, providing professional learning on the NGSS for administrators, and implementing the NGSS in tandem with other content-area standards.

Support for administrators is embedded in the efforts described in the bulleted list above, and is a hallmark of California efforts to implement the NGSS. The state's science leaders went beyond addressing teacher needs, to also paying concerted attention to what it takes for administrators to lead the transition to the NGSS in districts and schools. Their organizations placed explicit emphasis on enlisting administrators' help with implementation.

Organizations paid consistent, substantial attention to administrator learning and empowerment.

Over the decades, science education leaders most often sought administrator involvement through invitation to sit in on teacher professional learning events, allowing a bird's-eye understanding of a new practice or project. The hope was that osmosis would occur and that, without benefit of any follow-up or tailored supports, administrators would actively assist with implementation of the particular practice or project they had observed. Unfortunately, limited awareness often led to tepid administrator support, or to making small moves when large steps were called for to drive implementation.

Craig Strang, Associate Director of the Lawrence Hall of Science, emphasized how the NGSS implementation leaders held a different mindset:

The notion that administrators need to be involved is obviously important to science education project leaders. However, the other side of that coin is that science has to matter to administrators. That's on us! We must make the case and demonstrate the importance of not only science for its own sake, but its importance for the achievement of other district priorities as well.

Leaders in the statewide endeavor to implement the NGSS knew they had to engage administrators. They needed to put themselves in administrators' shoes, learning what matters to these decision-makers, appreciating the things they are accountable for, and offering genuine information about how NGSS implementation speaks to those needs. This is not easy work for science education organizations. For example, K–12 Alliance Regional Director Karen Cerwin described the challenge:

We would bring administrative professional learning up in [NGSS Early Implementers] Initiative leadership meetings and you could see people looking the other way, because it's hard to tackle the administrative strands. But we had to enhance doing this to make progress. I don't think it's typically done head-on like this in science implementations.

In an early collaborative move, in 2016 the NGSS Early Implementers Initiative invited BaySci and the CSP to join in creating and running an Administrator Symposium about NGSS implementation. The event was offered twice and attended by administrator teams from dozens of school districts and counties from across the state. Administrators with some NGSS experience served as presenters and facilitators.

The Administrator Symposium agenda included learning how to connect science with the Common Core. Because administrators are more accountable for their students' success in the Common Core than in science, this agenda item is an example of speaking to the administrators' world instead of just pitching science in isolation.

Organizations in the NGSS Collaborative and the Science Community of Practice drew upon their prior work with administrators to inform the new approaches described below. These organizations also benefited from fresh lessons learned through administrator involvement in the NGSS Early Implementers Initiative (see Appendix C). Their efforts ensured that major implementation supports addressed teacher *and* administrator needs — and engaged both groups as lead players in bringing the NGSS to life for all students.

The NGSS Collaborative developed statewide professional learning Roll Outs. Members of the NGSS Collaborative moved quickly after the NGSS were adopted — building a plane as they were flying it — to ensure that teachers and administrators had learning opportunities and tools for implementing the NGSS in grades K–12. As described by Science Education Professor Laura Henriques at California State University, Long Beach, in 2014 the Collaborative worked intensively, aided by funding from the California Department of Education, to develop a two-day professional learning event, called a Roll Out. The goal was to familiarize attendees with the basic intentions and features of the NGSS:

We said, “Well, we need statewide implementation, so we ought to do some statewide professional learning for teacher leaders, county office folks, district

teachers on special assignment, and administrators, so they can provide professional learning in their home districts and counties!” We came together in teams and wrote the different sessions, vetted them, had people read behind them and give feedback. And we trained facilitators on how to present them.

The big question was whether districts and counties would send anyone to attend when there was a \$250 registration fee to defray the cost of meeting materials and facilitators’ time, in addition to paying for travel costs and substitutes. They did. This is especially notable since organizers requested that districts or counties send teams rather than an individual — a tactic intended to catalyze broad interest and increase the likelihood of participants sharing their learnings back home.

Word spread like wildfire about the usefulness of this Roll Out #1, and it was subsequently offered many times around the state within a year. Demand ultimately led to a sequence of five two-day Roll Outs focused on implementing the NGSS. An additional symposium focused specifically on high school NGSS implementation.

Kirk Brown, a Regional Director for the CSP, explained how a trove of instructional resources was amassed during development of the Roll Outs and is publicly available:⁶

Putting together the Roll Outs is a big puzzle that is continually building upon itself. Last night, we were gearing up for the most recent Roll Out. Well, I’m getting teachers from all over the state of California that are the lead writers of these sessions sending me documents to upload to our system. I and a colleague in another region are uploading all these documents so that all 11 of the sites for this Roll Out can give these links out to all the participants. It becomes a great resource for now and the future as districts continually roll this out.

Each Roll Out has been offered at locations throughout the state. Multiple leaders from within each of the organizations in the NGSS Collaborative have jointly and earnestly worked on developing the sessions, vetting presentation materials and resources, and facilitating the almost 70 two-day events. More than 8,000 teachers and administrators have participated.

Several interviewees reported that Roll Out participants are indeed sharing learnings in their local jurisdictions, as illustrated by this comment from Jill Grace, a K–12 Alliance Regional Director and a recent president of the CSTA: “These are teachers on the forefront, and who are excited about trying something new. They figure it out, and share it with others.”

A toolkit helped districts select science instructional materials consistent with the NGSS. Because the NGSS require big shifts in instruction, the NGSS Collaborative wanted to help train science teachers to use an in-depth process⁷ for inspecting the extent and quality of instructional materials’ usefulness. The

⁶ Agendas and resources for all Roll Outs can be found at <https://cascience.org/ngss/ngss-collaborative>.

⁷ A common weak link in the education system across the nation has been hidden in plain sight. Although curriculum materials are a big budget item and can have a huge influence on teachers’ instruction, many times, localities have used a thin process for inspecting and selecting textbooks and other instructional materials.

NGSS Collaborative customized a national Toolkit for Instructional Materials Evaluation (TIME) to align with California’s version of the NGSS, and developed a three-day training on its use.⁸ A three-day time span is an important indicator of the rigor of the process — it contrasts with the “thumb tests,” or other limited inspections of materials, that often take a day or less. In TIME trainings, teachers go through a systematic process of using conceptual rubrics to examine the degree to which materials truly address the NGSS and contain other features important to local needs.

Jane Steinkamp, Science Subcommittee Chair of the Curriculum Instruction Steering Committee (CISC) of the CCSESA, described how carrying out trainings for districts to evaluate NGSS science materials departed from trainings for previous curriculum materials reviews. Steinkamp’s comment cites collaboration with the CSP and the CSTA:

Typically, when a toolkit is developed for any kind of standards implementation, CISC subcommittee members often take on that work alone. However, every county office has varying levels of capacity to do this work. And, even when there is capacity, I believe firmly that partnerships are essential. There is more work in professional learning and standards implementation than county offices can or should try to accomplish alone. To develop the toolkit, we needed and wanted the NGSS Collaborative partners’ help and expertise. For CISC and CCSESA to sanction a toolkit being jointly created and delivered with CSP, CSTA, and the K–12 Alliance at the table was pretty phenomenal.

Staff from across the NGSS Collaborative organizations were thoroughly trained in facilitating the TIME process. In December 2018, these facilitators ran two regional TIME trainings — one in Northern California and another in Southern California. More than 80 percent of California counties (49 of 58) sent teams to participate. Most teams had between three and ten members and included both county office and school district representatives. While the face-value purpose of TIME is to select high-quality, NGSS-aligned instructional materials, participants felt that this process doubles as serious professional learning about the NGSS.

Interviewees reported that TIME training was a quantum leap forward in helping them select appropriate science instructional materials. District and county officials were relieved to find that, instead of constantly fielding inquiries for their opinions on science instructional materials, they could now advise that inquirers get trained in the TIME process and reach their own well-informed judgements. There is interest and hope that TIME will now change how future materials selections are done in other subject areas.

Responsive implementation resources. The Science Community of Practice of the California Partnership for Math-Science Education (CAPMSE, also called “the Partnership”) is steadily producing a variety of publications and resources supporting NGSS implementation, including the three major resources in table 1 (these items can be found at <https://capmse.org/home>). The Partnership brokered different sets

⁸ TIME is an adaptation of original work by the K–12 Alliance at WestEd, developed for national application by BSCS, Achieve, and the K–12 Alliance.

of organizations from among its membership for developing each resource, based on interest and expertise.

Table 1. NGSS Implementation Resources

Resource	Description	Development Partners
<i>Principals Supporting the NGSS!</i>	Five professional learning modules to run with administrators, ranging from 2 to 5 hours each	Alameda County Office, BaySci (Lawrence Hall of Science), K–12 Alliance at WestEd
<i>3D NGSS Classroom Assessment Implementation Modules</i>	Online resource for developing classroom assessments consistent with the NGSS	CSP, Galt Joint Union Elementary School District, Stanislaus County Office, Ventura County Office
<i>Fostering NGSS Implementation Protocol</i>	Tool for elementary teachers integrating science with other subjects	California Science Center, CSTA, California STEM Network, California Teachers Association, 3 county offices, 2 school districts

Including Leadership Development Created Champions, Then and Now

Many statewide science leaders share a heritage. During California’s large systemic reform of science in the 1990s, a host of K–8 science education leaders was produced through the efforts of science education organizations. Unfortunately, for about 15 years after that era of systemic reform, activity in California to promote and support science education was comparatively lean or nonexistent.

However, the leaders forged in the systemic-reform era persevered year after year in their spheres of work and influence; many were regularly involved with the K–12 Alliance or other organizations cited in this story. They constituted a well-established, albeit informal, network of intrepid science champions.

When the NGSS came on the scene, these leaders were ready to be tapped for key roles, making California NGSS implementation more powerful than it might otherwise have been. In the following remarks, Don Whisman, a principal and formerly a district science coordinator, illustrated the influence of the past on the present (similar points were relayed by many interviewees):

The K–12 Alliance’s leadership development and inspiration totally affected my career. During the lean years in California science education, I informally did whatever I could to keep our district in contact with the K–12 Alliance and the cutting edge of science education. I would have never been a science program manager in my district, or probably never would have stepped out of the classroom or become a principal, if it wasn’t for the influence of them continuing to support my learning and saying “Hey,

go for it . . . Don.” I know they did that with a lot of other people, too, that they’ve worked with. That’s the legacy. I think they developed science leaders up and down the state.

The NGSS implementation wave swept in and was strengthened by people who had grown as science leaders more than two decades ago. They embraced the core tenets of the NGSS and brought the expertise, passion, stature, and willingness to lead its successful implementation. For example, many school or district central office administrators whose professional formation was bolstered by science education experiences stepped up to be project directors or play other point positions within the NGSS Early Implementers Initiative.

This cadre of California leaders in turn sought to mine the opportunities inherent in implementing the NGSS to nurture a new generation of science advocates. They built leadership development into implementation efforts, knowing these efforts would provide enduring capacity to establish and sustain science as a core subject. Future leaders with tenacious commitment to high-quality science instruction would be their legacy.

Statewide efforts hold leadership development as central to their purpose. For example, through the NGSS Early Implementers Initiative, teachers could learn about their own leadership styles, explore strategies to deal effectively with resistance to new practices, and understand ways to affect the system changes needed for NGSS implementation. Teacher leaders received communications training and gained experience crafting persuasive messages about NGSS for use with varied audiences.

However, leadership development was also addressed for administrators. Kathy DiRanna described the need to respond to a surprise encountered at the outset:

We assumed that principals had knowledge and skills around change theory and how to build collaborative opportunities for that change. We learned instead that many of them had not had that kind of training in their administrator preparation. So, our leadership meetings built in opportunities for those who needed it to understand the change-agent role and how to advocate for science. They had chances to practice with each other in a safe environment.

Emerging leaders are contributing in big ways. Today’s newest science leaders are advancing implementation of the NGSS in California — and illustrating their potential for continued impact. For example, within the six-year cycle of the NGSS Early Implementers Initiative, most teacher leaders have become adept at presenting or facilitating formal professional learning sessions for other teachers. In this short time, some teacher leaders took on additional leadership roles. Jo Topps, a K–12 Alliance Regional Director, offered the following examples, in which teachers in the Initiative have:

- replaced a district’s project director for the Initiative;
- testified about implementing the NGSS in front of the State Board of Education;
- become a consultant to other districts on implementing the NGSS;
- been named the California teacher of the year;

- become a member of the board for the CSTA; and
- served as members of state committees, including the Science Framework Committee or the Science Instructional Materials Review Panel.

None of these teacher leaders had participated in leadership development prior to the Initiative. Each of them told Initiative leaders that they would have been unlikely to step into such leadership situations if not for the leadership development component and opportunities in the Initiative.

If the past is a harbinger of the future, we should expect to see an expanding cohort of science leaders developed through California's NGSS implementation. And we should find them serving on school and district committees, as grade-level chairs or department heads, as assistant principals, and in many other positions that are pivotal to effective educational institutions and systems. As the Lakeside district project director Dave Tupper remarked, "The people aspect is hard to overstate. It's going to live on for a long time."

Human Factors Make Lasting Progress Possible

As described throughout this story, organizations across the state invested an extraordinary level of effort to develop new structures and ways of collaborating in order to effectively implement NGSS statewide. While organizations have played a pivotal role, human factors are also woven into the fabric of this story.

Leadership development included caring about people. Many interviewees noted that leadership development wasn't limited to imparting the techniques and affording the opportunities described throughout this story. The interviewees' work within their own spheres and in collaborations was based on *relationships*. Interviews conveyed that progress was made because participants cared about one another as well as their shared mission. These participants felt respected, connected, and supported as individuals, as illustrated by CSP Regional Director Kirk Brown: "There are people that you can reach out to and connect with. That makes the mission feel even more important, and doable."

Leaders across organizations formed a cohesive group that made things happen. Leaders reached out and formed deeper relationships with one another. Each became part of a group whose members constantly talked, grew to trust one another more and more, and supported one another. Together, they doggedly forged paths, jumped hurdles, and went where they hadn't gone before. When faced with barriers, they were not willing to stop or wait. They didn't take no for an answer and chose asking for forgiveness over requesting permission. The authors heard the following theme during many interviews:

It's just amazing to stop and think about what was accomplished by bringing a host of good people together to have a shared vision and a commitment to see it through, no matter what it takes.

The Path Ahead

The status of California’s NGSS implementation is a glass half full and half empty. While much good has happened, we’re far short of all students in all classrooms experiencing high-quality NGSS teaching on a regular basis, or at all. There have been mixed results in providing the funding and other supports needed for widespread local implementation of NGSS in California:

- The state has given districts the latitude to allocate funds to NGSS implementation. In contrast to Common Core implementation, however, the state has *not* provided any separate, dedicated funding for NGSS implementation.
- At the district level, many districts have limited implementation plans for science and are not allocating many of their resources to it.

The authors offer the following suggestions for bringing implementation of the NGSS to scale — deepening and spreading its adoption and impact.

Keep NGSS in all policy discussions — especially as decision-makers work to recover and rebuild from COVID-19. It’s critical for everyone’s future to not allow teaching challenges caused by COVID-19 to return science to California’s back burner. As districts and teachers scramble in 2020 to figure out online teaching, Common Core subjects have been the dominant focus. It would be unfortunate if science were to continue getting limited attention next school year (2020–21). People are faced with a constantly growing need for science education in order to understand the increasingly technological and scientific world around us. For example, everyone should have the opportunity to learn science so they can understand COVID-19 and how to stop its spread. Science must hold and elevate the nascent “core subject” status that is taking root through implementation of the NGSS.

Make science a core school subject in the elementary grades. Science could become a core school subject, like mathematics and ELA, by having required instructional time for science. Some school districts in the NGSS Early Implementers Initiative have indeed made science instructional minutes a requirement, and they also have enhanced outreach about science to parents and the larger community.

Pursue synergies of science with other school subjects. Integrating science with ELA and other school subjects can be a win-win. The nature of NGSS teaching, in contrast to past science standards, offers a huge, more natural opportunity for a synergy of science with other subjects. With that said, not all science instruction time should be fusing science with other subjects; some learnings about science investigation and science content show that it needs its own attention and time.

Consider NGSS implementation lessons for other subject-area initiatives. This story offers ideas that leaders of implementation projects in other school subjects might consider. How could providers of professional learning for mathematics or social studies, for example, similarly be brought together to work collaboratively rather than in isolation or competition?

Shift from simply promoting administrator awareness to engaging administrators and providing them with professional learning. Professional learning providers in science and other subjects should

approach administrators with a sharper focus on the administrators' needs and vantage points. Implementation projects should move from efforts that typically produce only limited administrator awareness to strategies that achieve administrator engagement. Such administrator professional learning is requisite to empowering administrators to take more active implementation roles.

Appendix A. Report Authors, Interviewees, and Methods

About the Authors

Edward (Ted) Britton is the Principal Investigator for the Evaluation of the California K–8 NGSS Early Implementers Initiative. He is the retiring Managing Associate Director of the Science, Technology, Engineering, and Mathematics (STEM) Program at WestEd.

Kathy DiRanna is the Principal Investigator and Director of the NGSS Early Implementers Initiative. She is the retiring Director of the K–12 Alliance at WestEd.

Burr Tyler is the Project Director for the Evaluation of the NGSS Early Implementers Initiative.

Interviewees and Methods

Approximately 30-minute interviews were conducted with 23 leaders of NGSS implementation in the state of California (listed in tables A1 and A2). The overarching topic of the flexible interviews was “What do you see as the legacies of NGSS implementation work by your organization and others in California?” The authors thank these accomplished professionals for generously making the time to share their thoughts with us, and, in some cases, for being additionally interviewed on video. Both the phone and video interviews were recorded and transcribed. The author team then analyzed the interviews, identifying and coding key points raised to be discussed in this report.

Table A1. Interviewed Leaders *Outside of* the NGSS Early Implementers Initiative

Name	Title, Organization*
Christine Bertrand	Past Executive Director, California Science Teachers Association (CSTA)
Kirk Brown	STEM Director, San Joaquin County Office of Education; Regional Director, California Science Project (CSP)
Valerie Chrisman	Facilitator, Communities of Practice for Mathematics and Science, California County Superintendents Educational Services Association (CCSESA)
Laura Henriques	Professor, Science Education, California State University, Long Beach; past President, California Teachers Association
Matthew Krehbiel	Past Director for Science, Achieve; Outreach Director, OpenSciEd
Phil LaFontaine	Director of Professional Learning and Curriculum Support Division, California Department of Education; California's Lead Representative for development of the NGSS; Regional Director, NGSS Early Implementers Initiative
Anthony Quan	STEM Coordinator, Los Angeles County Office of Education
Helen Quinn	Committee Chair, California Science Framework; lead author of the National Academy of Science's <i>A Framework for K–12 Science Education</i> (the blueprint for the NGSS)
Maria Simani	Executive Director, CSP
Jane Steinkamp	Chair, Science Subcommittee of the Curriculum Instruction Steering Committee (CISC) of the CCSESA
Craig Strang	Associate Director, Lawrence Hall of Science
Trish Williams	Member, California State Board of Education (appointed by Governor Brown, 2011–2019)

* The provided titles are those most relevant to the story at the time of the interviews, conducted in fall 2019.

Table A2. Interviewed Leaders *Within* the NGSS Early Implementers Initiative

Name	Title, Organization*
Cindy Anderson	School principal, Vista Unified School District
Karen Cerwin	Regional Director, K–12 Alliance
Kathy DiRanna	Director, NGSS Early Implementers Initiative and K–12 Alliance
Susan Gomez-Zwiep	Cadre leader, NGSS Early Implementers Initiative; Science Education Professor, California State University, Long Beach
Jill Grace	Regional Director, K–12 Alliance; past President, CSTA
David Polcyn	Cadre leader, NGSS Early Implementers Initiative; Biology Professor, California State University, San Bernardino
Ron Rammer	School principal, Galt Joint Union Elementary School District
Matthew Steitz	Past Assistant Superintendent, Vista Unified School District; Principal, The Preuss School at University of California, San Diego
Jo Topps	Regional Director, K–12 Alliance; Science Education Faculty Advisor, California State University, Long Beach
Dave Tupper	NGSS Initiative Project Director, Lakeside Union School District
Don Whisman	Retired principal, San Diego Unified School District; former science coordinator

* The provided titles are those most relevant to the story at the time of the interviews, conducted in fall 2019.

Appendix B. More Information about Key Organizations in the Story

Longstanding California Providers of Science Teacher Professional Learning

California County Superintendents Educational Services Association (CCSESA). This organization is the association for the 58 county offices of education in California, all of which provide professional learning

for teachers in their school districts. The Science Subcommittee of CCSESA's Curriculum Instruction Steering Committee is particularly relevant to this paper's story.

California Science Project (CSP). At each of 16 regional sites, university scientists collaborate with K–12 science education experts to provide opportunities for science professional learning and teacher leadership development.

California Science Teachers Association (CSTA). Besides publishing articles and other resources, the CSTA provides science teacher professional learning, mostly through the workshops and other sessions at its annual conference.

K–12 Alliance at WestEd. For more than three decades, the K–12 Alliance has provided science teacher professional learning and leadership development for many school districts in California. The K–12 Alliance also was the principal designer of the NGSS Early Implementers Initiative and was the professional learning partner for the participating districts.

California K–8 NGSS Early Implementers Initiative, and Its Evaluation Reports

A diverse group of eight California school districts and two charter management organizations is actively implementing the NGSS. Their progress, experiences, and lessons can inform others implementing the NGSS. The NGSS Early Implementers are supported by the K–12 Alliance at WestEd, and work in partnership with the California Department of Education, the California State Board of Education, and Achieve. Initiative funding is provided by the S. D. Bechtel, Jr. Foundation, with the Hastings/Quillin Fund supporting participation by the charter organizations.

The Initiative spans 2014 to 2020. It focuses on NGSS implementation in grades K–8 and incorporates the integrated course model (preferred by the California State Board of Education) for middle school.

Teachers are supported with strategies and tools, including an instructional framework that incorporates phenomena-based learning. This framework aligns with the three NGSS dimensions: disciplinary core ideas, crosscutting concepts, and science and engineering practices. Using science notebooks, questioning strategies, and other approaches, students conduct investigations, construct arguments, analyze text, practice descriptive skills, articulate ideas, and assess their own understanding.

Teachers engage in science lesson studies twice each year through a Teaching Learning Collaborative. In each district, the Initiative is guided by a Core Leadership Team of Teacher Leaders and administrators who participate in additional professional learning and coaching activities. Together, this core team and an extended group of Teacher Leaders are the means for scaling NGSS implementation throughout the district.

Learn more about this multi-year initiative and access evaluation findings as well as instructional resources at <http://k12alliance.org/ca-ngss.php>.

Report Series from the Evaluation of the NGSS Early Implementers Initiative

The S.D. Bechtel, Jr. Foundation has commissioned WestEd's STEM Evaluation Unit to evaluate the NGSS Early Implementers Initiative in its eight participating public school districts. Reports released to date are:

- #1. *The Needle is Moving in California K–8 Science: Integration with English Language Arts, Integration of the Sciences, and Returning Science as a K–8 Core Subject* (October 2016)
- #2. *The Synergy of Science and English Language Arts: Means and Mutual Benefits of Integration* (October 2017)
- #3. *Administrators Matter in NGSS Implementation: How School and District Leaders are Making Science Happen* (November 2017)
- #4. *Developing District Plans for NGSS Implementation: Preventing Detours and Finding Express Lanes on the Journey to Implement the New Science Standards* (February 2018)
- Special report. *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (May 2018)
- #5. *Making Middle School Science Whole: Transitioning to an Integrated Approach to Science Instruction* (October 2018)
- #6. *Engaged and Learning Science: How Students Benefit from Next Generation Science Standards Teaching* (November 2018)
- #7. *Investing in Science Teacher Leadership: Strategies and Impacts in the NGSS Early Implementers Initiative* (February 2019)
- #8. *Collaborative Lesson Studies: Powerful Professional Learning for Implementing the Next Generation Science Standards* (September 2019)
- #9. *Environmental Instruction Catalyzes Standards-based Science Teaching: How Environmental Literacy Aids Implementation of the NGSS* (September 2019)
- #10. *Administrators Matter in NGSS Implementation (2019): Updated Findings on How School and District Leaders are Making Science Happen* (November 2019)
- #11. *It's about TIME: A Rigorous New Process for Selecting Instructional Materials for Science* (June 2020)

Additional reports slated for summer 2020 are:

- #12. *Scaling Up District NGSS Implementation.*
- #13. *Advances in NGSS Teaching.*
- #14. *Overall Evaluation Highlights of the NGSS Early Implementers Initiative.*

All reports are available from both the Resources section of www.wested.org and the K–12 Alliance website, www.wested.org/project/k-12-alliance/.

Appendix C. Administrator Components in the NGSS Early Implementers Initiative

As noted throughout this report, administrators are critical drivers for any standards implementation efforts. The Initiative included explicit attention to administrators in many ways:

- Each district's core leadership included several administrators.
- In many districts, it became a regular practice for those administrators to give NGSS orientations or implementation updates during their districts' regular meetings that required all administrators' attendance.
- At the annual summer institutes for teachers, there were some concurrent administrator strands that provided professional learning for administrators; these strands were most often led by administrators.
- Administrators observed key teacher professional learning sessions at the school and district levels, and a science educator joined them to help administrators attend to and learn about specific NGSS teaching components.
- Technical assistance was offered to individual school administrators to help them with NGSS implementation issues specific to their schools.

Several interviewees remarked that these efforts were more robust than the usual efforts, including in the recent implementation of Common Core, as illustrated in comments by principal Cindy Anderson in the Vista Unified School District:

Oh my gosh, the administrator component in the Common Core effort doesn't compare. For example, we just did a math adoption. There was one full day of administrator training just so they could understand the curriculum's structure. Unlike the NGSS administrator sessions, it wasn't content, it wasn't about developmentally appropriate, it wasn't about application. As far as understanding the pedagogy behind it or the research or the content — that didn't happen. There's a huge understanding that happens when you discuss, "How do I teach it?" instead of, "Here's your new curriculum."

And principals, we're going to give you some time here, so you know what to maybe look for out in classrooms. I think if you go deeper on the front side of things, for true understanding of what teachers are going to teach, how they are going to teach it, and what is the effect on student learning and student knowledge — I think you save time and money in the long run.

Further information can be found in the Initiative's evaluation report #10, *Administrators Matter in NGSS Implementation (2019): Updated Findings on How School and District Administrators are Making Science Happen*, at <https://www.wested.org/resources/administrators-matter-in-ngss-implementation-2019/>.