NOVEMBER 2020 | EVALUATION REPORT #14

What Education Leaders Can Learn About NGSS Implementation: Highlights From the Early Implementers Initiative

Burr Tyler, Denise Estrella, Ted Britton, Kimberly Nguyen, Ashley Iveland, Katy Nilsen, Elizabeth Arnett, Josh Valcarcel

14

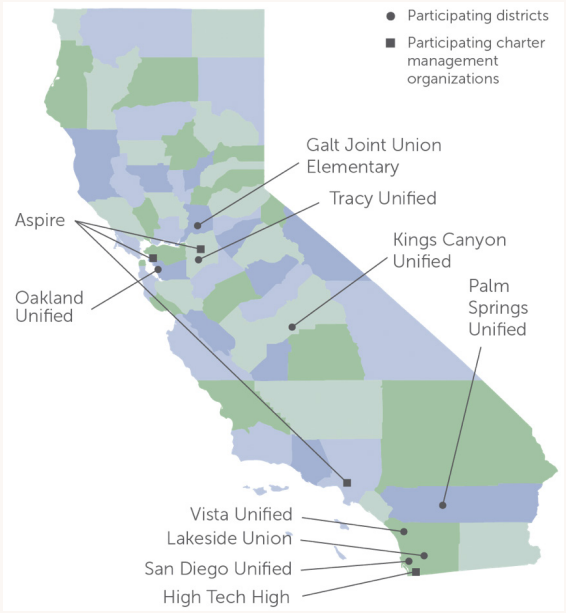
NGSS EARLY IMPLEMENTERS

WestEd

NGSS Early Implementers Initiative: Bringing Science to Life as a Core Subject in K–8 Classrooms

A diverse group of eight California school districts and two charter management organizations is actively implementing the Next Generation Science Standards (NGSS). The progress, experiences, and lessons of the NGSS Early Implementers, as they are called, can inform others implementing the NGSS. The 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. Funding for the Early Implementers Initiative (the Initiative) is provided by the S. D. Bechtel, Jr. Foundation, and the Hastings/Quillin Fund is supporting participation by the charter organizations.

The Initiative spans 2014 through 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 composed 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 multiyear initiative and access evaluation findings as well as instructional resources at k12alliance.org/ca-ngss.php.

Suggested citation: Tyler, B., Estrella, D., Britton, T., Nguyen, K., Iveland, A., Nilsen, K., Arnett, E., & Valcarcel, J. (2020). *What education leaders can learn about NGSS implementation: Highlights from the Early Implementers Initiative.* WestEd.

Contents

Evaluation of the NGSS Early Implementers Initiative

In addition to this current report (#14), evaluators previously released the following:

- *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* (Evaluation Report #1, October 2016)
- *The Synergy of Science and English Language Arts: Means and Mutual Benefits of Integration* (Evaluation Report #2, October 2017)
- *Administrators Matter in NGSS Implementation: How School and District Leaders Are Making Science Happen* (Evaluation Report #3, November 2017)
- *Developing District Plans for NGSS Implementation: Preventing Detours and Finding Express Lanes on the Journey to Implement the New Science Standards* (Evaluation Report #4, February 2018)
- *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (May 2018)
- *Making Middle School Science Whole: Transitioning to an Integrated Approach to Science Instruction* (Evaluation Report #5, October 2018)
- *Engaged and Learning Science: How Students Benefit from Next Generation Science Standards Teaching* (Evaluation Report #6, November 2018)
- *Investing in Science Teacher Leadership: Strategies and Impacts in the NGSS Early Implementers Initiative* (Evaluation Report #7, February 2019)
- *Collaborative Lesson Studies: Powerful Professional Learning for Implementing the Next Generation Science Standards* (Evaluation Report #8, September 2019)
- *Environmental Instruction Catalyzes Standards-Based Science Teaching: How Environmental Literacy Aids Implementation of the NGSS* (Evaluation Report #9, September 2019)
- *Administrators Matter In NGSS Implementation (2019): Updated Findings on How School and District Leaders are Making Science Happen* (Evaluation Report #10, October 2019)
- *It's About TIME: A Rigorous New Process for Selecting Instructional Materials for Science* (Evaluation Report #11, April 2020)
- *Six Years of Scaling Up Districtwide Implementations of the Next Generation Science Standards* (Evaluation Report #12, August 2020)
- *NGSS in the Classroom: What Early Implementer Science Instruction Looks Like* (Evaluation Report #13, September 2020)

Executive Summary

From 2014 through 2020, eight diverse school districts and two charter management organizations ran a substantial experiment with ways of implementing the Next Generation Science Standards (NGSS) in elementary and middle grades, called the California K–8 NGSS Early Implementers Initiative. The Initiative certainly illustrated that a big financial investment can produce powerful change. However, even districts facing resource challenges may benefit from the lessons that were learned and the strategies that were developed by the Initiative.

An external evaluation team has previously released a series of reports on what can be learned from the efforts of the Initiative districts. All reports are intended to be helpful to administrators at the school and district levels, education policymakers, and people charged with designing and/or delivering science professional learning. After briefly describing how the NGSS call for big shifts in science teaching and learning, this highlights report shares high-level, major learnings from the evaluation, distilled into only a couple dozen pages of main narrative. The report describes NGSS instruction as a powerful lever for equitable learning, explains how the Initiative made this kind of instruction happen, and describes the importance of the Initiative's ambitious professional learning for administrators.

NGSS Instruction Is a Powerful Lever for Equitable Learning

As the NGSS are implemented, children's science learning often becomes more powerful, exciting, and equitable. Indeed, Early Implementer teachers and administrators reported that NGSS instruction strongly addressed all students, including English learners and students with special needs, in the following ways:

- NGSS teaching was more accessible for all students.
- More students were more engaged.
- Student learning was deeper.
- Science learning compellingly contributed to language development.

Evaluators found from surveys that more than 90 percent of both teachers and principals indicated that NGSS-recommended, phenomena-based instruction was having a positive effect on low-performing students' learning. Further, one-third of teachers and administrators (36 and 34 percent, respectively) perceived a "substantial" change. A District Project Director remarked: "When the vision of the NGSS is at play in learning experiences, students tend to be so engaged, they don't really 'realize' they are reading, writing, engaging in mathematics, or developing rich vocabulary."

How the Initiative Made This Kind of Instruction Happen

Initiative leaders used a comprehensive implementation design that promoted buy-in by all critical stakeholder groups. Because the teaching shifts called for by the NGSS are substantial and could overwhelm teachers, the Initiative used these **implementation strategies:** start small and expand, start slow to go fast, cultivate support at all levels of the district, and prioritize science.

The Initiative emphasized substantial, experiential **professional learning** in which teachers, like students, learned the NGSS by doing science investigations. Similarly, teachers developed implementation leadership by being immersed in fulfilling leadership opportunities, with support; leadership development included learning how to be a change agent. At the end of the Initiative, 81 percent of Teacher Leaders said that they "thoroughly" or "fairly well" understood how to help other teachers transition to the NGSS.

Ambitious Professional Learning for Administrators Paid Off

The Initiative discovered early on that NGSS implementation efforts hinged on administrator support. Teachers looked to administrators for explicit permission to experiment in the classroom, time for planning and collaboration, access to professional learning, funding for substitute teachers, and adequate supplies for science investigations. Over the years, the Initiative increased the amounts and kinds of professional learning and support for administrators. By 2020, two-thirds (67 percent) of all K–8 science teachers in the participating districts reported that their principal was very supportive of them teaching the NGSS in their classroom, and only 5 percent of teachers identified "lack of support from administrators" as one of their three biggest barriers to implementing the NGSS.

Although getting the attention of administrators was challenging at first, over time, the Initiative leaders became increasingly aware that the more these administrators learned about NGSS instruction and its impact on students, the more supportive of the NGSS they became. Some of the Initiative's first offerings for administrators were extensive but relatively conventional and did not produce as widespread or deep administrator participation and resulting support as had been hoped. In later years, two strategies that districts found to be more effective were working one-on-one with principals to experience science walk-throughs and locally running a professional learning academy for administrators and district specialists. Some administrators remarked that they regarded the Initiative's approach to involving administrators as a model for efforts to implement standards in other school subjects.

Challenges and Recommendations

The report also discusses **challenges** that NGSS implementations often had to overcome, including the typically low status of science in schools, elementary teachers lacking confidence to teach science, reorganized and sometimes unfamiliar science content for middle school teachers, and funding. The last section of the report advances short **recommendations** for policymakers and administrators in implementing the NGSS, including keeping the NGSS on the radar, even during the COVID-19 pandemic; making science a priority in the elementary grades; pursuing synergies of science with other school subjects; and shifting from promoting only awareness among administrators to engaging them more fully and providing them with professional learning.

Introduction

From 2014 through 2020, eight diverse school districts and two charter management organizations ran a substantial experiment with ways of implementing the Next Generation Science Standards (NGSS) in elementary and middle grades, called the California K–8 NGSS Early Implementers Initiative (hereafter "the Early Implementers Initiative" or "the Initiative").[1] The authors of this report, as part of a team evaluating the Initiative, have previously released a series of reports on what can be learned from these sites' efforts. The series of more than a dozen substantial reports drawing on this evaluation covers a wide range of topics, as listed on page iv.

This highlights report is the last in the series and distills the earlier reports' hundreds of pages into a couple dozen pages of main narrative, guided by four overarching questions:

1. What big shifts are the NGSS meant to encourage in science teaching and student learning?
2. Did the Early Implementers Initiative produce these shifts, particularly for students who are English learners and other students typically facing extra challenges in learning?
3. How did the Initiative make these shifts happen?
   - What was this Initiative?
   - What comprehensive implementation approach was used to achieve buy-in among stakeholder groups, and what main implementation strategies were employed?
   - What professional learning was provided to build the capacity of teachers and administrators over time?
4. How did the Initiative place attention on non-typical kinds of administrator professional learning, to better empower administrators to support teachers' implementation?

After addressing these questions, the report briefly notes some implementation challenges and provides a few short recommendations for policymakers and administrators in implementing the NGSS.

The Initiative certainly illustrated that a big financial investment can produce powerful change. However, *any* district, even those facing resource challenges, may benefit from the lessons that were learned and the strategies that were developed by the Initiative. For example, the Initiative demonstrated the value of providing opportunities for teacher experimentation and collaboration, as well as the crucial role that administrators play in implementation, and it developed strategies and tools that support teacher and administrator learning. Teachers and administrators in California may already have run across some of these tools because the Initiative leaders were strong contributors to

1 The evaluation focused on the eight districts, and this report does not include data from the charter management organizations.

the series of "NGSS Rollouts" that have been offered around the state in recent years.[2]

Like every other report in the evaluation series, this report aims to be helpful to administrators at the school level, administrators and specialists at the district level, education policymakers, and people charged with designing and/or delivering science professional learning, such as Teachers on Special Assignment (TOSAs).

An Argument That Science Matters

Saying that science matters may sound like preaching to the choir, given that science education specialists and leaders of science professional learning are among the main audiences for this report. However, the importance of science needs to be reiterated to set the context for this report, which has been written with the full realization that administrators and policy experts find every school subject vying for their time and attention. A central aim of the Initiative has been to elevate the status of science in schools, making it a core school subject with status akin to that of mathematics and language arts. Initiative leaders did not advance this perspective for parochial reasons of advocating for the business they are in. Rather, as discussed in this report, Initiative leaders have seen how the kinds of instruction called for by the NGSS demonstrably aid instruction in any school subject, not only science.

Members of the science education community also argue that understanding science matters in life. It has always mattered that students become science literate in order to live their lives well (literally). The importance of understanding science has increased year over year as society adapts to an exploding rate of scientific and technological developments. Today, the importance of developing science literacy is especially glaring in the unexpected COVID-19 crisis. The following "Recommendations" section urges administrators and teachers who are scrambling to figure out distance learning to not let science instruction fade off the radar or revert to pre-NGSS methods of only providing information and seeing whether students can recall it.

About the Evaluation and Choosing Its Highlights

This report is *not* a compendium of all of the prior reports in the series, trying to shoehorn every major evaluation finding into one document. To choose a few highlights, the authors asked a dozen members of intended audiences for this report to read all of the prior reports in this series and then indicate which topics are most useful to their interests. Each advisor provided a written analysis. The authors also conducted several interviews online with small focus groups, each composed of either school administrators, central office administrators, experts in state education policy, or leaders of science professional learning.

Separately, the authors also reached out to a dozen senior leaders in the Initiative, who had seen the prior evaluation reports. These leaders were either project directors for the Initiative in school districts (District Project Directors) or staff of WestEd's K–12 Alliance who worked with the district-level leaders (Regional Directors). Each was asked to write out, free-form, no more than 10 points that they felt

2 Evaluators and Initiative leaders jointly produced a report that contains Initiative tools: *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (https://www.wested.org/resources/next-generation-science-standards-in-practice/). Another report describes the state rollouts and other statewide NGSS dissemination efforts that were aided by leaders and participants from the Initiative: *The Future of California Science: A Story of Leadership, Collaboration, and Legacy* (https://www.wested.org/resources/future-of-california-science/).

might be important for people outside the Initiative to know. The feedback helped this report's authors select the topics to cover, and provided some helpful quotes that are included in the report.

A subset of the leaders' lessons learned, in their own words, is included in Appendix A. Some readers may be keen to look over these leaders' thoughts, which often are more detailed or concrete than space permits in the rest of the report.

Each of the prior evaluation reports in this series provides information about the evaluation methods used for the report, to give readers a sense of the amounts and kinds of data upon which the findings are based. This highlights report, mostly a synthesis document of prior analyses, instead draws on the at-large main data sources of the entire $3 million evaluation: annual surveys of hundreds of teachers and dozens of administrators; frequent interviews (1–3 times per year) with all project leaders, three dozen teachers, and a dozen administrators; dozens of observations of professional learning sessions for teachers and/or administrators; observations of the monthly two-day strategic planning meetings of the Initiative's leadership team (District Project Directors and Regional Directors); and dozens of observations of lessons taught by Early Implementer teachers.

The NGSS Emphasize Big Shifts in Science Teaching

The NGSS, first released in 2013, were not just the latest periodic standards revision, merely requiring that everyone get a tune-up. They called for very big, but highly desirable, shifts in science teaching and learning. All teachers faced the challenges of making major pedagogical changes, while elementary and middle-grades teachers had additional, different challenges. Elementary teachers had to worry first about *whether* to teach science at all, or how much science to teach, given the typically low status of science, compared to mathematics and language arts. Middle-grades teachers had to handle teaching science content that often went beyond their prior experience, particularly in California, where the state's Integrated Science Model significantly regroups what science is taught at each grade.

Teaching that is consistent with the NGSS shifts students away from learning, memorizing, and recalling isolated facts and information. Instead, students do science investigations, enabling them to take responsibility for and agency in their own learning. In this way, the NGSS embed what science education experts have long sought: having students and their teachers learn in the same ways in which scientists work. For example, teachers guided by the NGSS have their students ask questions, conduct investigations or design engineering solutions, build and test their designs, conduct online research, develop models to show their thinking, explain their reasoning to support their claims with evidence, and communicate their explanations orally and in writing.

An elementary principal in one of the Early Implementer districts described this new instruction brought about by the NGSS:

> ***Our administrators saw our kids, instead of being students, 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.***

A biology professor who worked in the Initiative's summer institutes for teachers 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.***

In short, NGSS instruction has the potential to provide deep, meaningful learning for all students, including — or especially — those who have been historically underserved or who are just having a difficult time in school. The pedagogy needed to address the NGSS is informed by research on how people learn (National Research Council, 2000; National Academies of Sciences, Engineering, and Medicine, 2017). Importantly, the NGSS can also be leveraged to support learning in other content areas — not only science — as the following section of this report explains.

For interested readers, the following sources provide more explanation and illustrations of the shifts that the NGSS prompts in students' science learning opportunities:

- **Appendix B of this report.** In this brief appendix, an evaluator first describes a grade 4 science lesson that was observed, and then discusses NGSS teaching illustrated in the lesson.
- **NGSS in the Classroom: What Early Implementer Science Instruction Looks Like** (https://www.wested.org/resources/ngss-in-the-classroom/). The penultimate report (#13) in the evaluation series contains much more material along the lines of what is in Appendix B — vignettes of observed science lessons, at both elementary and middle grades, each followed by a debrief on how the lesson addressed features of NGSS instruction.

NGSS Instruction Is a Powerful Lever for Equitable Learning

This section describes the evaluation's findings that, as NGSS teaching is implemented, children's science learning often becomes more powerful, exciting, and equitable. NGSS implementation has been particularly effective in achieving the goal of reaching all students, a goal that is often under-attained by projects in other school subjects. The goal of equitable learning has been integral to the NGSS since the standards were first released. For example, the main NGSS document includes Appendix D: "All Standards, All Students": Making the Next Generation Science Standards Accessible to All Students (Next Generation Science Standards, 2013a).

The standards explicitly advise against pulling students who are English learners or who receive special education services, or other sometimes marginalized students, out of science classes to provide them with targeted services. As one District Project Director in the Initiative remarked, "Make sure students learning English and students with IEPs [Individualized Education Programs] are addressed in teachers' NGSS teaching plans from day one. Do *not* leave them out or try to add them in later."

In every Early Implementer convening attended by participants from all eight districts, the Initiative included sessions that were explicitly about raising awareness of how the instructional shifts that the NGSS call for can meet the needs of the entire range of learners. Indeed, Early Implementer teachers and administrators reported that NGSS instruction strongly engaged all students, including English learners, students with special needs, and advanced learners.

> NGSS teaching is positive for all, but we're reaching students that we might have not reached — giving them self-confidence and getting their interest and tying it into their experiences.
>
> —*Grade 8 teacher*

Initiative participants' instruction successfully enhanced the participation and learning of their students who face extra challenges. The remainder of this section highlights how the Initiative served such students better, compared to pre-NGSS instruction, in the following ways:

- More students were more engaged.
- Student learning was deeper.
- Science learning compellingly contributed to language development.
- NGSS teaching was more accessible for students.

Although this section highlights learning by students facing extra challenges, students in general also experienced these increased benefits. For example, elementary teachers who were interviewed as part of the evaluation said frequently that

the NGSS teaching caused all of their students to clamor for more science time. Both elementary and middle-grades teachers related that more of their students dived into the science lessons and were experiencing deeper learning. The evaluators also frequently witnessed these experiences, in dozens of observations, when the teacher was strongly implementing key features of NGSS teaching that had been modeled in the Initiative's professional learning opportunities.

The only different kind of experience that occasionally arose was difficulty by students who, in more traditional instructional modes, had excelled at memorization and recall of information, or at reasoning with prescribed information sets (in other words, high-achieving students in traditional instructional modes). Some of these students were initially thrown off by the kinds of science investigation and student-initiated thinking involved in NGSS instruction — that is, they were out of the element in which they'd previously had success.

Focusing on Science in Students' Lives and Cultures Engages Them

The NGSS call for students to investigate phenomena, which are occurrences that can be observed in the natural or human-made world and that may cause one to wonder and ask questions. Students' natural curiosity about these phenomena means that they arrive in the classroom with prior conceptions and misconceptions. The NGSS engage this prior knowledge with the aim of facilitating deeper learning that remains for the student to build on, rather than being forgotten immediately after a test. Phenomena can be large enough in scope to drive instruction for an entire unit, or small enough to serve as the basis for only a lesson or two. Ideally, a teacher uses several smaller phenomena that are directly linked to a unit's overarching phenomena.

In interviews, many teachers discussed students from their classes who had previously been rarely engaged, or had been struggling to learn, but now were participating in class and gaining skills and confidence from NGSS instruction. A grade 3 teacher described how a low-performing student previously fared during traditional methods of teaching science:

> *I do have one little boy that sticks out in my mind for this year. . . . Previously, he hasn't been able to progress a lot. At the beginning of the school year he spent most of the day with his head down on his desk. He'd always felt like he couldn't do science in the old ways of teaching it because he couldn't read or he couldn't do his math or he couldn't write.*

The teacher then described this student's reaction to NGSS teaching and learning:

> *Whenever we did anything with science or engineering, he would be a lot more engaged, because it was a lot more about doing and talking and comparing. . . . Once he was engaged and he had to do a report on the polar bear, he was really interested. And you could see that he was gaining a lot from it and he was feeling so much more positive about his achievement. He felt like he could do something that the other kids were doing.*

Comments by other interviewees illustrate how students eligible for special education often fared better with NGSS teaching than they had with previous instruction.

> *Special ed kids were very engaged in building designs for earthquake-proof buildings, making building modifications after researching it. If there was more lecture, they would have tuned out. But with the NGSS, they felt more engaged and felt respected, had great ideas, and were able to share those ideas. (Grade 8 teacher)*

> *I walked into a class where there were probably 30 students, of which 12 to 14 were special ed students. And the phenomenon the teacher was working on was mudslides. It was a totally different science class than I'd ever seen. The kids were talking, but not, "Well, it rains, and all the water . . ." They were talking about particle size, particle structure, friction. I mean, it was like little soil scientists in there talking about how come a mudslide happens, and I went, "Wow, this is really something!" Just the way they talked to each other and the way they listened to each other and the way they questioned each other . . . It was like a college class. (Middle-grades principal)*

Phenomena-based instruction can be powerful, using almost any phenomena that are appropriate for the grade's content. Importantly, as the previous quotes illustrate, using phenomena that better reflect what students experience in their local environments and communities tends to hook students into even stronger engagement and foster deeper learning.

Similarly, another aspect of the NGSS that supports learning by historically underserved students is the emphasis on cultural relevance in the classroom. Culture influences all aspects of learning; students who find the learning environment confusing, unwelcoming, or unsupportive will be at a disadvantage. When teachers plan instruction around phenomena that reflect what students experience in their local environments and communities, those experiences serve as a base upon which meaningful and memorable academic learning can be built.

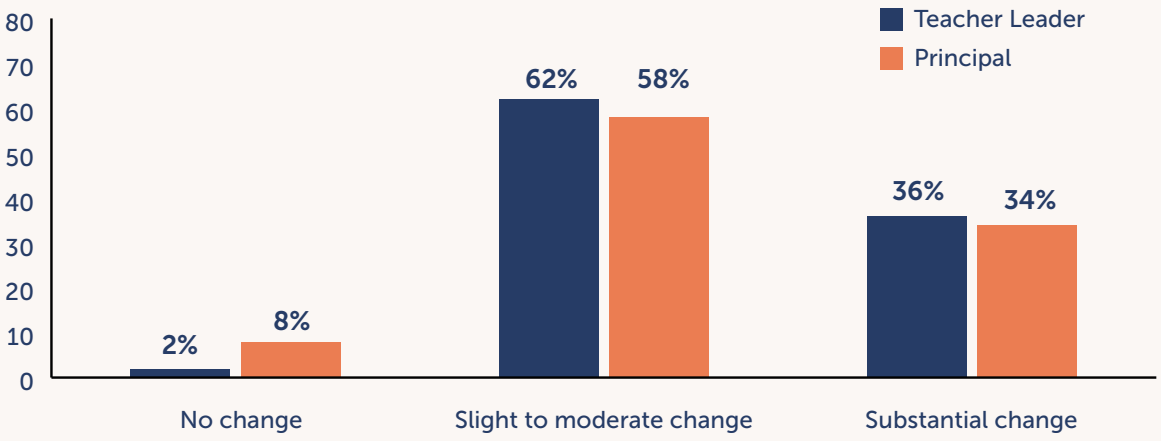
Students Experience Deeper Learning

An overwhelming majority of Early Implementer teachers and administrators told evaluators that all students in their NGSS classrooms were learning at a deeper level than they had been prior to NGSS implementation. According to interviewees and to observations conducted for this evaluation, because more students were more strongly engaged, it was possible for deeper learning to occur more often.[3]

Teacher Leaders and administrators were asked specifically about low-performing students. In surveys, more than 90 percent of both Teacher Leaders and principals indicated that NGSS instruction was having a positive effect on low-performing students' learning, and one-third of Teacher Leaders and administrators (36 and 34 percent, respectively) perceived a substantial change (Figure 1).

3 Standardized state achievement tests could not be used to evaluate the Initiative's impact on student learning, because California's state science test was suspended during the Initiative's early years, and because a new NGSS-aligned state test had been only piloted prior to the COVID-19 pandemic and then was suspended, due to the pandemic, in spring 2020.

Figure 1. Teacher Leaders and principals reported improved science learning by low-performing students



Sources: Teacher Leader Classroom Science Teaching Survey, "As a result of changes you have made toward teaching the NGSS, how much of a change have you seen in the quality or depth of science learning by low-performing students?" administered by WestEd in 2017–18 (*N* = 293); Survey for Principals, "What kind of changes, if any, have you noticed in the quality or depth of science learning by low-performing students in classrooms implementing the NGSS?" administered by WestEd in 2017–18 (*N* = 65).

The following teacher comment is illustrative of many interviewees' comments indicating that deeper learning was happening:

> ***Where I see the biggest shift is in students' depth of learning. The way we're asking them to explain and what we want them to understand [are] taking them to that deeper knowledge. Students can explain, for example, not just physics, but the link to the biological system of an animal. Not memorizing Newton's Laws, but figuring out how they apply to a biological system. (Grade 8 teacher)***

Learning Science Supports Language Development

For years, English learners have been pulled out of science classes to receive extra instruction in English. Even in this Initiative, some districts initially "protected" English language arts (ELA) and mathematics in the elementary grades, by prohibiting any science teaching during scheduled instructional time for those subjects. However, research has shown (Feldman & Malagon, 2017), and Early Implementer teachers attest, that these practices are counterproductive for ELA and mathematics, not only for science.

Learning NGSS science helps develop language skills, not only for English learners, but for all students. For each core concept, the NGSS assist

To learn more about how NGSS teaching affected students, see Evaluation Report #6: *Engaged and Learning Science: How Students Benefit from Next Generation Science Standards Teaching* (https://www.wested.org/resources/engaged-and-learning-science/).

teachers with planning cross-subject lessons, by listing relevant Common Core State Standards (CCSS), for ELA and mathematics, that are associated with the core concept.[4]

English learners can learn science before having English language fluency. One Early Implementer teacher provided the following anecdote to illustrate the value of relevant NGSS learning experiences for her English learners:

> *This year I had two students who were beginner English language learners. . . . We were doing an activity [about] how to explain a weather hazard. . . . These two little boys were just so into the activity that even though one of them was very reluctant to speak English, [they both] explained their design to me. Both of them were very successful in explaining, mostly in English, how their model had worked. (Grade 3 teacher)*

In NGSS classrooms, students use language to formulate and share their ideas, even when they struggle with language itself. Effective NGSS instruction prompts students to do many things that contribute to learning English. A District Project Director remarked: "When the vision of the NGSS is at play in learning experiences, students tend to be so engaged, they don't really 'realize' they are reading, writing, engaging in mathematics, or developing rich vocabulary." Teachers reported that their students were using such practices as more consistently presenting specific evidence to back up their written and verbal assertions, reading more complex texts, and putting their ideas into more detailed writing.

Administrators came to see the value of integrating instruction in science with instruction in other school subjects. An indicator of this integration is that teachers reported that their administrators had become supportive of the synergy of science and ELA.[5] The following administrator comment is illustrative of administrators' views as the Initiative progressed:

> *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. (District-level administrator)*

For more about this topic, see Evaluation Report #2: *The Synergy of Science and English Language Arts: Means and Mutual Benefits of Integration* (https://www.wested.org/resources/synergy-of-science-and-english-language-arts/).

4 See Next Generation Science Standards (2013b, 2013c).

5 More specifically, in 2019–20 survey results, about two-thirds (65 percent) of Early Implementer teachers reported that their principals were "very" or "somewhat" supportive of their teaching science integrated with ELA during time allotted for ELA.

Having Varied Ways to Learn Science Provides More Access Points

Because the NGSS emphasize doing science instead of only hearing about it, students participate in multiple modes of learning and experience a variety of structures for communicating. This approach allows each student to find ways to access learning that are most effective for the student. Interviews with teachers bore out this finding. Teachers described that students had more access points and opportunities to express understanding, compared to learning science before the NGSS or to learning in other subjects.

Many teachers expressed that their traditionally underserved or unengaged students were experiencing success in science, and even that these students were often the ones who offered the most creative ideas in class. A grade 3 teacher conveyed this point at length:

> *I've noticed that, in science, we all start in the same spot. I mean, we all don't know. For example, one of the things we talk about for fossils is, "Why are there whale bones in the desert?" And all the kids come up with these hypotheses.*
>
> *Well, the kids in GATE classes, they're used to taking over the conversation, but this is something totally out there. The students who are better at memorizing the facts and can say them back to me are not as comfortable. Now they actually have to think and analyze and be creative. I think it evens the playing field.*
>
> *So, everybody feels involved because it's not the same people who are raising their hands to give the answers. Even the illiterate kids, the ones who can't write two words correctly, they're able to raise their hands, and they come up with these great ideas for why this happened, the phenomenon.*

A grade 4 teacher related a similar example:

> *One of my English language learners just lit up. He completely made the connection and was able to verbalize the science on the quiz and when we were having a discussion. That was an "aha" for me. . . . And he's low[-performing]. He's going to be tested for special education. I just thought, "Wow, he made that connection pretty quickly." I think just because there were so many visuals, and hands-on [activities], and things that he could make those connections with, and all those learning modalities.*

In pre-NGSS instruction, students tended to be led to understand some thinking and content that were provided to them. Students with learning challenges often were less able to absorb the material and could be less apt to participate, for fear of failing to get correct answers in front of their classmates. In contrast, NGSS instruction is all about doing science investigations, and teachers noted that failure is an important and productive aspect of the work during scientific experimentation.

As a result, the evaluation study found that the learning environments in NGSS classes had become more welcoming to all students, including low-achieving students and traditionally underserved populations. As one teacher said, "There are

no wrong answers when we're exploring." Another teacher put it this way:

> *As they go through the process [of doing more NGSS science], . . . they'll be a lot more willing to disagree with somebody, and they'll be a lot more willing to give any answers they know might be wrong, because of how we respected [sharing ideas] in class. Students definitely got more confident, and a lot more willing to try things they haven't tried before, because they know that it's okay to fail. If they fail, or are not successful, that's just part of science. (Grade 8 teacher)*

A Comprehensive Implementation Approach That Promoted Buy-In Across Stakeholder Groups

Having highlighted the kinds of student benefits gained from NGSS teaching, this report now addresses how the NGSS Early Implementers Initiative promoted the shifts to NGSS teaching. That is, what were the overarching implementation strategies of the Initiative? But first, briefly, what was the Initiative?

Thumbnail Description of the Initiative

The Early Implementers Initiative was collaboratively planned by the California State Board of Education, WestEd's K–12 Alliance, Achieve, and the S.D. Bechtel, Jr. Foundation ("the Foundation") to support a small number of districts in working toward districtwide NGSS implementation and, ultimately, to share lessons learned with the rest of the state. Eight districts and two charter management organizations[6] were chosen based on the following criteria:

- Prior demonstrated commitment to science education.
- Willingness to prioritize science as a core subject.
- Agreement to support teacher and administrator participation in Initiative activities.
- Agreement to adopt California's Integrated Science Model in the middle grades.
- Commitment to assume increasing financial responsibility for NGSS implementation over time.

Although the Foundation provided substantial external funding (more than $20 million), each participating district agreed to provide cost-share resources, with the amount of these resources becoming substantial in the last few years. The original plan was for a four-year Initiative, but the Foundation extended it to a six-year plan, for reasons described in the following "Start Small and Expand" section.

Implementation Strategies Used by the Initiative

While the end goal was to spread NGSS professional learning to all teachers of science in each district, the Initiative did not immediately try to reach all staff through small implementation and support doses. The professional learning approach was not to merely familiarize participants with, or tell them about, the NGSS and assume that that would be sufficient to enable teachers to dive into the NGSS.

6 Because the evaluation focused on the eight districts, this report does not include data from the charter management organizations.

Instead, the Initiative used the following implementation strategies:

- Start with a few core participants, and use those core participants to expand.
- Start slow, with large doses of learning and support for those core participants, and then those participants will be able to go faster.
- Create a culture of support at all levels of the district.
- Prioritize science.

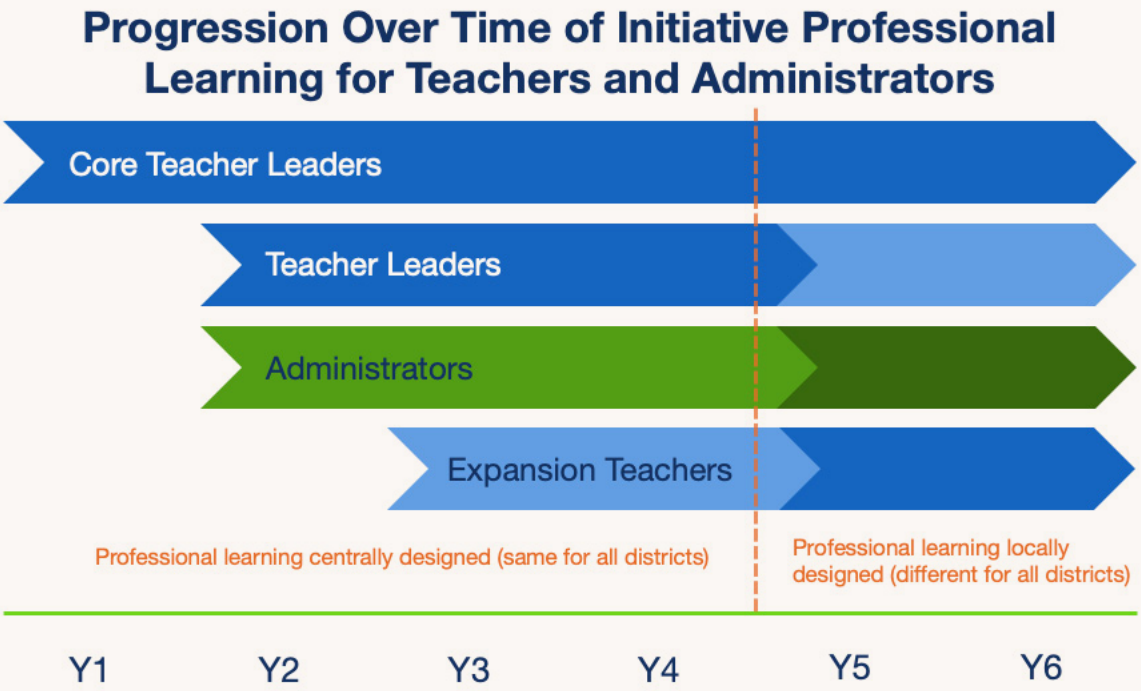
Start Small and Expand

Because moving science teaching to the NGSS involves big shifts, the Initiative did not begin by immediately reaching out to all teachers. Initiative leaders assumed that if all teachers were approached to dive into NGSS teaching in earnest right away, many of them would be overwhelmed or would balk at the scale of change being requested. Additionally, when the Initiative began, nobody in the participating districts really understood what these new standards were or how to teach them. Therefore, the Initiative's district implementation strategy was to start small, with focused pockets of participants who were deeply engaged in the work, and then progressively expand to reach additional teachers.

As shown in Figure 2, in Year 1, the majority of the Initiative's emphasis and focus was on each district's handful of full-time classroom teachers who were designated as Core Teacher Leaders, and on Core Administrators.[7] These teachers and administrators constituted a Core Leadership Team that focused on two things: meeting monthly to develop a district NGSS implementation plan for the next few years, and participating in intensive NGSS and leadership professional learning from the Regional Director and from Initiative-wide sessions. Teachers were released and provided with substitutes on about a dozen days per year to make this participation possible. The following "Transition to New Pedagogy Requires Sustained Professional Learning" section describes the professional learning extensively. For more information on the important topic of developing a comprehensive district implementation plan, see Evaluation Report #4: *Developing District Plans for NGSS Implementation: Preventing Detours and Finding Express Lanes on the Journey to Implement the New Science Standards* (https://www.wested.org/resources/developing-district-plans-for-ngss-implementation/).

7 Appendix C provides more information about the different participants in the Initiative and their interactions within the Initiative's structure.

Figure 2. Groups of participants learned about the NGSS in stages, helping others who joined after them



Note: Shading pertains to concentration of professional learning: darker color = more focused professional learning geared specifically to the group; lighter color = less intensive professional learning for the group.

The Initiative evaluation found that having administrators and/or professional learning specialists join teachers on the district's Core Leadership Team was valuable. All District Project Directors indicated that having this team lead intensive planning was critical to the Initiative's implementation, as illustrated by one director's comment: "Make a plan and keep it in the forefront of the work, to *guide*, but also to be a living document that is revisited often and *revised* as needed; both are important."

In Year 2, the Initiative expanded to include large groups of Teacher Leaders (full-time classroom teachers, 30–70 per district, depending on district size) who started to receive professional learning in the NGSS and in leadership. The training was similar to, but less intensive than, the training provided for the Core Teacher Leaders. Professional learning specifically for administrators was also launched. As explained further in the "Ambitious Professional Learning for Administrators" section of this report, the Initiative leaders learned the importance of enhancing the amounts and types of professional learning opportunities provided for administrators, and providing this enhanced support as early as possible.

The reach of the Initiative expanded as Teacher Leaders gained expertise and confidence in NGSS teaching and learning and began to informally share this knowledge with their peers (referred to in this report as "expansion teachers"). In the final years of the Initiative, the professional learning provided to Teacher Leaders lessened, and the focus shifted to transitioning as many expansion teachers as possible to the NGSS.

When asked what advice they had for other districts beginning to implement the NGSS, some

District Project Directors said that they recommended preparing Teacher Leaders to act as NGSS resources in their schools. For example:

> *[Two key pieces of advice for other districts are] investing in teacher leadership . . . and making sure that each site has one teacher that can really live, breathe, and advocate for science. And then you start to create these leaders that actually end up moving up their school and, collectively, the system. (District Project Director)*

As districts began to reach out to expansion teachers in earnest in later years, four districts chose one teacher per school to be a designated NGSS Site Lead. Most Site Leads taught at the school to which they were assigned, and all Site Leads reported that they talked about the NGSS in their professional learning communities (PLCs) and grade-level meetings and/or acted as a resource for individual teachers who asked for help. A major responsibility of Site Leads was to collaborate with their school principals.

The Initiative was initially funded as a four-year effort, but that proved overly ambitious. As the Initiative progressed, Initiative leaders and the Foundation realized that two additional funded years would be needed for districts to be able to more fully enact the substantial instructional changes called for by the NGSS. Also, California did not finish vetting the adoption of its instructional materials until Year 4 of the Initiative.

Concurrent with the extension, Year 5 saw a pivot in Early Implementers professional learning, from the centralized strategy utilized in Years 1–4 to efforts designed and delivered by the districts themselves in Years 5–6, when districts were afforded more autonomy and assumed larger financial responsibilities for their own NGSS implementation activities.

Start Slow to Go Fast

Because the NGSS embody such a major shift from previous science standards, Initiative leaders wanted to avoid intimidating and overwhelming teachers. The expectation for changing instruction was invitational and flexible; teachers were initially encouraged to try only one new instructional strategy on their own with their students. This "start slow to go fast" approach supported teachers to experiment in a low-stakes context, and then motivated them to challenge themselves by trying even more sophisticated teaching strategies. This approach characterized the professional learning of the Initiative as a whole, and is described in greater detail in the following "Transition to New Pedagogy Requires Sustained Professional Learning" section.

> When we switched to Common Core with [ELA] and math, it was a hard shift. . . . The initial rollout of the NGSS has been very soft and . . . "What are we getting ourselves into? Why do we have to make this change?" But the way that teachers have owned [NGSS teaching] and appreciated it and celebrated it, it definitely has generated a really positive buzz and excitement across the campus, and all the teachers want in.
>
> —*Elementary school principal*

Cultivate Support for the NGSS at All Levels of the District

Of course, teachers were the primary focus of the Initiative, because they would be doing the heavy lifting of transitioning to new standards and pedagogy. However, because Initiative leaders knew that including science as a core subject would be a big change in most districts and that innovative changes are often met with resistance, they consistently and actively sought to inform, include, and solicit support from individuals at all levels in the districts.

One of the strongest lessons of the Initiative is how important principals are to the successful implementation of the NGSS, or of any innovation. In part through having enlisted administrators and specialists on the Core Leadership Teams in Year 1, Initiative leaders realized that administrators needed to become a greater focus for professional learning efforts.

Another reason for recognizing the importance of administrator professional learning was that Initiative leaders discovered that even some of the deeply trained Core Teacher Leaders were hesitant to try out NGSS approaches in their own teaching as Year 1 progressed, saying they feared that their school administrators would disapprove, or noting that administrators had actively discouraged their first forays. Thereafter, the Initiative focused more attention on professional learning for administrators and increasing support year over year as the Initiative experimented with different approaches, to determine which ones best engaged administrators and were effective in empowering them to support teachers' science implementation. The following "Ambitious Professional Learning for Administrators" section of this report focuses on the role of administrators in NGSS implementation.

The Initiative also succeeded in involving district superintendents by bringing them and their curriculum deputies together for one day each year to discuss NGSS implementation progress, plans, and district priorities. These sessions served to renew these leaders' interest in and support of Initiative activities.

Prioritize Science

Moving Science Toward Being a Core Subject. A major charge for participating districts and schools was embracing science in several key ways: embracing science as a school identity, establishing science as a core subject, and ensuring equitable access to science. An example of embracing science as a school identity, observed by the evaluators, was a one-hour session in which elementary and middle school principals brainstormed how they could brand their schools as places where science matters, through strategies such as posters, announcements, and meetings with parents.

As the Initiative progressed, more administrators also communicated the expectation that science should be an instructional priority, on par with ELA and mathematics, in a variety of ways. In the same way that teachers needed the administrators' approval to run with changes in science teaching, some site administrators reported that having such changes endorsed by the district office administrators, including the superintendent and deputies, empowered them to relay the same message to their staff.

Required Minimum Science Instructional Minutes. Early in the Initiative, a major barrier to teaching science that elementary teachers faced was a school day already jam-packed with required instruction, particularly for ELA and mathematics. One of the most effective ways in which districts communicated to all teachers that science was an

instructional priority was mandating a minimum number of weekly minutes of science instruction for each grade. One district's school board passed a policy for elementary instructional minutes, and other districts directed expectations less formally.

In two of the Initiative districts, the amount of science taught was determined at the discretion of the school site, but in the other six districts, the mandated or suggested minimum times for science instruction in the elementary grades ranged from 60 to 270 minutes per week (from 12 to 54 minutes per day), generally much greater than national minimums. In the latest National Survey of Science and Mathematics Education, the teacher-reported average minimum times were only 18 and 27 minutes per day in grades 1–3 and 4–6, respectively (Banilower et al., 2018, p. 77).

Transition to New Pedagogy Requires Sustained Professional Learning

Because the shifts prompted by the NGSS are conceptually large and are often foreign to many teachers' experience, teachers cannot merely be told about the NGSS, given tools and templates, and then reasonably expected to teach in NGSS-aligned ways. Creating NGSS instruction requires teacher collaboration, rather than individual teachers doing it in isolation. Additionally, many elementary teachers face a barrier of having no or little science background; some may even be afraid of science.

Therefore, the largest amount of activity in the Initiative, and in the district NGSS implementation plans, was devoted to providing teacher professional learning. This section focuses primarily on the professional learning that was provided consistently to all participating districts in Years 1–4. In Years 5–6, Early Implementer districts became more autonomous and had the freedom to tailor professional learning to their circumstances and priorities, although many tended to model their professional learning on that of the first years.

For information on how districts in Years 5–6 reached their science teachers generally (expansion teachers) by making local adjustments to professional learning, see Evaluation Report #12: *Six Years of Scaling Up: Districtwide Implementations of the Next Generation Science Standards* (https://www.wested.org/resources/districtwide-implementations-of-ngss/).

Teacher Leaders Learned the NGSS by Doing the NGSS

The NGSS call for students to gain knowledge, understanding, and skills in the same way that scientists do: through hands-on activity in an authentic context. That is, they learn science by doing science. Similarly, much of the Early Implementer professional learning placed teachers in a classroom setting to experience firsthand what NGSS teaching could be.

In yearly **summer institutes,** teachers at each grade level experienced the NGSS by doing hands-on investigations, led by cadres of three experts. Each cadre consisted of a teacher at the designated grade level, another K–12 teacher, and a university or professional scientist. At least half of each five-day institute was devoted to this hands-on science time, commonly referred to as "cadre time." Other summer institute sessions included time focused on the NGSS and opportunities for teachers to ask questions and talk about specific features of the NGSS and NGSS teaching. See Appendix D for an outline of the professional learning progression of NGSS teaching topics over the years of the Initiative.

Biannual **Teaching Learning Collaboratives** (TLCs) were the Initiative's version of lesson study. Lesson study, in which teachers jointly prepare, teach, and debrief authentic lessons done with actual students,

has become a staple of professional learning. During each school year, small teams of three to four teachers engaged in two-day TLCs, once in the fall and once in the spring. The grade-level teams spent a full day collaboratively planning, and then a full day co-teaching an NGSS lesson to two groups of students. After each lesson, the teachers looked at student work from the lesson, discussed what worked and what did not, and made changes to improve the lesson. In the final debrief, teachers shared what they had learned and how they expected the experience to impact their classroom instruction.

All of the professional learning was done with the intention of creating and maintaining a safe, supportive environment for teachers to grow without judgments. In this context, teachers even experienced some early failures as they attempted NGSS lessons — just like in science itself — reinforcing a message that teachers conveyed to students about learning from mistakes.

In survey data (elaborated upon in Appendix E), teacher reports indicated that the Initiative's professional learning had strong positive effects, such as the following:

- A majority of teachers said that the TLCs helped them "a lot" or "moderately" to understand key features of the NGSS and the California Integrated Science Model. A majority similarly reported that the TLCs helped them understand how to use tools and practices modeled in the Initiative.
- Toward the end of the Initiative, 81 percent of Teacher Leaders said that they "thoroughly" or "fairly well" understood how to help other teachers transition to the NGSS. This represents a complete reversal of how teachers felt before joining the Initiative, when 83 percent had said they understood this "poorly" or "not at all."

Teacher Leaders Developed Leadership by Doing Leadership

The Initiative accepted all teachers who volunteered, rather than screening or selecting teachers, because the K–12 Alliance approach is to accept all who are interested and then work with them from where they are beginning. As a result, teacher participants all had interest in NGSS implementation, but varied widely not only in the amounts and kinds of science teaching they had done previously, but also in terms of their leadership experience — that is, how much experience they had with prompting and helping other teachers to make instructional changes.

Professional learning sessions explicitly provided participants with knowledge about being a leader and a change agent, but what appeared to be most useful for developing leadership were the opportunities and support that the Initiative provided for teachers and administrators to actually "do leadership" by carrying out leadership functions.

Collaborative Culture and Support Helped Teachers Fulfill Leadership Expectations

Soon after being introduced to the NGSS at their first summer institute, Core Teacher Leaders were offered the responsibility of leading sessions about the NGSS for the new Teacher Leaders at the following summer institute. In turn, Teacher Leaders, early in their participation in the Initiative, were charged with advocating for science in their schools. Throughout the Initiative, Teacher Leaders first gained knowledge and then were invited to take on leadership roles, through which they developed skills in communication, presentation,

facilitation, and mentoring. This experience of taking on leadership roles could be stressful, as the challenges often were presented before teachers felt ready. However, the Initiative's stance that (as articulated by a Regional Director) "the authentic work of taking on risks with co-presenters is what builds expertise over time" led most Teacher Leaders to report that they felt supported and therefore were able to be successful. The result was that Teacher Leaders developed confidence and were increasingly willing to accept, and even seek out, subsequent leadership opportunities.

The support built into every step taken by Teacher Leaders has been key to the success of the initiative. When Teacher Leaders were given their first leadership responsibilities at events such as districtwide professional development days, none were asked to do anything completely on their own. They planned and presented professional learning sessions in pairs, typically with a Regional Director, District Project Director, or Core Teacher Leader in attendance as backup and to answer any questions that were beyond the understanding or experience of the primary presenter.

Teacher Leaders Were Empowered to Be Change Agents

Core Teacher Leaders also received substantial professional learning related to being change agents in their districts. For example, during the annual January and June Core Leadership Team professional learning sessions, Core Teacher Leaders learned about their own leadership styles, learned strategies to deal effectively with resistance, received intensive communication training from Achieve about messaging regarding the NGSS, and learned how to effect system changes needed for NGSS implementation, based on guidance from the Change Game (Hergert et al., 2003).[8]

To learn more about the teacher professional learning provided by the Initiative in Years 1–4, see Evaluation Report #7: *Investing in Science Teacher Leadership: Strategies and Impacts in the NGSS Early Implementers Initiative* (https://www.wested.org/resources/investing-in-science-teacher-leadership-ngss-early-implementers/).

8 A full day of professional learning was devoted to the Change Game, an activity that provided insight into school district systems and mechanisms, with the goal of enabling participants to be agents for creating changes that were needed for teachers to teach the NGSS. During the game, groups of players tried to determine what combination of activities would benefit the largest number of people on their game board, including administrators, teachers, and parents. The game and its rules are set up to make clear the importance of building *key* relationships at school sites, such as with parent groups or in school boards, prior to making large and expensive schoolwide or districtwide strategic moves. A critical takeaway for participants was that change takes longer than expected and requires the support and involvement of an unexpected number of people.

Strategies That Were Less Effective

The following implementation strategies were used by one or more Early Implementer districts, but were noted by District Project Directors as being ultimately less effective for scaling up NGSS implementation to expansion teachers:

- Providing professional learning opportunities that are only informational, rather than letting teachers experience NGSS teaching.
- Providing little or no follow-up to professional learning opportunities.
- Having professional learning sessions that are too long and/or that cover too much territory, even if they otherwise are soundly experiential.
- Not providing stipends for teacher participation in professional learning outside of contract time.

Illustrative comments about these strategies include:

> *A significant professional learning event I wouldn't do again is the rollout awareness day for all teachers in Year 2. We didn't have a clear enough message: "This is what we want you to try and how we'll support you." It almost killed us. It was just too much too soon. We should have had something very specific, two hours, maybe twice in the year. Very specific, like modeling. (K–12 Alliance Regional Director)*

> *We tried to offer just freebies. After school, anybody who's interested, come spend two hours with us on crosscutting concepts, or phenomenon-based instruction. If it wasn't paid time, we got no participation. (District Project Director)*

For information on how districts in Years 5–6 made local adjustments to the Initiative's professional learning for reaching their science teachers at large (expansion teachers), see Evaluation Report #12: *Six Years of Scaling Up: Districtwide Implementations of the Next Generation Science Standards* (https://www.wested.org/resources/districtwide-implementations-of-ngss/).

Ambitious Professional Learning for Administrators

Some administrators remarked to evaluators that the Early Implementers approach to involving administrators could be seen as a model for efforts to implement standards in other school subjects. They reported that, by contrast, they had received less professional learning and support for implementing the CCSS, and the support that was provided had been narrower in scope and less effective.

Teachers Need Administrators' Backing to Try Big Changes

During Year 1, when Core Teacher Leaders expressed reluctance to try in their classrooms the new science instruction they were learning, because they feared that their principals would not approve, Initiative leaders were taken by surprise. Often, teachers need explicit permission from administrators to experiment in the classroom, and at the elementary level, teachers need ways to make time for science instruction during the instructional day, including permission to integrate science with ELA and English language development instruction. Other types of administrative support that teachers need include time for planning and collaboration, access to professional learning, funding for substitute teachers, and adequate supplies for science investigations.

Early Attempts at Engaging Administrators

Initiative leaders had always intended to involve some administrators in Early Implementer activities, as evidenced by administrators being included in Core Leadership Teams. However, Core Teacher Leaders' concerns about administrators' reactions in Year 1 indicated that Initiative leaders had underestimated how important administrators would be to the success of the Initiative. Beginning in Year 2, Initiative leaders made a greater effort to provide professional learning to administrators on the structure of the standards and on the substantial pedagogical shifts required to teach and implement the NGSS. However, getting the attention of all administrators proved challenging because administrators had very full plates.

An initial strategy to reach administrators was to piggyback their professional learning onto Early Implementer activities that were already being planned for teachers. Some districts were more successful than others at rallying their administrators to attend these events. For example, sessions specifically for administrators were offered as part of the annual summer institutes, complete with an opportunity to hear from a state-level leader, such as a member of the State Board of Education. However, two obstacles inhibited administrator attendance. Since these events were regional rather than local, they required significant travel and, therefore, time for some administrators. Also, summer institutes typically took place in July, when many administrators had pre-planned vacations. Although all

expenses were paid by the Initiative, the time and the timing were prohibitive for many.

The TLCs were another teacher professional learning activity that principals were encouraged to observe. Some administrators observed parts of teachers' TLCs, and some took advantage of protocols designed to maximize administrator learning from the TLCs, but many attended a TLC only if a session was held at their school, and most administrators were unable to stay for the entire session. As a result, this professional learning opportunity did not reach all administrators and was not as influential as had been hoped.

What Worked Better at Reaching Administrators

Over time, District Project Directors and other Early Implementer leaders became more strategic about how to address the needs and interests of administrators. Consequently, the most effective strategies to reach administrators were observed during Years 5 and 6.

Some District Project Directors made a point of meeting with each principal individually, at the principal's school, to provide information about the Initiative. Once this personal connection had been made, these principals were more likely to respond to other requests. One District Project Director was able to regularly secure time on the agenda for the quarterly districtwide leadership meetings attended by all administrators; this strategy was also used in other districts, but less often.

Evaluators noted that the most effective professional learning provided to administrators:

- Focused on observing NGSS instruction, to deepen administrators' understanding of the shifts that teachers must make and the benefits for student engagement and learning;
- Integrated discussion and collaboration;
- Was not "one and done," but included follow-up or concrete next steps; and
- Connected directly to the principal's school, and sometimes connected the school to the district.

Two examples of district offerings that reflected these criteria follow.

A Yearlong Academy for All Principals

One district decided to prioritize districtwide professional learning for administrators and district curriculum specialists in Year 5. During this year, all K–8 principals in the district, as well as district specialists, attended a series of four two-hour meetings facilitated by administrators who embraced and vigorously supported NGSS implementation.

At the first session, participants were trained to use an observation tool as they watched videos of science instruction. During the months between sessions, principals completed "homework assignments" at their sites. These assignments included observing science instruction and responding to survey questions about what they observed. Their experiences were debriefed at the next session, and aggregated survey responses were examined, shedding light on trends in science teaching across the district. The purpose of the series was to familiarize the site administrators with the NGSS, the shifts required to teach these standards, and the links between these standards and the CCSS in ELA and mathematics.

Participants and the district office both highly valued the gains from this deeply collaborative training model. When the COVID-19 pandemic hit, science was retained in the distance learning that was launched, and the needs of distance learning prompted some of the NGSS instructional methods

to be used in other school subjects. The District Project Director remarked, "We see this as a culmination of all of our work. Not only is science recognized as key in this time of crisis, but also, we are inspiring the next generation to become scientifically literate, curious, creative change makers."

Science Walk-Throughs

In Years 5 and 6, most districts implemented some form of walk-throughs (also called "learning walks"), in which one or more principals, accompanied by one or more Early Implementer participants, observed 5 to 10 classrooms where science was being taught, briefly visiting each over a few hours. The group would select a topic from the observation tool (see Appendix F) to focus their attention and their follow-up discussion. After the tour, the group would debrief on their observations and plan next steps, such as possible professional learning for teachers.

In 2019–20, the vast majority (92 percent) of surveyed administrators said they had experienced at least one walk-through, and one-third (34 percent) said they had gone on more than six. More than two-thirds said that the walk-throughs had impacted their understanding of the NGSS "some" or "a great deal" (42 percent and 27 percent, respectively).

The More Administrators Learned, the More Supportive They Became

Witnessing the effects of the NGSS on students' engagement and learning influenced how administrators felt about NGSS implementation, as well as their willingness to support it. Connecting with administrators, which began as a tough nut to crack, turned into one of the Initiative's successes.

In the spring of 2019, principals were asked how much they had supported teachers in teaching the NGSS during the prior year (2017–18), and then if they had provided more or less support in the most recent year (2018–19) than in the prior year. Almost three-quarters (70 percent) of respondents said that they supported teachers "somewhat" or "very much" in 2017–18, and 60 percent said that, compared to the prior year, they had increased their support for teachers teaching the NGSS in 2018–19.

Surveyed administrators reported supporting teachers in a variety of ways in 2020. Eighty percent of administrators reported that they had enabled teacher collaboration on science; 78 percent reported that they had supported new approaches to teaching science; 73 percent reported that they had provided science materials and supplies; and 80 percent reported that they had observed science instruction for purposes other than evaluation.

In 2020, two-thirds (67 percent) of expansion teachers reported that their principal was very supportive of them teaching the NGSS in their classroom, a slight increase from 61 percent in 2019. Only 5 percent of teachers identified "lack of support from administrators" as one of their three biggest barriers to implementing the NGSS.

To learn more about the professional learning provided to administrators by the Initiative and its effects on NGSS implementation, see Evaluation Report #10: *Administrators Matter in NGSS Implementation (2019): Updated Findings on How School and District Leaders Are Making Science Happen* (https://www.wested.org/resources/administrators-matter-in-ngss-implementation-2019/).

Challenges

Attempting any major districtwide educational innovation is inherently challenging, but the Early Implementers faced a combination of additional obstacles from the outset of the Initiative. Most, if not all, of the following challenges that they faced are likely to be encountered in other California school districts.

The Low Status of Science. Although they had been screened for demonstrating a strong commitment to science education when applying to join the Initiative, Early Implementer districts all bumped up against the prioritization of ELA and mathematics over other subjects. This issue manifested early in the Initiative when Core Leadership Teams tried to include science in districtwide professional development days. They had to compete for substitute teachers and for engaging the attention of principals. One of the earliest requests that the Initiative made of Early Implementer district administrators, including superintendents, was for them to communicate widely that science is important, a core subject, on par with ELA and mathematics.

Over the course of the Initiative, as more teachers and administrators became acquainted with NGSS instruction, priority support for the standards increased. Still, the percentage of surveyed teachers who reported that their principal communicated that science was a priority did not increase above 39 percent from 2017–18 through 2019–20.

Elementary Teachers Lack Confidence to Teach Science. Most elementary teachers have little to no science education background, which creates a hurdle for them in teaching science. K–5 Early Implementer teachers expressed that they felt intimidated: they did not know a lot of science information; how could they teach it to students? Only through professional learning, during which they had the chance to wear both student and teacher hats, did these educators realize how wrong they had been. The evaluation found that not only were they able to capably lead NGSS science instruction, but they and the students had a lot of fun, and all learned while doing so.

Under-Attention to Science Built into Grade 6. In the NGSS, all middle school grades (grades 6–8) are expected to receive a full year of science. However, in many districts, grade 6 can be taught in a self-contained classroom in which one teacher is responsible for teaching all subjects, as in a typical elementary classroom. Often, in this situation, the amount of science that students learn depends on how much time remains after demands related to other subjects are met. Alternatively, grade 6 teachers may be responsible for teaching science and another subject, often mathematics, in a block-scheduled course. Both circumstances result in less time for high-quality science instruction and more complications when trying to implement districtwide changes. Evaluators encountered an additional challenge: Some middle schools in some districts, or certain schools within a district, allowed science to be taught for only half the school year in grade 6.[9]

9 These configuration challenges exist in most districts, and grade 6 is most often when science is not being taught as a separate class. However, there are some teachers in grade 7, and even in grade 8, who also face this challenge. For more information about the NGSS in middle school, see Evaluation Report #5: *Making Middle School Science Whole: Transitioning to an Integrated Approach to Science Instruction* (https://www.wested.org/resources/making-middle-school-science-whole/).

New Content for Middle School Teachers. The science content shifts from previous science standards to the NGSS in middle school grades are substantial and are accentuated by the California Integrated Science Model, presenting two challenges. First, middle school science teachers, who often come from specialized science backgrounds or have many years of teaching within a single science discipline, must become responsible for teaching content that they are less familiar with, or perhaps less enamored of. For example, one principal said, "[For] our seventh-grade teachers, life science seems to be emotionally hard to let go of. They've had a mourning process." Second, at the school or district level, the transition to the NGSS must be meticulously planned to ensure that students do not miss out on important content. Early Implementers found that the full transition to teaching NGSS content took at least three years, with some content needing to be taught in more than one grade for a year or two.

Lack of Truly Aligned Instructional Materials. Although "NGSS-aligned" instructional materials are now available for adoption, Early Implementer district leaders have indicated that most materials, if not all, have gaps. It is unlikely that any instructional materials will be a perfect fit for any district. Even if a district has adopted instructional materials for science, the district should not consider NGSS implementation a done deal. High-quality instructional materials are a cornerstone to launching NGSS implementation efforts, but ongoing high-quality professional learning is needed in order to help teachers understand how to best use those materials to support what the NGSS refer to as "three-dimensional learning." [10] Equally important, administrators also need professional learning to understand what NGSS instruction should look like, to support teachers in best using the materials.

Making Time for Teacher Collaboration and Planning. In order to do the necessary risk-taking and experimenting to implement the NGSS, teachers need time to plan and prepare before teaching a lesson, and then need time to evaluate and learn from the experience after the lesson. Meeting regularly and sharing experiences with their peers allows teachers to progress in their own thinking and to learn from one another. Administrators need to help prompt, facilitate, and arrange time and conditions for collaboration. Also, while teachers are learning how to interact with their students in distance learning, they and administrators will face challenges in making teacher collaboration happen in this context.

Funding. At the state level, funds have been provided expressly for implementing CCSS subjects, but not for implementing the NGSS. Although Early Implementer principals reported leveraging a variety of funding sources to ensure that teachers had the materials, supplies, and equipment needed to deliver NGSS instruction, teachers in several districts cited funding for supplies as a significant challenge. The COVID-19 pandemic undoubtedly will further complicate the funding situation.

10 See Evaluation Report #11: *It's About TIME: A Rigorous New Process for Selecting Instructional Materials for Science* (https://www.wested.org/resources/its-about-time-ca-ngss-toolkit/).

Recommendations

Keep the NGSS in All Policy Discussions — Especially as Decision-Makers Work to Recover and Rebuild From COVID-19. Since science is critical for everyone's future, education leaders and policymakers must not allow science to return to the back burner in California because of teaching challenges created by COVID-19. As districts and teachers have scrambled to figure out online teaching in 2020, CCSS subjects have been the dominant focus. It would be unfortunate if science were to continue to receive limited attention. Society is faced with a constantly growing need for science education to help everyone understand the increasingly technological and scientific world. For example, everyone should have the opportunity to learn science so that they can understand COVID-19 and how to stop its spread. Science must hold and elevate its "core subject" status that is taking root through implementation of the NGSS.

Don't Expect Teachers' Transition to the NGSS to Happen Overnight. Teachers cannot make the many significant shifts called for all at once or without sustained professional learning. Keep in mind that the strategy to "go slow to go fast" can help alleviate teacher anxiety and give teachers permission to engage in necessary experimentation. As much as possible, districts should make a long-term plan for implementing the NGSS, and include a range of partners who can contribute to making the plan a reality.

Make Science a Priority in the Elementary Grades. Science should continue to become a core school subject, like mathematics and ELA. Giving science this status should include ensuring that elementary teachers are devoting appropriate instructional time to it. Some school districts in the Initiative have made science instructional minutes a requirement. Many schools also have made science part of their school identity, including enhanced outreach about science to parents and the larger community.

Ensure That All Students Have Equal Access to High-Quality Science. All people need science literacy to function in the world, and all students deserve to learn science — especially including English learners, students who are eligible for special education, and other historically underserved students. The NGSS can help address opportunity gaps. The Initiative has shown that historically underserved and previously underperforming or unengaged students benefit from NGSS instruction in meaningful ways.

Pursue Synergies of Science With Other School Subjects. Integrating science with ELA and other school subjects can be a win-win situation in that it benefits learning in both science and the other subjects. NGSS teaching, in contrast to teaching under past science standards, offers a more natural and substantial opportunity for a synergy of science with other subjects. Nonetheless, not all science instruction time should involve fusing science with other subjects; the Initiative evaluation has found that sometimes science investigation and science content need their own attention and time.

Consider NGSS Implementation Lessons for Other Subject-Area Initiatives. The Initiative's science implementation offers ideas that leaders of implementation projects in other school subjects might consider. For example, leaders of such projects might consider how providers of professional learning for mathematics or social studies could similarly be brought together to work collaboratively rather than in isolation or competition.

Shift From Merely 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 perspectives. Implementation projects should shift from efforts that typically produce only limited administrator awareness to efforts that achieve administrator engagement. Such administrator-focused professional learning is necessary in order to empower administrators to take a more active role in implementation.

References and Related Resources

Achieve, Inc. (2017). *Next Generation Science Standards district implementation indicators.*

Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+.* Horizon Research, Inc.

Brunsell, E., Kneser, D. M., & Niemi, K. J. (2014). *Introducing teachers and administrators to the NGSS: A professional development facilitator's guide.* NSTA Press.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins and effectiveness.* BSCS. https://media.bscs.org/bscsmw/5es/bscs_5e_full_report.pdf

Center for the Future of Teaching and Learning. (2011). *High hopes, few opportunities: The status of elementary science in California.* WestEd.

Estrella, D., Tyler, B., Britton, T. Iveland, A., Nguyen, K., & Arnett, E. (2019). *Administrators matter in NGSS implementation (2019): Updated findings on how school and district leaders are making science happen.* WestEd. https://www.wested.org/resources/administrators-matter-in-ngss-implementation-2019/

Feldman, S., & Malagon, V. F. (2017). *Unlocking learning: Science as a lever for English learner equity.* The Education Trust—West.

Hergert, L. F., Mundry, S. E., Kolb, F. A., Rose, R. M., & Corro, J. (2003). *Making change for school improvement — A simulation game* (2nd ed.). The NETWORK, Inc.

National Academies of Sciences, Engineering, and Medicine. (2017). *Seeing students learn science: Integrating assessment and instruction in the classroom.* The National Academies Press. https://doi.org/10.17226/23548

National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn II: Learners, contexts, and cultures.* The National Academies Press.

National Research Council. (2000). *How people learn: Brain, mind, experience, and school: Expanded edition.* The National Academies Press.

National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* The National Academies Press. https://doi.org/10.17226/13165

Next Generation Science Standards. (2013a). *Next Generation Science Standards: For states, by states (Appendix D: "All standards, all students": Making the Next Generation Science Standards accessible to all students).* The National Academies Press. https://www.nap.edu/read/18290/chapter/10

Next Generation Science Standards. (2013b). *Next Generation Science Standards: For states, by states (Appendix L: Connections to the Common Core State Standards for Mathematics).* The National Academies Press. https://www.nap.edu/read/18290/chapter/18

Next Generation Science Standards. (2013c). *Next Generation Science Standards: For states, by states (Appendix M: Connections to the Common Core State Standards for Literacy in Science and Technical Subjects).* The National Academies Press. https://www.nap.edu/read/18290/chapter/19

Rammer, R., Hayes, J., & Woods, B. (2017, August 24). *Supporting and enhancing NGSS implementation: A tale of two principals' efforts.* California Association of Science Educators. https://classroomscience.org/articles/ngss/ngss-early-implementers/supporting-and-enhancing-ngss-implementation-tale-two-principals-efforts

Tyler, B., Britton, T., Iveland, A., Nguyen, K., Hipps, J., & Schneider, S. (2017). *The synergy of science and English language arts: Means and mutual benefits of integration.* WestEd.

Tyler, B., Britton, T., Nilsen, K., Iveland, A., & Nguyen, K. (2019). *Investing in science teacher leadership: Strategies and impacts in the NGSS Early Implementers Initiative.* WestEd.

Tyler, B., Britton, T., Nguyen, K., Estrella, D., & Arnett, E. (2020). *Six years of scaling up: Districtwide implementations of the Next Generation Science Standards.* WestEd.

Tyler, B., Iveland, A., Nilsen, K., Britton, T., Nguyen, K., Estrella, D., & Arnett, E. (2019). *Collaborative lesson studies: Powerful professional learning for implementing the Next Generation Science Standards.* WestEd.

Williams, T. (2015). *The case for California's new integrated model for middle school science.* EdSource. https://edsource.org/2015/california-adopting-integrated-model-for-science-in-middle-grades/74814

York-Barr, J., & Duke, K. (2004). What do we know about teacher leadership? Findings from two decades of scholarship. *Review of Educational Research, 74*(3), 255–316.

Appendix A. Advice From Early Implementer Regional Directors and District Project Directors

In the last funded months of the Initiative (spring 2020), evaluators asked the District Project Directors from all of the Initiative districts and the Regional Directors from the K–12 Alliance for their major lessons and learnings from the Initiative's effort to implement the NGSS.[11]

These directors had been steeped in NGSS implementation for years, and this appendix includes examples of what they had to say, in their own voices, about the major learnings from the Initiative — drawn from their own experiences in classrooms and from work with their colleagues. Most comments reinforce and elaborate the main ideas in this report, but a few learnings are additional. The comments address a range of issues — from creating the right environment, to advice on how to effectively implement practices, to integration across subjects — and they close with observations about student engagement and impact.

Culture Matters

You need a community. You can't do NGSS in isolation. The entire system needs to come together. Find knowledgeable partners to get support. Sit admin at the table with teachers. Give teachers time (without strings attached) to learn together, plan together, and try out together.

It takes a village. Providing high-quality science instruction and implementing the NGSS cannot be done by a sole administrator or teacher leader. As one teacher leader reflected, "The most powerful thing was to have as many teacher leaders as possible present at the Summer Institute from my school site. We were able to collaborate and plan together. We then were a collective voice at my school site pushing for science instruction."

Building community. The K–12 Alliance created a grassroots approach to building a community of science teachers by creating a sense of belonging and providing support and resources to be successful. Through creating a network, teachers found they were a part of something bigger, and made deeper connections with colleagues, districts, the country office of education, and other regional communities of practice. Without the emphasis on creating a familial culture, the connectedness to the work and imperative to realize our goals would not be as evident.

Network of professionals. Implementation of significant change needs to include a connection or link to a network of professionals working on the

11 All of the District Project Directors had been involved since the first year of the Initiative, if not as a director, at least as a Core Teacher Leader. They had collaborated on the mission, vision, and goals, and, most importantly, the detailed plan that the Core Leadership Team developed during Year 1. They had seen progress and challenges in their own district as well as across all the districts at the monthly convenings of Early Implementer Regional Directors and District Project Directors.

same change. The network of professionals needs to know change theory and strategies to help districts meet unexpected and expected challenges.

When they knew more about the NGSS, administrators were more supportive. As our administrators' knowledge of NGSS grew, they were more likely to both support NGSS implementation in their sites as a whole and be more effective at soliciting teachers' needs and providing needed support.

Adapt to the different PLC cultures in the district. At some sites, there is a culture that focuses more on why things can't be done, how teachers will be impacted (not students), not embracing change. Other schools have the exact opposite culture, and some are in between. You may need to implement NGSS slightly differently with each PLC, based on those different cultures. As Project Director . . . I can see how being aware of how each elementary school is culturally different would have helped us be more efficient and thoughtful in how we rolled out NGSS to each group.

Planning and Monitoring Are Crucial

Plans empower and lead to results. Creating an NGSS implementation plan for our district gave our CLT the capacity to support our science Teacher Leaders in the creation of NGSS implementation goals and action plans specific to their site. When these plans are made in partnership with site leadership and teachers, the plan empowers teachers and schools to grow in the area of science teaching [and] learning, based on their own school's data and needs.

You need a plan. Make a plan and keep it in the forefront of the work, to **guide** you but also to be **revised** as needed: Both are important. The District Plan was probably the most important document we created, as we referred to it not only as a guide but also as a measurement tool (i.e., how are we doing and what do we need to do to get there?).

Watch STUDENTS to know what's working. From the earliest days, evaluate how the work is going by watching students and closely analyzing student work — NOT teachers' teaching, but students' learning actions and work products. That's where the proof of the work's success is. Do this with a rubric on which all admins are consistently trained and normed.

GIVE IT TIME. NO, MORE TIME. NO, EVEN MORE. NO, MORE THAN THAT. Whatever your goal(s) is/are for the work, this will take WAAAAAAAAAAAAY longer than you think, like, want, are comfortable with. But if you are keeping a close eye on students' learning actions and student work products, you will have the information you need to inform what you need to do next.

NGSS takes time. Effective shifts do not happen overnight. Everyone needs time to learn, grow, try things out, make appropriate adjustments, try things out again, shift gears once more, try things out again and again . . . be patient, be a learner, trust that this will be powerful for kids.

Start slow. Do not do "big" moves or large one-day districtwide events before support has been established with key teacher leaders and key principals.

Less is more to start. NGSS can be overwhelming to teachers and administrators at first, so less is more at the beginning of implementation.

NGSS Pedagogy = High-Quality Teaching Across Subjects

Science supports interdisciplinary learning. We know NGSS is an opportunity to drive interdisciplinary learning and make connections in

the standards be real and come to life through our curriculum and professional development.

Science is an enhancer. When the vision of NGSS is at play in learning experiences, students tend to be so engaged they don't really "realize" they are reading, writing, engaging in mathematics, or developing rich vocabulary.

Real science cuts across disciplines and grades, which means opportunity for increased collaboration across grades, less focus on discipline, and more focus on real problems and student-centered questions. Through DCIs that spiral through the K–12 student experience and SEPs that push students to look at real-world problems, the NGSS force practitioners to think beyond a single-year science experience. This also calls on teachers to reach out and collaborate with other teachers because real student-driven scientific questions and engineering problems aren't always solved or answered in a class period.

Phenomenon is a tricky concept to convey to teachers, but once they understand, it can be a powerful driver of not only science but other content areas as well.

a. Kids love learning via authentic, relevant phenomena.

b. Phenomena are contextual and important to make local, though not always easy.

Time to integrate science and ELA. Teachers are fully on board with the idea of integrating and exploiting the convergences across science and ELA. However, most elementary schools are using or are beholden to a set ELA curriculum and/or a predetermined (to some degree) scope and sequence. It can be tough for teachers to align ELA with science as they are pretty constricted with ELA driving the bus. More often, the ELA materials provide a list of stories that are tangentially related to the topic (often with a lot of telling or giving away of the science), and that sort of masquerades as "integration."

The elephant in the room is time for science at elementary. We could have the most prepared and NGSS-ified teachers, moral support, and teacher buy-in around science; a well-aligned, high-quality NGSS curriculum; and all of the necessary parts, but implementation is stymied if teachers are not provided time in their instructional day for science. I think this is the largest barrier of all, and no one talks about it because there is no easy solution.

Pivoting in a time of crisis. The launch of distance learning empowered us to create K–5 across-district resources to teach NGSS. We see this as a culmination of all of our work. Not only is science recognized as key in this time of crisis, but also we are inspiring the next generation to become scientifically literate, curious, creative change makers.

Solicit Support at All Levels

You need a network of support at all levels in the district. The network of professionals needs to know change theory and strategies to help districts meet unexpected and expected challenges. Some principals will be supportive, then may change that support to something new unless upper management is also behind the plan. Upper admin in a district needs to be a part of the bigger plan but not the day-to-day operations. Engagement of the school board needs to be addressed at a time the upper admin is in total support. **This is important.**

Administrators are key. Do not underestimate the powerful role that administrators have in supporting or hindering progress in successful implementation of the NGSS. Like teachers, they need ongoing high-quality professional learning to help with understanding of the nuances of three-dimensional phenomenon-based teaching, learning, and assessment; how to support and position

teachers for success; and how to effectively communicate with families and the community.

Grow district leadership support. As we've developed a site culture that embraces science as a lens through which we can support literacy and numeracy, science has been recognized in our district as a valuable part of the culture and curriculum in all grades TK–12. Support at the district leadership level has made science a priority.

Involve district administration at the planning stage. I wish the district plan had been developed in conjunction with district admin . . . Our plan existed essentially separate from the district, and, though we followed it, many at the district office did not know it existed, and we had a hard time infiltrating things at the district level.

Share progress; spread the word that expertise is growing and help is available. A critical thing we missed was a way to share what we were doing in our district. Highlighting that teachers were working really hard and moving forward so others could reach out to them for advice. And getting recognition for them from admin and community.

Develop evidence of progress. Develop materials, like student notebooks or projects, that can be shared with all stakeholders.

A network of support is critical. We experienced a change in support when our ally at the district office left. When this kind of change happens, a supportive network can help teacher leaders stay the course and work in ways they are allowed, even if ways are limited. The network can help advise strategic moves to regain support:

- Develop relationships with key principals to carry the message to other principals and upper management.
- Invite key principals to events (even if upper admin does not attend).
- Continue to invite upper management to all events.
- Support teacher leaders with encouragement to stay the course and wait for an opportunity to move with greater momentum.
- Continue to offer staff development opportunities for teachers so that, at the moment of movement, there will be sufficient support within teachers.

Connect to career and community partners. The standards provide a roadmap for developing industry and partner experiences. NGSS is outcome-driven, and a lot of those outcomes align to what people do in the working world, allowing for connection outside of the school. Importance of seeing the standards in the real/working world is a part of our science excursions for middle school and STEAM curriculum for elementary.

Teachers Lead, If Allowed

Treat teachers like they are leaders and they will lead (e.g., presenting at CSTA, facilitating lesson study, presenting at early implementation session). Treat teachers like designers and they will create beautiful work. Free teachers from worksheets and they will send students outside (e.g., increased fieldwork, bringing phenomena into the classroom).

Scaffold teacher leadership. Teachers gained an opportunity to move from novice to expert in their NGSS knowledge. An expert makes something that is difficult look and feel easy, and we have been able to develop resources that allow a novice teacher to deliver NGSS-aligned 3D experiences. Through the [Initiative], teachers were instilled with a desire to keep learning and improving through experiences

from summer institutes, TLC, and Capacity Builder workshops. Teacher leaders who became part of the Core Leadership Team went from supporting their classrooms, to building capacity at their school sites, to supporting districtwide NGSS implementation.

Empower teachers, and they will lead. Teachers who had previously not thought of themselves as science teachers or leaders increasingly gained confidence, took on roles as facilitators and mentors, joined state science organizations (some running for offices), participated at the state level on adoption and assessment committees, and more.

Build the cadre of leaders to scale. Build capacity and scale out deliberately and thoughtfully: Have a core group of trained/indoctrinated/true believers; then bring on a larger group (say, 5–10 per core member) and build their knowledge/commitment to the work/vision; then bring on a larger group (say, 5–10 per larger group member) and do the same with them.

Teacher leadership is critical. The purposeful scale-up from Core Leadership Team to Teacher Leaders to expansion teachers was a valuable and effective strategy. Overt work on teacher leadership was invaluable. One big learning is that the Core Leadership Team (CLT) should have to apply for the position or be made aware of the responsibilities beforehand. Our CLT was "voluntold," and teachers also showed up in summer 2014 with no clue what they were getting into. Even though they did what was asked, a lot of them did not have the "fire in their belly" or the passion for the work. We had more turnover than I would have liked. When we replaced CLT we were able to select more purposefully, and that was a gamechanger.

BTW, you will have created a monster. True believers will not be satisfied with anything less than perfection. But they'll also keep at this work long after others might have counseled a strategic abandonment! Then, LET GO. At some point you have to let the work be distributed out to sites/others to lead/control while also keeping a consistent quality control. This is extremely difficult, and those monsters you have created will not be happy to see any deviation from perfection.

Make Time for Professional Development for Teachers

NGSS can be done. With the proper ongoing support and high-quality professional learning, teachers can be effective in teaching NGSS. Do not, however, underestimate how significant the shift is for teachers. Ongoing high-quality professional learning is needed to help with understanding of the nuances of three-dimensional learning, how to position students for success in explaining phenomena and solving problems, and the shifting of the role of the teacher to master architect who builds opportunities for student sense-making.

Focus professional learning on a practice. Early events should target key moves individual teachers can make (e.g., work on a practice, start notebooking, identify phenomenon). Use protocols that are embedded in the work of a teacher: lesson study, student work analysis, coaching, etc.

Lesson studies were powerful. TLCs were effective tools for supporting teachers in the NGSS shifts and had more lasting effect in districts that continued these throughout the six years.

Sustaining/expanding professional learning design. Our district found value in both lesson study and summer institutes. Involving district administrators and district instructional coaches in both activities increased district buy-in that these were valuable avenues for professional learning. Therefore, our district will continue with both lesson study and summer institutes in future years.

NGSS Reaches ALL Students — and Enhances Learning!

Students love science. When the vision of NGSS is at play in learning experiences, students become scientists. They become critical thinkers, individuals seeking to understand their world, generate new knowledge, and broker understanding with their peers. This is incredibly empowering for youth.

Students in K–12 are much more capable of engaging in sense-making than teachers and administrators typically give them credit for.

Phenomena are real, engaging, and meaningful, meaning fewer questions about using this in the "real world."

Secret sauce. Engaging students in phenomena that are relevant to students, especially those that are tied to their local environment and experiences or issues their community is facing, is incredibly powerful for rich learning opportunities.

NGSS can engage student activism. Humans impact the world, and students can change the world for the better (creating climate activists, mitigating extinction).

Student engagement = high achievement. When the vision of NGSS is at play in learning experiences, when students are scientists, achievement increases.

ALL STUDENTS COUNT. Make sure students learning English and students with IEPs are addressed in that plan from Day 1. Do NOT try to add them in later. Do NOT say that good teaching for everyone will give these students good enough teaching.

Equity is that ALL students have access to rich, engaging science.

Appendix B. A Glimpse of What NGSS Instruction Looks Like

Teaching consistent with the NGSS is quite different from past science instruction. To briefly illustrate this point, the following vignette describes a grade 4 lesson taught by an Early Implementer teacher who participated in extensive professional learning provided by the Initiative. The teacher was observed by an evaluator toward the end of the fourth year of the Initiative (spring 2018). Words that are particularly relevant to understanding the essence of NGSS teaching are in **boldface**. Following the vignette, its key aspects are discussed in the "NGSS Teaching Illustrated in the Lesson" section.

A Grade 4 NGSS Lesson

In this class, students plan and conduct an investigation to determine whether the speed at which objects move affects energy transfer during collisions. In a way that has become usual for her, the teacher has structured each part of the lesson to maximize the degree to which students can formulate their own ideas and pursue their own questions. The teacher makes a point of, as she puts it, letting students "discover on their own and teach each other."

The lesson begins with a video showing close-ups of a series of collisions (e.g., two people chest-bumping; a car hitting a truck). The teacher has **students talk at their tables about what they know** about collisions, from experience or from prior lessons.

The table groups talk, and some students are seen referring to their notebooks. Then, the teacher facilitates a brief **whole-class discussion** about energy transfer. She **asks questions** such as, "How do you know where the energy went?"

A student explains, "There's energy in your hand. If you're using a ball, when you hit it, the stored energy turns into action energy in the ball."

The teacher counters, "How do you know it turns into action energy?"

Student: "When the ball starts moving, it's action."

Teacher: "Can anyone add to that?"

Student: "If a car hits another car, and it hits another car, and that one hits another car, the energy transfers from the first car, to the next car, to the next car."

The teacher continues: "OK, you know energy transfers in collision. Now we're going to throw in speed. Does speed make a difference? Take 30 seconds and **talk in your group**. Do you think speed makes a difference? And maybe how you know?"

After students in table groups share their ideas, the teacher introduces the next student activity: "OK, write this question in your notebooks: Does speed make a difference in energy transfer? This is coming from our Wonder Wall; **one of you**

asked this question during our first lesson about collisions. Once you've written the question, your answer is going to be your **claim** (i.e., prediction). Please write your answer underneath."

The teacher then explains how students will individually flesh out their thinking further: "Now you're going to create a model. You're going to pick from items that I'll show you, and you're going to **come up with a plan for how you are going to gather evidence to support or disprove your claim**." She holds up all kinds of objects the students can use in their investigation: Wiffle balls, golf balls, pennies, marbles, Frisbees, tennis balls, toy cars. "I want you to pick two or three items, three max, that you'll use to change the speed of your first item into the second or third item. How will speed change and how will energy transfer? **Draw a model now, with labels and arrows predicting how the energy will transfer** when you carry out your plan."

After the students have had a while to individually create a model and write a claim in their notebooks, the teacher asks them to refine their thinking by **comparing models with each other**: "Now you're going to compare models and talk about ideas in your science group. Remember, you're trying to test your claim — does speed matter? You want to pick the model for the group."

A student asks, "Do you make another model if you mess up?"

Teacher: **"Yes, you can always change your model."**

The teacher explains what students should consider as they plan and conduct their actual investigation: "You're going to need to collect some data. If you say speed matters and there's a difference in the way energy moves, you have to have evidence. What will your evidence be? You have to collect data. I want you to think about: If I do this, that happens. I want you to try to make a table — some of you are really good at this — this goes with this. I'm going to walk around and, if you need it, I might give you a little hint to help with your tables. Once you do all that, I want you to record in your notebook what happened. Did you have any patterns in your data? You can draw a model of what happened. Questions?"

Soon all groups are actively **implementing their plans**, testing the influence of speed on energy transfer in collisions. Some students begin by rolling balls into one another without recording the outcome. But, after a few minutes, all students are becoming more controlled and methodical, measuring the distance that the items roll after they have collided.

After about 30 minutes, the teacher asks the groups to stop. "Would anyone like to explain if speed matters when energy is being transferred? How does energy transfer at different speeds? I'd like you to use your data. If you want to show your data under the projector, you can." After a student walks to the front of the room and places her notebook under the overhead projector, the **teacher and student discuss the work**.

The teacher comments, "Oh! She set up a table! But I can't tell which is fast and slow."

Student: "I put an 'S' and an 'F.'"
Teacher: "OK! What did you do?"
Student: "We collided two balls."
Teacher: "What did you measure?"

Student: "The distance the balls went. There's four distances. The slow one is 4 centimeters. The fast is 28, 32, and 52 centimeters. When you go faster, the more stored energy there is. So it goes farther."

Another student puts his notebooks under the projector and explains his team's investigation. The teacher exclaims, "These are great! Great data! Now, I'm going to have you create a poster. This is new, so I'll walk you through it. This is **'Claim, Evidence, Reasoning [i.e., CER].'** You're going to put your evidence on the left."

The teacher gives a large blank sheet of paper to each table. The students work to transfer their claim and the evidence they collected onto the large sheet. She explains, "At the bottom, you're going to connect the two. It's called reasoning. 'Yes, speed makes a difference in energy,' or 'No, it doesn't, *because* . . .' You're going to use your numbers there: 'Because when it went slow, it went this far; when it went fast, it went this far.' I want to see something about stored energy in there too."

At the end of the class, students hand in their posters.

Teacher: "On Monday we'll finish the posters, discuss our ideas a bit more, and write our CERs in our notebooks."

NGSS Teaching Illustrated in the Lesson

This lesson was chosen because it includes pedagogy that results in high levels of student engagement and learning. For example, the teacher begins the lesson with open-ended questioning that prompts students to talk, first in small groups and then as a whole class, about what they know about energy transfer. *Such questioning strategies elicit student sharing that goes beyond factual recall to explanation*, complete with examples that illustrate their thinking.

Starting the lesson with small-group discussion *creates an accessible entry point to the topic for all students*. Giving further opportunities to share ideas with their table groups allows more students to vocalize and clarify their thoughts and to learn from one another.

The teacher bases the lesson on a question asked previously by students in the class (i.e., Does speed make a difference in a collision?), making the lesson particularly relevant to them. Before carrying out their investigations, students are asked to make a claim, based on their current understanding, predicting whether speed does or does not make a difference in energy transfer. Asking students to make a prediction is important because it requires each of them to access and record their prior knowledge, which will *facilitate them truly making sense of new information* gained during the investigation. It will also be food for reflection after the lesson, when they can revise their claim and *gain an appreciation for how much their understanding has grown*.

Finally, having students design, plan, and carry out their own investigations, an NGSS Science and Engineering Practice (SEP),[12] is *highly engaging for students and fosters development of other SEPs that will be useful in future learning* (e.g., asking questions, analyzing and interpreting data). Students also engaged in other SEPs in this lesson, such as developing and using models and arguing from evidence (Claim, Evidence, Reasoning [CER] protocol). Through this inquiry-based, hands-on experience, students collected evidence to back up their claims. They shared their findings with one another and learned in a way that is both more inclusive and more impactful than traditional instruction.

For additional K–8 vignettes of NGSS instruction and explanations of how each one addresses the standards, see Evaluation Report #13: *NGSS in the Classroom: What Early Implementer Science Instruction Looks Like* (https://www.wested.org/resources/ngss-in-the-classroom/).

12 The three "dimensions" of the NGSS are Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs). In this lesson, SEPs were dominant, the DCI was related to energy transfer, and there was no explicit attention to a CCC.

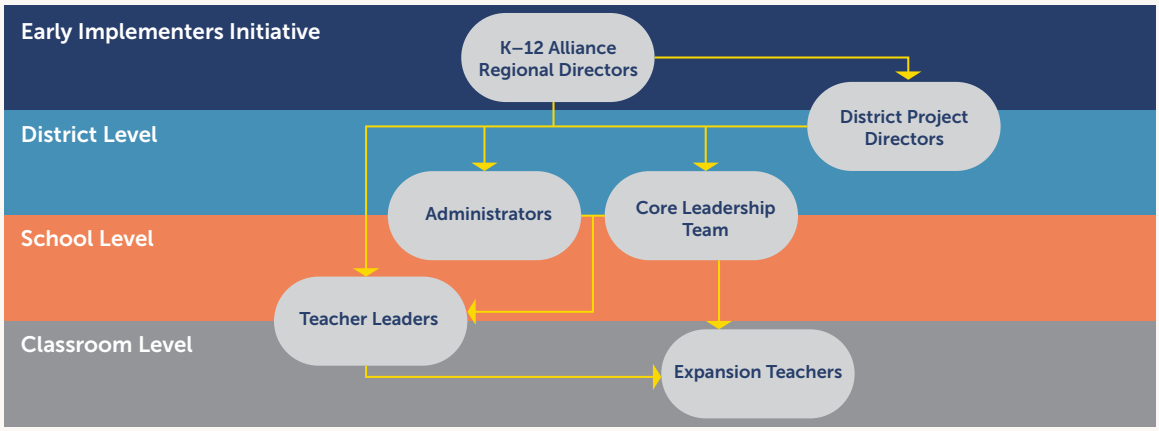
Appendix C. Initiative Participants and Their Interactions

The Initiative created an organizational structure (shown in Figure C1) to support NGSS implementation in participating districts at multiple levels — from teachers to site administrators to district leaders. The following briefly describes the roles of the key Initiative players:

- **K–12 Alliance Regional Directors.** Seasoned science education professional learning providers; each Early Implementer district was supported by one designated Regional Director for the duration of the Initiative.
- **District Project Directors.** District employees responsible for leading and coordinating NGSS implementation in the district and managing the grant; worked closely with the Regional Director and the district Core Leadership Team.
- **Core Leadership Teams.** 5–8 **Core Teacher Leaders** and 3–5 **Core Administrators** per district, who joined the Initiative in Year 1 (2014–15) and received intensive professional learning in NGSS content, pedagogy, and leadership; worked closely with the Project Director to plan[13] and support district-level NGSS implementation activities; and were responsible for sharing their NGSS expertise with others in the district. Core Leadership Teams were convened twice a year, in January and in June, for deep training on the NGSS and leadership.
- **Administrators.** All elementary and middle school site administrators were strongly encouraged to attend a range of NGSS Early Implementer professional learning to garner their support, as described in the "Ambitious Professional Learning for Administrators" section of this report.
- **Teacher Leaders.** The 30–70 teachers per district who joined the Initiative in Year 2 and received similar, but less intensive, professional learning, compared to the Core Teacher Leaders; also responsible for sharing their NGSS expertise with others in the district.
- **Expansion Teachers.** K–8 teachers of science who did not directly participate in Initiative professional learning activities during Years 1–4. Because the ultimate goal of the Initiative was to expand implementation of the NGSS to all teachers of science, the participating districts included expansion teachers in a range of professional learning experiences in later years.

13 For information about the Early Implementer districts' NGSS implementation planning, see Evaluation Report #4: *Developing District Plans for NGSS Implementation: Preventing Detours and Finding Express Lanes on the Journey to Implement the New Science Standards* (https://www.wested.org/resources/developing-district-plans-for-ngss-implementation/).

Figure C1. Diagram of the Early Implementers Initiative district organizational structure



In Figure C1, the placement of some participant types across more than one level is intentional. For example, although District Project Directors led work in their district, they also met monthly with the K–12 Alliance, at the Initiative level, to co-plan the implementation; some administrators were in central district offices (district level), while others were site personnel (school level); and Teacher Leaders made changes in their own teaching (classroom level), but also led professional learning and/or provided informal learning or support to their school colleagues (school level) and often also at district professional learning sessions (not shown in the figure).

Appendix D. Evolution of Professional Learning Topics From Basic to Advanced

The focus of professional learning in the Initiative evolved over time, from basic to increasingly sophisticated. In general, in their first year, Teacher Leaders were first introduced to:

- The overall structure of the standards,
- The crucial role of equity in the NGSS classroom, and
- A few relatively accessible Science and Engineering Practices (SEPs — e.g., modeling, arguing from evidence), as well as beginning sense-making strategies (e.g., notebooks).

As both the K–12 Alliance and the Teacher Leaders gained understanding of what the NGSS looked like in practice, professional learning gradually progressed to:

- Using phenomena to drive instruction,
- Planning lessons around inquiry and student sense-making, and
- Addressing all of the SEPs.

In later stages, Teacher Leaders learned more about:

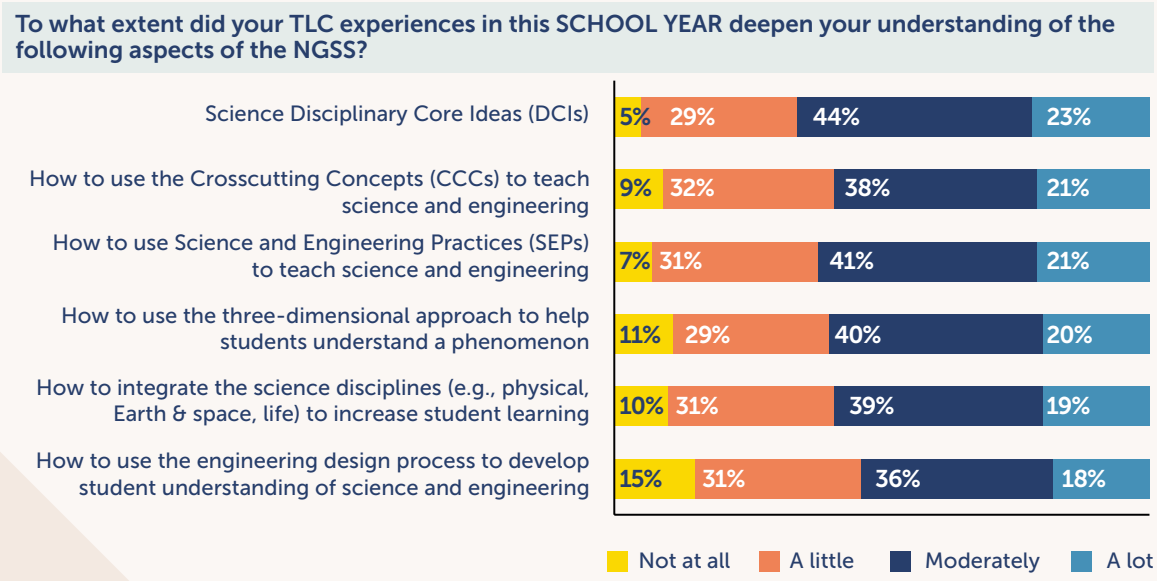
- How to use the NGSS Crosscutting Concepts to frame student discourse,
- NGSS-aligned assessment, and
- How to evaluate instructional materials.

Concurrent professional learning regarding leadership and how to be a change agent similarly evolved over the course of the Initiative.

Appendix E. Teacher-Reported Impacts of Early Implementer Professional Development

During the 2018–19 school year, all but one district implemented locally adapted versions of large-scale lesson studies (the Initiative's Teaching Learning Collaboratives, or TLCs) with both Teacher Leaders and expansion teachers. At the end of the school year, teachers (Core Teacher Leaders, Teacher Leaders, and expansion teachers) were surveyed about how much their TLC experiences had impacted their NGSS understanding and practice. A majority of teachers reported that their understanding of all key aspects of the NGSS and the California Integrated Science Model (in grades) deepened "a lot" or "moderately" from their TLC participation (Figure E1).

Figure E1. Extent to which TLC experiences deepened teachers' understanding of aspects of the NGSS



Source: Early Implementers Spring Survey administered to all Early Implementer classroom teachers by WestEd in spring 2019 (*N* = 431).

Note: Percentages may not sum to 100 due to rounding.

When asked how much the TLCs empowered them to use key Initiative tools and practices modeled in the professional learning, teachers gave similarly strong responses. Majorities of teachers responded "a lot" or "moderately" for the following:

- How to use phenomena to drive instruction
- How to use questioning strategies (e.g., teacher-to-student discourse, student-to-student discourse) to develop student understanding
- How to use science notebooks to elicit student sense-making
- How to use the 5E instructional model to design and teach lessons
- How to look deeply and systematically at student work as evidence of student understanding

In the Early Implementers spring 2020 survey, Teacher Leaders were asked how much impact certain types of activities had on their science instruction. They reported that interacting with other teachers (outside of formal professional learning events) had the greatest impact. A key tenet of the Initiative was promoting the informal sharing of resources and collaboration among teachers, whereby Teacher Leaders acted as NGSS ambassadors in their schools and districts and were tasked with supporting other teachers' NGSS implementation. Teacher Leaders reported that participation in a professional learning community and independent research/learning were the second and third most impactful activities, respectively.

Surveyed Early Implementer Teacher Leaders gained understanding of how to help other teachers transition to the NGSS. During 2014–15, prior to their joining the Initiative, Teacher Leaders felt unprepared. That is, 83 percent indicated that they understood how to help other teachers transition to the NGSS "not at all" or "poorly." However, by the 2017–18 school year, 81 percent understood it "fairly well" or "thoroughly"; only 1 percent said that they understood it "not at all," and 18 percent said that they understood it "poorly." For the Core Teacher Leaders, who had joined the Initiative one year earlier and benefited from more intensive professional learning, survey data showed even greater gains in understanding. For example, by the 2017–18 school year, only 4 percent of Core Teacher Leaders indicated understanding "poorly," and none indicated "not at all."

For more information about the Initiative's tools and practices, see a special evaluation report (unnumbered), *Next Generation Science Standards in Practice: Tools and Processes Used by the California NGSS Early Implementers* (https://www.wested.org/resources/next-generation-science-standards-in-practice/).

Appendix F. Science Walk-Through Observation Tool

Early Implementers Walk-Through Tool: SCIENCE Instructional Core

Grade Level: _____ Walk-Through #: _____

Task: What is the Focus Question?	Content: What are students learning?
What question are students trying to answer, or what problem are students trying to solve?	**What is the content? Is it aligned to grade-level three-dimensional learning?**
Teacher: What is the teacher doing?	**Students: What are students doing?**
How is instruction allowing all students to do the thinking and three dimensional learning? ***(quantitative & qualitative evidence)***	**How are students interacting — with each other, the teacher, the task, and the three dimensions?** ***(quantitative & qualitative evidence)***

Source: Developed by Oakland Unified School District in collaboration with NGSS Early Implementers Initiative, 2017.

Glossary

5E Instructional Model: Based on the understanding that people learn by building new ideas on top of old ideas (National Research Council, 2000), the 5E instructional model is driven by student questioning and discussion. The five stages of a lesson are engage, explore, explain, elaborate/extend, and evaluate. The model was originally developed by Biological Sciences Curriculum Study (Bybee et al., 2006).

Core Leadership Team (CLT): A group of 3–5 administrators and 5–9 teachers, distributed across the lower elementary, upper elementary, and middle grades, established at each district at the beginning of the Initiative. The CLT met with the District Project Director regularly during each school year to plan and lead all Initiative activities, and with its K–12 Alliance Regional Director for six technical assistance days each school year. CLTs were convened together each January and June for specialized training in the NGSS and leadership.

Core Teacher Leader: A teacher member of the Core Leadership Team. Core Teacher Leaders provided professional learning to Teacher Leaders, other teachers, and/or administrators in their district, or at Initiative-wide events such as the summer institutes.

Crosscutting Concepts (CCCs): One of the three NGSS dimensions, and a way of linking the different domains of science. CCCs include patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change.

Dimensions of the NGSS: The NGSS include three dimensions: Disciplinary Core Ideas (what scientists know), Crosscutting Concepts (how scientists make connections among the sciences, and a lens for observing and understanding the science), and Science and Engineering Practices (what scientists and engineers do, and how scientific knowledge develops).

Disciplinary Core Ideas (DCIs): One of the three NGSS dimensions. According to the National Research Council's Framework for K–12 Science Education (2012), DCIs are the important concepts in each of four domains: physical sciences; life sciences; Earth and space sciences; and engineering, technology, and applications of science.

District Project Director: District person responsible for leading all Initiative activities for the district and representing the district at monthly Initiative-wide planning meetings with Regional Directors.

Expansion Teacher: A teacher who had not directly received significant professional learning or support from the Initiative, but who benefited through the shared expertise of those who had. In larger districts, expansion teachers were typically in schools with at least one Teacher Leader.

The K–12 Alliance: A WestEd program of science education leaders and professional learning providers who planned and delivered all Initiative-wide activities.

Learning Sequence: Three-dimensional (3D) NGSS phenomenon-based instruction lasting several lessons. A learning sequence is based on investigative phenomena and represents part of a conceptual flow for an entire unit of instruction. Learning sequences can be designed using the 5E instructional model.

Lesson: 3D NGSS phenomenon-based instruction lasting for one class period or a few class periods, typically 45 to 90 minutes.

Next Generation Science Standards (NGSS): A set of K–12 content standards developed by 26 states to improve science education for all students. They are composed of three dimensions based on the National Research Council's *Framework for K–12 Science Education* (2012).

NGSS K–8 Early Implementers Initiative: A six-year initiative (summer 2014 to spring 2020) supporting implementation of the NGSS by eight public school districts and two charter management organizations in California. Developed by the K–12 Alliance at WestEd, in collaboration with the S.D. Bechtel, Jr. Foundation, the California State Board of Education, and Achieve, the Initiative built capacity of participating local education agencies to fully implement the NGSS in grades K–8.

Phenomena: Natural phenomena are observable events that occur in the universe and cause people to ask questions. Science knowledge can be used to explain or predict phenomena.

Regional Director: Member of WestEd's K–12 Alliance staff assigned to provide leadership and support to one or two Early Implementers Initiative districts and to meet with District Project Directors at monthly Initiative-wide planning meetings.

Science and Engineering Practices (SEPs): One of the three NGSS dimensions. SEPs are the behaviors that scientists engage in as they investigate and build models and theories about the natural world, and the key set of engineering practices that engineers use as they design and build models and systems. They include asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; and obtaining, evaluating, and communicating information.

Summer Institute: A three- to five-day professional learning event held every summer to kick off the new Early Implementer school year, held regionally during Years 1–4 of the Initiative, and attended by all Initiative participants, some as leaders (Regional Directors, Project Directors, Core Leadership Team members) and others as learners (Teacher Leaders). Beginning in Year 5, districts organized and held their own summer institutes.

Teacher Leader: One of 30–70 teachers in each district who joined the Initiative in Year 2, one year after the Core Teacher Leaders. Teacher Leaders attended annual summer institutes and participated in two TLCs each school year (one in the fall and one in the spring) and in other district-level professional learning.

Teaching Learning Collaboratives (TLCs): A version of lesson study implemented in Years 1–4 of the Initiative. Each TLC brought together three to four same-grade Initiative teachers, from different schools within the district, and a trained facilitator. Teachers planned and taught a lesson to a classroom, then debriefed the effectiveness of the lesson design, using student work. Based on the analysis of that work, the lesson was redesigned and taught to a different classroom, and then participants discussed the effectiveness of the changes to student learning. In Years 1–4, each Teacher Leader participated in two TLCs per year. Districts began making modifications to the TLC design in Year 5 to reduce teacher time out of the classroom, but some returned to the original format in Year 6.

Toolkit for Instructional Materials Evaluation (TIME): A suite of tools and processes for curriculum-based professional learning, designed to help educators evaluate, select, and implement instructional materials aligned to the NGSS. This toolkit is based on the original work of the K–12 Alliance.

NGSS EARLY IMPLEMENTERS

WestEd

What Education Leaders Can Learn About NGSS Implementation: Highlights From the Early Implementers Initiative

EVALUATION REPORT #14

Burr Tyler, Denise Estrella, Ted Britton, Kimberly Nguyen, Ashley Iveland, Katy Nilsen, Elizabeth Arnett, Josh Valcarcel