Lessons Learned from the NGSS Early Implementer Districts: Professional Learning

Introduction

The Next Generation Science Standards (NGSS) are K–12 science standards, developed by states and released in 2013, that set the expectations for what students should know and be able to do to in science to be ready for college, career, and citizenship upon graduation from high school. Unlike previous science standards, the NGSS combine three dimensions of science learning — crosscutting concepts, science and engineering practices, and disciplinary core ideas — into each performance expectation.

The California NGSS K–8 Early Implementation Initiative is a project with the goal of building local education agency capacity to fully implement the NGSS, focusing solely on grades K–8. Eight districts and two charter management organizations were selected to participate in the initiative, becoming the first in California to begin implementing the state's new science standards, the Next Generation Science Standards for California Public Schools K–12 (CA NGSS). As part of this initiative, WestEd's K–12 Alliance provides teachers and administrators with in-depth, content-rich professional learning support from leaders in California's science education community who have been engaged with the NGSS from the beginning and have strong experience in the professional learning of science educators.

The Early Implementer districts and charters — Galt Joint Union Elementary, Kings Canyon Joint Unified, Lakeside Union, Oakland Unified, Palm Springs Unified, San Diego Unified, Tracy Joint Unified, Vista Unified, Aspire, and High Tech High — are diverse demographically and structurally. Therefore, learning about their experiences in the first years of implementing the CA NGSS can be instructive to a wide range of other districts throughout California and the rest of the country. To that end, Achieve interviewed district leaders, school administrators, and educators from eight of the traditional public school districts and one charter management organization— Galt Joint Union Elementary, Kings Canyon Joint Unified, Lakeside Union, Oakland Unified, Palm Springs Unified, San Diego Unified, Tracy Joint Unified, Vista Unified, and High Tech High — with the goal of sharing their reflections on early implementation of the CA NGSS.[1] For simplicity, the eight districts and charter management organization are referred to as nine school districts throughout this document.

The following sections focus on the districts' reflections regarding the professional learning needed to implement the new standards, including formats and audiences for professional learning, content and design of professional learning for both teachers and administrators, and criteria for selecting or designing professional learning. As part of the Early Implementation Initiative, teams from the nine districts received support and professional learning from WestEd. However, this document focuses on the professional learning the nine

[1] The interview methodology is described in detail here

districts offered outside the support they received from WestEd.

The nine school districts included in these interviews had nine different approaches to professional learning. Differences in professional learning were often related to differences in the districts such as size, funding, and capacity. For example, some districts had multiple individuals at the district level to lead the implementation of the CA NGSS, whereas other districts searched for funding over the first years of implementation to create such a position. Districts also differed regarding their norms of and existing systems for professional learning. For example, some districts have a history of centralized professional development in which the district has influence on, or even offers the majority of, the professional learning. Other districts leave it to the schools to find or provide professional learning and instead take the role of providing guidance to schools on what learning opportunities should look like.

According to the California K–8 NGSS Early Implementation Initiative, the core program includes strategies and activities aimed at specific outputs, initiative outcomes, and impacts, including the following:

Strategies	**Activities**	**Outcomes**
Change local education agency policies and practices for science education	Establish an LEA Core Leadership Team	*Specific Output*: Institutional change leads to prioritizing and implementing the NGSS
Build administrator leadership	Provide professional learning for district administrators and superintendents	*Specific Output*: Early Implementers serve as lighthouse districts
Build teacher leadership	Provide summer institutes each year for teacher leaders	*Initiative Outcome:* K–8 articulated science education programs aligned to the NGSS are implemented
Change teacher practice	Engage all teacher leaders in lesson study through the Teaching Learning Collaborative	*Initiative Outcome:* Early Implementers inform policy decisions at the state level
Increase opportunities for student learning	Expect teacher leaders to embrace and use NGSS shifts	*Ultimate Impact*: Positive science education for all K–8 students in Early Implementer districts
Build a community of learners to share best practices within the state and nationally	Convene participants regularly to develop a community of practice; Reach non-Early Implementers through presentations, policy briefs, and networks	*Ultimate Impact*: Positive science education for all K–8 students in California districts

The aspects of professional learning mentioned in this report are meant to show the variety of approaches these nine districts have taken. This collection of strategies is not meant to imply that particular approaches are better than others. Districts using this resource should consider what aspects of these approaches make sense for their context and should consult existing research on what works in professional learning.

Relevant research regarding what works in professional learning is referenced throughout this document, including the Council of State Science Supervisors' *Science Professional Learning Standards*; National Research Council's *Science Teachers' Learning Enhancing Opportunities, Creating Supportive Contexts;* the *Guide to Implementing the Next Generation Science Standards; America's Teachers on Teaching in an Era of Change: Teachers on the Common Core,* High Hopes, Few Opportunities (Full Report): The Status of Elementary Science Education in California and the *Next Generation Science Standards District Implementation Indicators*.

Formats and audiences for professional learning

Professional learning is an essential part of any education system, and it is even more crucial when a district or state is beginning to implement new educational standards that are very different in content and format from previous standards. Each of the nine Early Implementer districts in this study was faced with the task of shifting its existing professional learning programs or creating new ones to support the educators in the district. Deciding when and how to provide professional learning, and to whom, was a big part of the district's task.

Starting with core lead teachers

As districts began planning to implement the CA NGSS, each of the nine districts had the opportunity to start implementation with a relatively small cohort of core lead teachers (CLTs), which included K–8 teachers and elementary and middle school site/district administrators. Other districts may or may not have this option based on standards adoption and implementation timelines, which vary by state and district. However, almost all of the districts noted their appreciation of the opportunity to start with smaller cohorts of teacher leaders.

> *"If you expect people to teach it, provide professional development on it."*
> Principal

The districts viewed working with a small cohort of leaders as a chance to build capacity by supporting their development not only to teach the NGSS but also to serve as leaders, advocates, and resources as the districts progressed in the implementation of the NGSS. The CLTs were considered part of larger networks of district leadership — along with administrators and district-level representatives — that will provide sustainable expertise on the implementation of the NGSS for years to come. Some districts also strategically added teacher leaders each year to expand this network and increase representation in needed areas. For example, one district cited an effort to have at least one teacher from every elementary and middle school, which required including more teachers than it was able to start with during the first year of implementation. Another district had focus schools where it expanded the network of implementers more quickly.

Additionally, starting with a cohort of leaders was used as an opportunity to test approaches to professional learning for teachers and administrators and to receive feedback on these approaches. One district leader said, "Our approach has been to look at what our early implementing teachers [i.e., CLTs] are doing well and what they feel has been effective and supportive, and then identify what we can share that others can build off of. It's a combination of looking districtwide and asking: How can we continue to [dig into our] work, and what can we simultaneously take to scale? We are constructing the work as we are going and keeping different audiences in mind: [both] early implementers and those new to the NGSS."

One teacher leader reflected on her experience as a part of the team that started implementing the NGSS early: "We [teachers, school administrators, and district leaders] are all learners in this. We need to try things over and over again, and it will take a while to get. And I know there is still so much more to know. It's been uncomfortable but also comfortable." From the same district, the science supervisor said, "We stumbled through things, but we had the luxury of time and a team of teacher leaders to provide feedback." The science supervisor in another district reported, "We are learning as we are implementing. You realize some of what you did was a waste of time, and we had to trash some of our work and start over. Now that we see the transformation of what science will be — it's no longer we tell them, they validate, we test — I think we will explain [the NGSS] differently now that we have been a part of it."

A district science lead from another district said, "We started our first year looking at ourselves as learners. We started with, 'what do we know, what are our strengths, and how can we build on them.' We want to continue to use this model." While the districts have learned a lot about implementation through working with small cohorts and will be able to use these lessons to make rolling out professional learning to all teachers more effective, it is important to remember that all teachers deserve the opportunity and time to wrestle with the new standards and their implementation. They deserve to start with what they know and their strengths and to build from there, just as those who implemented the standards early did.

And finally, multiple districts noted that working in depth with the CLTs has allowed these teachers to get excited about the NGSS and that this excitement "infects" teachers who are not yet implementing the standards. One district leader reported, "Teachers get excited about the relevancy, engineering, practices … When they do it they love it, and they love that the kids love it."

Rolling out to all teachers

When districts have an opportunity to refine their professional learning through pilots and working with the CLTs, it is important not to forget the time it took the teacher leaders to feel comfortable with using the standards in their classrooms. All teachers will need time even if professional learning and resources are more available and refined than they were for the original cohort of implementing teachers. As noted in the *Guide to Implementing the Next Generation Science Standards*, "Teachers need time to practice, and they need ongoing reinforcement to support the effort it takes to change both their own teaching practice and their classroom culture. It takes sustained effort and ongoing learning and reflection for any teacher to achieve facility and flexibility in implementing a new approach to instruction."

> *"I love NGSS! I think science is one of the best ways to get kids interested in education; they are interested in what is happening in their world. They have questions and want to speak and read and write about science. It is an equal playing field because everyone has something to learn about how to communicate in science — we are all learners together. Kids are naturally interested and engage; they want to understand. It's a powerful part of the day; the more I can integrate science the better the learning goes."*
>
> Educator

The nine districts varied significantly in how much they have planned for the rollout of professional learning for all teachers. This variation largely seems to be based on when they expect all teachers to be implementing the NGSS. However, despite where they were in their planning, the districts acknowledged the importance of

professional learning for *all* teachers. As one principal said, "You must give it to everyone. If you expect people to teach it, provide professional learning on it." Districts acknowledged that they should be planning for a coherent system for all teachers to receive robust professional learning and that it is not sufficient to expect educators to teach themselves about the NGSS. And while they saw their teacher leaders as experts who could serve as resources to other teachers, they did not feel that simply having this expertise on campuses was sufficient support for teachers new to the standards. Robust professional learning was still seen as necessary.

As an example of teacher needs during a recent standards transition, teachers were asked about the Common Core State Standards (CCSS) in 2013 and 2014 in the for the report, *America's Teachers on Teaching in an Era of Change: Teachers on the Common Core*. In 2014, even as teachers reported having more experience with the CCSS and feeling more enthusiastic about them than in 2013, the amount of teachers reporting that implementation was challenging increased. After instructional materials, the top supports and resources teachers identified needing were quality professional learning (84 percent of teachers surveyed reported this as a need), additional planning time (78 percent), and opportunities to collaborate with other teachers (78 percent). Many in the field expect the same needs for implementation of the NGSS.

Multiple districts also mentioned the importance of planning not only for the content and structure of the professional learning opportunities for all teachers but also for the necessary logistics and funding required to provide professional learning to everyone. Two districts stated that they had worked hard to find the funding to create a new district-level position to help lead the work of implementing the NGSS. In terms of logistics, districts and schools said finding time, substitutes, and space for professional learning can be quite challenging given the numerous initiatives happening in districts and schools. One district-level science supervisor reported working with the math supervisor coordinating logistics and timelines for a variety of initiatives, saying, "This helps not only with the logistics — subs, bigger timelines, etc. — but also keeps shifts manageable for teachers. And [professional learning] isn't sending different messages by subject; participants are getting a coherent message about priorities and delivery of instruction." In terms of funding, districts noted the importance of being flexible and creative with funding, including strategies such as (1) shifting funds to support professional learning (e.g., since a district was not ready to purchase instructional materials, it shifted funds for instructional materials to be used for professional learning in which teachers developed transition materials); (2) having professional learning sponsored by local businesses and organizations invested in supporting science education; and (3) trying to take advantage of existing, local resources (e.g., available space and expertise from scientists, engineers, or individuals who work with informal science education organizations).

While providing high quality professional learning for all teachers can be incredibly challenging given these very real constraints, it is critical for teachers to feel prepared and supported for the successful implementation of the NGSS.

Including administrators within the district

As described in *Science Teachers' Learning Enhancing Opportunities, Creating Supportive Contexts:*

> Administrative leadership and access to colleagues are important characteristics of the school context that shape teachers' learning opportunities. The significance of administrative leadership and support is

> a common refrain in the research on policy implementation and school reform (e.g., Bryk et al., 2010; Sykes and Wilson, in press). In the most recent national survey conducted by Horizon Research, the principal's support was the factor in promoting effective science instruction cited most frequently by both middle school (Weis, 2013) and high school (Banilower et al., 2013) teachers, and was the second most important factor (after students' motivation, interest, and effort) cited by elementary teachers (Trygstad, 2013).

The nine districts in this study agreed on the essential role of administrative support for science. However, they varied in their approach to including administrators in professional learning. Some districts reported that they have:

- Invited administrators to trainings designed for teachers but had few school administrators come, did not have administrators come consistently, or had them come for only part of the session;
- Asked their school administrators to "figure out the NGSS" and contact their teacher leaders when they have questions on "why the teacher leader is doing what they are doing";
- Provided general communication about the NGSS at school administrator meetings; or
- Provided one-day trainings on the NGSS because the school leaders will need to observe NGSS instruction this year.

As a district leader in one of these districts stated, "A few [school administrators] are proactive, but they have a lot on their plate, too!"

However, most districts strongly emphasized providing professional learning for administrators, especially as administrators are seen as instructional leaders. One district leader emphasized the importance of educating administrators, saying, "If a leader doesn't have a vision and isn't championing it [the NGSS], it isn't going to happen. School-level leadership will move the work forward much more than at the district level. It's a high leverage, important investment to bring your administrators along." Later, the same district leader said, "If [administrators] are not in the loop it could be really easy to make good implementation harder or impossible for teachers."

Another district leader said, "Principal development has been important — in terms of communications, advocacy, and getting resources."

In addition to providing NGSS professional learning for school leaders, some districts have also provided learning experiences for cabinet members, school board members, district leadership for other subjects, and other stakeholders within the district they felt would benefit from a deeper knowledge of the NGSS or would be important allies for the NGSS. Different stakeholders having at least a foundation level of understanding of the NGSS is important since they might be called on to advocate for the resources necessary to implement the standards, coordinate efforts across initiatives and disciplines, or simply know what is being asked of teachers as the district transitions to the NGSS.

Formats

In addition to the strategies and activities of the core program, a variety of formats of professional learning were used both within and across districts. Large meetings such as cluster meetings (elementary, middle, and high schools that feed together) or whole-school or district meetings were used, especially for professional learning intended to be introductory in nature. Some districts also noted having breakout sessions that were either required or optional during such large meetings.

Some districts mentioned summer institutes that ranged from two to five days and targeted different audiences (e.g., teachers only, administrators only, teachers and administrators). One district has one Monday every month slated for professional learning, and it provides a variety of professional learning options on those days. This approach highlights something many districts valued, which was having multiple opportunities for professional learning throughout the year as opposed to only a single learning opportunity during the summer or school year.

Multiple districts noted the importance of grade-level specific professional learning. One district said that this approach allowed it to focus on elements of the science and engineering practices and crosscutting concepts that are specific to each grade band (e.g., developing and using models to make sense of observed patterns in 2nd grade) and to focus on disciplinary core ideas with which students will engage in classrooms. “This is the ticket to making it relevant,” according to one district science lead. Another district science lead had a few 2nd grade teachers who offered to train other 2nd grade teachers on a lesson sequence they had been working on. Participants could learn about and then try out the lesson sequence in their classrooms. He noted that the training was well attended and liked and that they hoped to use this as approach as a model for grade-level and science-discipline specific professional learning in the future.

One of the most mentioned formats for professional learning was using Professional Learning Communities (PLCs) — defined for the purpose of this document as groups of teachers who had regular, structured time to meet and work together — as an opportunity to focus on NGSS implementation. One of the strengths of PLCs mentioned was that they provided a consistent time throughout the year that could be used in a variety of ways to meet the needs of teachers. Teacher leaders can share what they have already been learning, teachers can co-facilitate each other as they learn together, and teachers can invite district or outside experts to join them and provide specific supports during this time. However, it should not be assumed that simply providing a time for teachers to meet will be sufficient for an effective PLC. Other structures and supports may be necessary, such as protocols on how to engage in the PLC. Protocols like these were developed by the CLTs.

One district leader said, “There is so little time for teachers to get together, but that is what they really need. Teachers really need sustained time to get into the NGSS, work with it, process it, get their hands dirty … We are really going to try to find time for them.” If PLCs are used for all content areas, educators may need to request PLC time for science specifically.

Content and design of teacher professional learning

With standards as different as the NGSS, format and scope are not the only considerations for professional learning programs. The content also needs to change dramatically. Though the content and design of professional learning varied across districts, some patterns emerged.

NGSS basics

Many districts mentioned the need to include the NGSS introductory basics in their professional learning programs. However, districts used different approaches to the timing of introducing the NGSS during professional learning. Some districts included the NGSS basics as the first thing in professional learning to ensure that participants felt familiar with the basics before moving on to other professional learning experiences like engaging in three-dimensional learning. Other districts focused on having educators jump into three-dimensional learning experiences early in professional learning and inserted NGSS basics throughout the learning experience, on an as-needed basis. Regardless of the sequence, most districts included the following NGSS basics in professional learning:

- The need for the NGSS;
- The vision of the NGSS;
- The architecture of the NGSS;
- How to read the NGSS;
- What each of the three dimensions are and what they mean (one district noted the importance of not using unnecessary jargon or "acronyms at first or for a long time");
- What three-dimensional learning is; and
- What phenomena are and how trying to explain phenomena can be used to drive learning.

One district noted that differentiating professional learning will be important for those who are new to the NGSS and those who have already been implementing them. The district emphasized that sitting in a professional learning about the basics of the NGSS is not a good use of participants' time if they have been implementing the NGSS for an extended period, nor is providing learning experiences that are misaligned to participant needs a good use of limited district resources. However, it is important to recognize that not all teachers will know something about the NGSS even after many years of district implementation since new teachers join districts every year. Professional learning that includes these basics will remain necessary for some educators.

Lesson study: The Teaching Learning Collaborative

The most mentioned and emphasized professional learning design across the districts was the Teaching Learning Collaborative (TLC) or lesson study. Lesson studies included different aspects in each district, but they all consisted of a group of teachers and a facilitator creating a learning sequence, studying an extant lesson, and/or modifying a lesson. As one district leader said, "Dealing with standards in the abstract is not helpful; lesson study makes the most sense [for professional learning]." A leader from another district said, "The best bang for the

buck is lesson study." He added that, while it could be "resource consuming" due to the time it takes for a group of teachers to engage in a lesson study, it was worth expending the resources.

One advantage of TLC is that it provides an opportunity to focus on specific issues within lessons that are important to the implementation of the NGSS. One district leader said, "We use the lesson study model to discuss equitable access to science and integration with other subjects." When considering what features to look for within a lesson, districts used the 5E Instructional Model as well as the Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric for Lessons & Units: Science as a starting place to identify criteria. Collectively determining criteria for lesson study will allow teachers to have a common understanding of progressions and what to look for, which should make conversations more productive and increase buy-in. The

> *"Research dating back decades shows that gains in schools' academic performance and teachers' successful implementation of new curriculum or instructional practices are furthered by a collaborative and improvement-oriented culture (e.g., Bryk et al., 2010; Little, 1982; McLaughlin and Talbert, 2001, 2006; Stein and D'Amico, 2002). Yet science and mathematics teachers generally lack opportunities to observe their colleagues teaching (Smith et al., 2002). Peer observation has never been a frequent and systematic phenomenon in U.S. schools, even though it has been found to spur teacher learning and innovation (Little, 1982; Little et al., 1987). In 1993, only 11 percent of teachers in grades 1-4 and 5-8 reported regularly observing their colleagues teaching classes; by 2000, that percentage had fallen to 4 percent for grades 1-4 and 5 percent for grades 5-8 (Smith et al., 2002). Only one in four teachers had time during the week to collaborate with colleagues in their school, and even these discussions were not devoted to decisions about curriculum (Banilower et al., 2013, p. 120)."*
>
> Science Teachers' Learning Enhancing Opportunities, Creating Supportive Contexts, p. 108

districts began with a stated TLC structure as defined by the Early Implementation Initiative and then explored their own. The TLC model consists of a two-day professional learning approach, during which a team of four teachers works with a facilitator to plan a learning sequence to be taught on the second day. The planning day uses a phenomenon-based conceptual flow, the 5E Instructional Model, and three-dimensional teacher questions or prompts with accompanying Expected Student Responses. The teaching day involves collaborative teaching by all members of the team, debriefing and adjusting the learning sequence, looking at student work to inform instruction, re-teaching, and final debriefing.

From the TLC model, three variations emerged across districts for the structure of lesson studies:

- Model 1: The team starts with two days to create a learning sequence together, making sure to include a means of gathering evidence of student learning. The means for gathering evidence could be a variety of things, including written explanations, models, or a description of how the students plan to collect and analyze data. The teachers then teach the lesson to their classes. After teaching the lesson, teachers analyze the artifacts that the students have created to understand what the students have learned. This analysis informs the teachers' discussion about their instruction and the instructional materials — or lesson — they created. They then collectively make modifications to the lesson, reteach it to a different class, and analyze it once again.

- Model 2: Teachers in one district all use a particular lesson structure. Those leading the lesson study feel that continuing to use that same lesson structure as they transition to the NGSS is important so that the lesson study is connecting to something teachers are familiar with and already doing, thus making the transition more accessible and manageable. Therefore, they choose an existing lesson that already is in this structure or can easily be put into the structure. Teachers then analyze the content of the lesson to identify how it aligns to the NGSS and how it does not. Identifying these misalignments informs the teachers as they make modifications to the lesson so that it will be more aligned with the NGSS but still in a structure they are comfortable with.
- Model 3: The team members collectively select a lesson they have previously taught, which often includes making modifications to the lesson so that it better aligns with the NGSS. The teachers then visit one another's classroom to observe the lesson in action, including what the teacher is doing and what the students are doing. After teachers have had the opportunity to teach the lesson and observe other classrooms, they then discuss what they saw and look at student work to reflect on their own instruction, the lesson they used, and the questions they asked.

Other lesson-focused approaches

In addition to TLCs, schools provided other professional learning opportunities that focused on lessons:

- In one district, coaches taught the lesson for teachers before school, and then teachers engaged students in the lesson while the coach observed. Then the coach and teacher met to discuss instruction and the lesson.
- In another district, a few lead teachers offered training to other teachers in their grade on a lesson sequence that they could then use in their own classrooms.
- Some districts have had their teachers and district leaders work together to create lessons. This approach differs from lesson study because teachers did not necessarily observe each other teaching the lessons, analyze student data together, or make modifications to the lesson based on implementing it.
- One district that has modified its existing elementary curriculum paid teachers to attend meetings to learn more about the curriculum and why and how changes were made.

> *"Designing a quality set of curriculum resources for a new course or course sequence is a demanding multiyear, multi-expert team process. In designing, development teams need to include experts in science, science learning, assessment design, equity and diversity, and science teaching, each at the appropriate grade level (National Research Council, 2014a)."*
>
> Guide to Implementing the Next Generation Science Standards, p. 55

Engaging in three-dimensional learning

Many districts also focused on the importance of engaging professional learning participants in three-dimensional learning with one saying that it is "a non-negotiable part of this work." They stated the need for participants to experience three-dimensional learning so that they could (1) get excited about it, (2) see what it looked like, (3) believe that it was possible, and (4) feel more prepared to provide three-dimensional learning experiences for their students. One district said it likes to reflect on this learning by posing the question, "Who is carrying the cognitive load?" This question implies that it is the student who should be engaging in the three-dimensional learning and making meaning as opposed to the educator doing this work.

Another district reported that it used a task similar to that in The Economically Disadvantaged Students Case Study in Appendix D of the NGSS, which describes a 9th grade chemistry class that is challenged to explain the phenomenon of a railroad tank car imploding after being washed out with steam and closing the outlet valves. In addition to providing participants with a chance to engage in three-dimensional learning, this approach can have the additional advantages of (1) also being able to analyze how students engage in learning experience and (2) including engineering, which is another aspect of professional learning districts noted was important.

Conceptual flow, standards mapping, and bundling

While all districts received professional learning on developing conceptual flows through the Early Implementation Initiative, one district in particular did a lot of work on creating and using its conceptual flows to guide an entire project. A conceptual flow is both a process and a product: It begins with a phenomenon and the important science concepts students need to understand the phenomenon, and then the big ideas of science are nested in a concept map format, with disciplinary core ideas, science and engineering practices, and crosscutting concepts identified and aligned to the teachers' ideas. Teachers then use the conceptual flow to identify standards they want to address through classroom projects, laying out the entire project from beginning to end. This approach of focusing on coherence and storylines within units and lessons is intended to give students opportunities to explain phenomena and design solutions to problems. One district shared that its teachers "would like phenomena that can be investigated for a significant portion of the school year [e.g., using an anchor phenomenon for an entire unit]; this will require a large transformation," as students currently engage only in relatively short investigations.

Additionally, ensuring coherence across grades or courses so that districts have a common understanding of which performance expectations are to be addressed in which grades or courses in middle school and high school is important because the standards are organized by grade band at these levels. All of the Early Implementer districts committed to using the preferred Integrated Learning Progression Model for grades 6–8, but if a district does not yet have standards organized into grades or courses, mapping the standards could be a valuable professional learning opportunity for educators. More on Model Course Mapping can be found in Appendix K of the NGSS.

Finally, in terms of coherence throughout the grade or course, districts could provide professional learning opportunities in which educators bundle standards into units within the grade level. This approach will ensure that all standards are not only covered within a grade but also organized in a logical and efficient way that lends itself to engaging students in the work of explaining phenomena and designing solutions to problems.[2]

Focusing on a limited number of practices and crosscutting concepts

Multiple districts said that they started implementation and professional learning with a focus on science and engineering practices and crosscutting concepts. For example, one district said it "only focused on modeling for a long time before we moved on." The district felt that learning the other practices would be faster after such a

[2] More information about standards bundling and example bundles can be found at www.nextgenscience.org/resources/bundling-ngss.

deep focus on one practice. Likewise, districts chose a focus crosscutting concept and looked at phenomena they used during the year through the lens of that crosscutting concept, reflecting on how to bring explicit learning about crosscutting concepts into their classrooms along with practices and core ideas. One district said it liked this approach of "incremental change so that people won't be overwhelmed."

Addressing problems of practice identified by schools and teams

Two district science leaders had teams of teachers or schools identify "problems of practice" — particular issues in the practice of implementing the NGSS — to focus on for six weeks or so. Problems of practice might include how to support students as they learn to develop arguments with evidence, how to choose phenomena that will be engaging to diverse learners and drive a lesson, or how to authentically and meaningfully incorporate NGSS-aligned engineering. Teams of teachers or schools then focused on the identified issue in meetings, tried different approaches to addressing the issues in classrooms, and collectively reflected on their approaches. Additionally, by having teams of teachers or schools identify areas of need, school and district leaders could better target their support and resources to these more specific and stated needs as opposed to providing general support that may not be seen as necessary to teachers.

Discussing case studies

One district has used the NGSS Appendix D Case Studies resource to be able to have concrete examples of what the NGSS look like in a variety of classrooms. The district compared science instruction illustrated in the case studies with traditional science instruction. This approach allows for discussion of the shifts of the NGSS, issues of equity, and the roles of the student and teacher in an NGSS classroom.

Looking at student work and evidence of student learning

While every TLC looked at student work, a few districts highlighted looking at student work in particular in their professional learning. One said that in professional learning, participants "discuss ways to assess student understanding through daily work," and teachers ask themselves, "What does this student work tell us about the students and about what we need to be doing? What is the evidence of student learning?"

> *"Children rarely encounter high-quality science learning opportunities … because the conditions that would support them are rarely in place."*
>
> High Hopes, Few Opportunities (Full Report): The Status of Elementary Science Education in California, p. 21

Another district has been focusing on strategically using student science notebooks as a learning and assessment tool, allowing students to use them to express ideas and make sense of science concepts. The district's process using notebooks emphasized the importance of looking at all students' notebooks, as opposed to just a selection, and the need for having a protocol in place to do this review. Two other district representatives mentioned notebooks in relationship to evidence of student learning. One said, "There is no need for check-in points [i.e., summative assessments] because students are always showing what they know as they work to explain a phenomenon."

And a teacher from a yet another district said, "Student work is very different [with the NGSS]; students are writing a lot. We wanted to write before, but it was not very authentic. Now it is because they have lots of ideas to capture and update with evidence. I just want to elicit where they are with their understanding so I can know where to go. I don't have an expectation. It is a lot messier and more organic where it used to be linear. There are a lot [fewer] handouts, and instead they are recording how they are understanding. It creates a record of how their understanding changes. Models can also be included in journals. Students need to include revisions and describe how what they thought was true is not true. We are using notebooking as sense-making in their own way; they get to show understanding in a way that makes sense to them. It takes scaffolding, but it is a lot less cookie cutter."[3]

Subject matter integration

One district science lead said she found that "people are excited and more likely to show up [to professional learning] if topics are about how to integrate [the NGSS] with learning to read [and other content areas]." Another district lead said "Integration — it's really the key to get doors open for NGSS." A teacher from another district reported that she tried to make strong connection to English language arts (ELA) through notebooking. She said that this was one of the district's main focuses for implementation and that her classroom was spending a long time on notebooking and trying to learn to do it well. However, one district cautioned that science should not simply become an "add-on to ELA"— that while science and ELA can be integrated, science requires engaging in a variety of practices, some that overlap with ELA but others that do not.

And as noted previously, one district science supervisor said that he started working more closely with the math supervisor in his district. This work was mostly focused on logistics and messaging, but they could also jointly plan and deliver professional learning. The NGSS Classroom Sample Tasks may be a helpful resource in thinking about integrating across subject areas.

Building teacher expertise in the disciplinary core ideas

A couple of districts noted the importance of providing support for deepening understanding of disciplinary core ideas during professional learning, especially for anyone new to particular disciplines (e.g., middle school teachers who have only ever taught one science discipline and are now being asked to teach multiple). The districts have had scientists and professors come work with teachers to help provide a deep understanding of the disciplinary content. However, they caution that having a disciplinary core idea focus in particular professional learning experiences does not imply that teachers should teach the disciplinary core idea in isolation. Learning experiences should allow engagement with the disciplinary core ideas in concert with engagement in the practices and crosscutting concepts. This need for engagement is true for both teacher professional learning and for student classroom experiences. Professional learning should support teachers in their abilities to create these three-dimensional learning opportunities for students.

[3] Additional resources for evidence of student learning can be found on www.nextgenscience.org including the Video: NGSS EQuIP Rubric: Evidence of Student Learning and Evidence Statements.

Equity

Many districts described a focus on equity in terms of policies that ensure that all students get instruction in science. Additionally, equity is included within other aspects of professional learning (e.g., focusing on equity through a lesson study, thinking about equity within the basics of the NGSS such as how it relates to the vision of the standards and explaining phenomena). Oakland Unified School District made an explicit effort to include equity throughout professional learning. Incorporating equity in professional learning can help identify concrete strategies to use in NGSS implementation.

A Focus on Equity in Oakland Unified School District

By Laura Prival

In response to the research that shows disproportionality in access to high quality science learning opportunities in school, our district-level science department engaged in a year-long exploration of equity as we began our implementation of the Next Generation Science Standards (NGSS). We started by looking at our own personal histories and then spent time learning about and discussing institutional racism and implicit bias. Our team then formed working groups, each focusing on one of the following: professional development, curriculum, 5th–6th grade transition, or science notebooks, all through the lens of equity.

We spent time defining what equity means in the context of science teaching and learning. The following are seven attributes of high quality science education that drive the work in Oakland Unified School District (OUSD) because we believe these attributes will go a long way toward teaching science in equitable ways:

- Hands-on, collaborative science;
- Relevant and engaging content;
- Attention to language demands;
- Appropriate and flexible scaffolds;
- High expectations, including meaning making by students;
- Frequent formative assessment and next steps; and
- An equity mindset among educators.

These attributes reflect both high quality science teaching and learning and principles of equity pedagogy, such as culturally relevant pedagogy and culturally responsive teaching. Science is sometimes discussed as if it is culture free, and we rarely see equity pedagogy addressed as a core piece of science teacher education. However, upon closer examination, we find overlap between high quality science education and equity pedagogy, especially as we look toward the shifts necessary for the NGSS. For example, both areas of work call for students to construct knowledge from experiences rather than memorize facts. Both call for hands-on, collaborative, and relevant experiences.

What does this mean for professional development in OUSD? Here are some specific elements included in professional learning:

- Discuss equity through posing the questions: What is equity? How do we teach science in equitable ways? We continuously come back to these questions throughout our work.
- Analyze the data on underrepresentation of people of color and other groups in science and engineering majors and careers, as well as local data such as Advanced Placement enrollment and scores. We do not dwell on these data exclusively but rather use them to establish urgency.
- Identify institutional reasons for this underrepresentation, including a close look at our own classrooms and access to high quality science learning experiences in school. Also, we seek to understand and respond to the lack of preparation for equitable teaching in science.
- Identify ways with school leaders to establish structures and expectations that enable high quality science learning for all students.
- Examine the relationship between equity and pedagogy by analyzing a given set of equity pedagogy statements within the context of science teaching and learning. Participants can create posters using the statements from the equity pedagogy literature (e.g., students' lives, experiences, and cultures are valued in the curriculum). Each poster includes "What I see" and "What could be" in the science classroom.
- Model and discuss the attributes of high quality science education mentioned above, including what is meant by high expectations, appropriate scaffolding, etc.
- Use simple protocols to analyze formative assessments of all students on a regular basis and ensure that lessons are adapted to respond to results of those assessments.
- Create content language objectives throughout the curriculum. Creating these objectives requires that teachers look closely at the language demands and opportunities in every lesson. This attention to language helps us use the hook of science to accelerate language development as well as deepen understanding of science practices and concepts.
- Strive for relevance by analyzing whether students are able to respond to these questions: Why is this science experience important to me, and how does the science I am learning relate to my life (e.g., home, family, community, and friends)? Why is this important to the world, and how does the science I am learning relate to the real world?

As we have developed trust with teachers and school leaders, we've challenged them to look closely at their classrooms to determine for themselves the extent to which the science education happening is high quality and equitable. Within this assessment, it is crucial to examine who is allowed to participate in science and who is not. We still find that judgments about who can and can't do science are being made in some classrooms, and deficit thinking by adults leads to groups of students being excluded from science instruction. We support teachers and school leaders in analyzing and interrupting the systems that perpetuate this exclusion, in part by asking, "How can we tap into the strengths and assets of all students as well as offer appropriate supports to groups who have been neglected in science such as students of color, English language learners, students living in poverty, and students in special education programs?"

We strive to put equity at the front of our work, not as an add-on or afterthought. This focus is a departure from the way professional development and learning about teaching, especially in science, often happen. More frequently, teachers learn the basic strategy and then, if time permits, talk briefly about differentiation, for example. By placing equity at the front, we have a driver for our work that can help ensure that all students

can experience high quality, meaningful science learning. We want teachers and leaders to recognize that science education is high quality only if it is equitable.

While we have come far in incorporating equity throughout our work in science, we recognize that we still have a long way to go, both here in Oakland and nationally. This is a work in progress for us, and we are constantly learning from our students, colleagues, and experiences.

Content of administrator professional learning

Many of the elements of the professional learning used with teachers were also included in professional learning for administrators. The two main areas of professional learning overlap were the inclusion of the basics of the NGSS and engaging in three-dimensional learning. Districts stated that the goal was for administrators to know what the NGSS look like — what teachers and students would be doing in the classroom.

However, some professional learning topics are necessary for administrators but may not be needed for teachers. For example, some districts provided professional learning in how to lead in an NGSS school and specifically how to be an instructional leader during the transition to the NGSS; what supports teachers should get from the district as well as what additional supports teachers will need from administrators and how to provide them; best practices for rolling out standards implementation; logistics relating to the NGSS, such as scheduling and school events; how to advocate for the NGSS as a school leader; and how to measure progress and success during the transition to the standards.

> *"School administrators who do not understand the nature of the changes required by the NGSS may place demands on teachers, including criteria for evaluating teachers, which undermine implementation of the new strategies needed. It is unrealistic, for example, to assume that each day or two the classroom should move onto a different performance expectation or to assume one-to-one mappings between sequences of lessons and performance expectations."*
>
> Guide to Implementing the Next Generation Science Standards, p. 49

Additionally, four districts mentioned working with their administrators to use observation protocols. For professional learning, administrators in one district practiced using the protocols with video of teachers in NGSS classrooms. One district described the use of the protocol as a "gentle rollout" and said that "it will be a coaching tool and not an evaluative tool; the important piece is in the discussion, and the protocol will support administrators and teachers learning together through these discussions." Teachers reported positively about using the observation protocols in this way and also appreciated knowing how they would be evaluated in the future.

Criteria for selecting or designing professional learning

When districts were asked to reflect on their experiences selecting or creating professional learning programs, some patterns emerged in the criteria that districts value. Districts had not yet determined explicit criteria for the purpose of selecting or creating professional learning programs, although some were beginning this work. However, all the districts had implicit criteria, and they designed particular features into professional learning

or looked for those features when selecting professional learning:

- Professional learning should be sustained over multiple sessions throughout the year and over multiple years.

- Professional learning should be offered to meet a variety of needs based on position and/or experience with the NGSS. It should be designed to increase in cognitive demand over the year and to be accessible to educators with different levels of familiarity with the NGSS. Some professional learning should have the goal of developing classroom-, school-, and district-level leaders.

- Professional learning should include a focus on equity.

- Professional learning should engage participants in three-dimensional learning.

- Professional learning should include concrete tasks such as working on bundling standards, creating conceptual flows, engaging in lesson study, etc. as well as concrete strategies to use in classrooms such as ways to assess student understanding in daily work and ways to meet the diverse needs of students.

- Professional learning should be practical and should raise questions like: "How do we do this in reality? Given our instructional day and resources, how can we reasonably do this and do it well?"

- Professional learning should have the goal of creating a network of educators within and across schools and even across districts. Since the districts had meetings with one another, facilitated by WestEd, they had a chance to share with and learn from each other. As one leader in a district said, "The ideal is to start figuring stuff out in local context and then share across different contexts and reflect together." Districts want to provide that same opportunity to their educators: to be parts of networks that can "cross-pollinate and share ideas, solutions, and best practices, especially when facing similar constraints." As a teacher in another district put it, "Build allies because this work can't be done by yourself; you need people to support the work."

- Professional learning should include time for planning and discussion of priorities and logistics such as timelines and next steps.

- Professional learning should promote the idea of continuous improvement and incremental change, and it should include assurances that teachers are not expected to get implementation right on the first try.
- Professional learning should include extended time and space for teachers "not just to talk together but to really work together."

- Professional learning should include opportunities to reflect, including opportunities to reflect on "how the NGSS are different from what we experienced as students," "having students do the work," and other shifts inherent in the NGSS.

- Professional learning should be designed to complement other initiatives happening in the district and should connect to what teachers are already doing. It should be about "supporting people figuring out [how to implement] in their own context without getting in their way."

- Professional learning should be modified based on feedback. Multiple districts mentioned surveying teachers, both about professional learning and other needs, and using this information to direct their work.

It is important to note that this list of criteria is not exhaustive, and there are existing sources for peer-reviewed criteria, such as the Council of State Science Supervisors' *Science Professional Learning Standards*. Determining criteria for the design of professional learning is an important step to ensuring high quality programs.

Conclusion

The nine districts involved in these interviews have had the opportunity to begin implementing the CA NGSS before many other districts in the state. Implementing early has come with challenges, such as not having well-established, ready-to-use resources and professional learning, but having additional support and a central design to work within gave the districts the time and space to be able try different approaches to professional learning. Hopefully their experiences and reflections captured in these lessons learned will inform other districts as they begin implementing the standards.

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