

Collaborative Lesson Studies

Powerful Professional Learning for Implementing the Next Generation Science Standards

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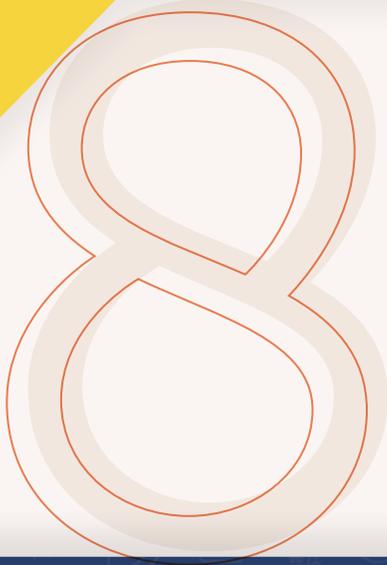
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NGSS Early Implementers Initiative: Bringing science to life as a core subject in K–8 classrooms

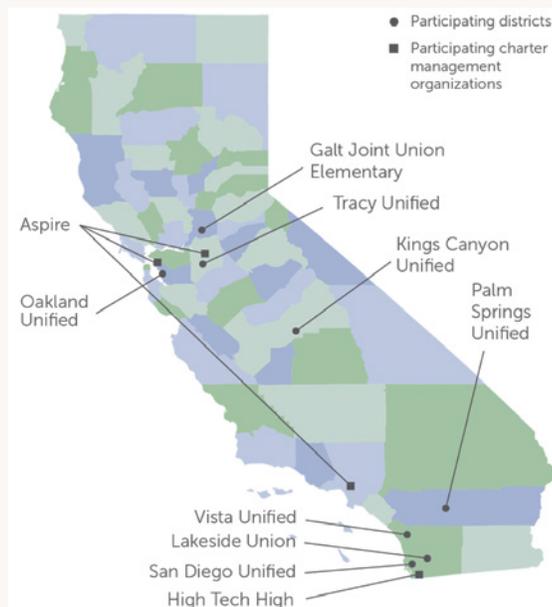
A diverse group of eight California school districts and two charter management organizations is actively implementing the Next Generation Science Standards (NGSS). Their progress, experiences, and lessons can inform others implementing the NGSS. The NGSS Early Implementers are supported by the K–12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

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

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

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

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



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Evaluation of the NGSS Early Implementers Initiative

The S. D. Bechtel, Jr. Foundation has commissioned WestEd's STEM Evaluation Unit to evaluate the NGSS Early Implementers Initiative in the eight participating public school districts. This independent evaluation is advised by a technical working group that includes representatives of the California Department of Education and the State Board of Education. Evaluators investigate three main aspects of the Initiative's NGSS implementation:

- › districts' local implementation,
- › implementation support provided by K–12 Alliance, and
- › the resulting science teaching and leadership growth of teachers and administrators, as well as student outcomes.

In addition to this current Report #8, evaluators previously released:

- › *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)

Executive Summary

This evaluation report describes a central professional learning strategy that the California NGSS Early Implementers Initiative used to help teachers effectively transition to the Next Generation Science Standards (NGSS). The Initiative's approach to lesson study, called a Teaching Learning Collaborative (TLC), brings together teams of teachers who collaboratively plan, teach, critique, and then re-teach NGSS lessons. Trained facilitators ensure that participants feel professionally safe and supported to experiment with the substantial and sometimes daunting instructional shifts required by the NGSS. The especially strong emphasis on active collaboration is why the Initiative uses the term "TLC" rather than the more general, commonly used term "lesson studies."

Initiative leaders chose to focus heavily on TLCs because, while teacher professional learning often takes place outside of the classroom, TLCs, like all lesson studies, provide true hands-on learning in a classroom setting where teachers can grapple with authentic instructional issues.

All NGSS Early Implementer districts followed the same TLC model during Years 1 through 4 of the Initiative. In Year 5, when grant funding began to scale back and professional learning became less centralized, districts made a variety of modifications to TLCs to meet their local needs and circumstances.

This report describes:

- The original TLC model used Initiative-wide in Years 1–4, and its benefits
- District modifications to TLCs in Year 5
- Feedback from participants about what was gained and lost through those modifications

- Recommendations for using TLCs as NGSS professional learning

Like the entire evaluation series for the NGSS Early Implementers Initiative, this report provides useful information to school and district administrators, leaders of science professional learning, and state policymakers. The report is based on an extensive amount of data: evaluators' observation of 27 TLCs; responses from a dozen surveys; and over 100 interviews with teachers, administrators, district Project Directors, and K–12 Alliance Regional Directors.

TLCs in Practice

The TLCs of Years 1 to 4

Every fall and spring during the first four years of the Initiative, TLC teams of three to four grade-level teachers, drawn from different schools in their districts, convened for a lesson planning day and then, one to three weeks later, a teaching day. During the planning day, a facilitator led the team through a process of developing a lesson to be collaboratively taught by the team during a single class period. During the teaching day, the team co-taught the lesson to students and immediately afterward examined student work to debrief the lesson's effectiveness in advancing student understanding. The team then made revisions to improve the lesson, taught it to another class, and held a final debrief that included sharing what they each had learned and would take back to their classrooms. The report includes a detailed vignette of the full planning and teaching days of a grade 6 TLC observed by an evaluator.

Benefits of the Early Implementer TLCs

Evaluation data show that the TLC experience accelerated teachers' enactment of the pedagogical shifts required by the NGSS. More specifically, the TLCs:

- Powerfully engaged teachers in learning, motivating them to want to implement instruction aligned with NGSS
- Gave teachers detailed, grounded insights into what the NGSS standards are — and what it means to implement instruction aligned with these standards
- Enhanced the culture of teaching, learning, and collaboration in school sites and districts

About 80 percent of teachers reported that TLCs deepened their understanding of each of the following core aspects of NGSS “a lot” or “moderately”: science disciplinary core ideas (DCIs), science and engineering practices (SEPs), cross-cutting concepts (CCCs), and how to use these three dimensions to help students understand a phenomenon. Further, TLCs also helped the many administrators who took advantage of an open invitation to observe. For example, when asked in a survey, “During the 2017–18 school year, how much of an impact did the following have on your understanding of NGSS?”, 41 percent of principals reported that observing a TLC teaching day had “A great deal” of impact, and 32 percent said it had “Some” impact.

Modified TLCs in Year 5

The largest section of the report presents the variety of modifications made by districts to TLCs when Early Implementer grant funding decreased (per the Initiative budget schedule) in Year 5. In most districts, there was a need to reduce release time for teachers and reliance on substitutes. Further, districts in Year 5 aimed to expand professional learning to a much larger number of teachers.

All districts retained certain features of the original TLC: a facilitator to shepherd the teams through the TLC process; an emphasis on collaboration and support; and some version of planning, teaching, and debriefing. In all districts, reviewing student work was central to the debrief discussion. Some facilitators provided lessons to the TLC teams or brought suggestions for phenomena or lessons in order to reduce planning time. Most teachers taught the lessons on their own with their own students, bringing student work to the debrief sessions. None of the districts conducted TLCs exactly as they had in Years 1 through 4. According to feedback, the biggest loss in Year 5 was the co-teaching element of the original TLC since it was such a rich learning opportunity. A vignette in the report illustrates one district's use of the TLC to support both NGSS implementation and integration of science and ELA in Year 5.

Lessons Learned

- The steep learning curve to understand and teach the NGSS as intended necessitates intensive professional learning opportunities for teachers, such as the TLCs.
- While TLCs are costly and time-intensive, the needs they meet and the benefits they deliver are high — that is, they require investment that pays dividends.
- Because the instructional changes called for by NGSS can be intimidating (particularly for elementary teachers), strong attention must be paid to the need for a collaborative and nonjudgmental space for teachers to try new things.
- The real payoff of bringing teachers together for lesson planning will not happen unless participants also come together to teach, then debrief, the lessons.
- With new instructional materials for science available for adoption, it may be tempting to assume that the need for professional learning is reduced, but administrators and teachers should not expect new curricula to stand in for professional learning.

Introduction

This report, the eighth in a series of evaluation reports about the NGSS Early Implementer Initiative, describes how the Initiative's deep and extensive use of lesson studies has yielded widespread, powerful NGSS professional learning. The Initiative's lesson studies are called Teaching Learning Collaboratives, hereafter referred to as TLCs (DiRanna, Topps, Cerwin, & Gomez-Zwiep, 2009). TLCs held during the school year have been one of the two strategies that compose the lion's share of the Initiative's professional learning efforts, the other being Summer Institutes.¹ The Initiative chose to focus this heavily on TLCs because, while most professional learning for teachers takes place outside of the classroom, TLCs, like all lesson studies, provide true hands-on learning in the classroom setting where teachers grapple with instructional issues. Indeed, researchers have found that the most effective professional development for teachers is that which occurs closest to the classroom (Cohen & Hill, 1998; Grossman et al, 2009; Putnam & Borko, 2000).

TLCs establish intimate teams of Early Implementer teachers who come together to plan, teach, critique, and reteach an NGSS lesson. The experience accelerates teachers' enactment of the pedagogical shifts required by the NGSS. Specifically, evaluators learned from Initiative participants as well as their own direct observations that the TLCs:

"Just going to professional development is not the same as writing and implementing a lesson with a team." [Middle school principal]

- Powerfully engaged teachers in learning and motivated them to want to implement NGSS
- Gave teachers detailed, grounded insights into what the NGSS standards are and what implementing them means
- Enhanced the culture of teaching, learning, and collaboration in school sites and districts

During Years 1 to 4, all of the Initiative's Teacher Leaders² had two rounds of TLCs per year. The TLCs in Years 1 to 4 were mostly designed and executed in similar ways under the direction and facilitation of Initiative leaders. Beginning in Year 5, as Initiative grant funding was reduced, each district adapted the TLC model to best meet its circumstances and goals.

This report addresses the following questions:

- What are the benefits and challenges of TLCs?
- What was the Initiative-wide configuration of TLCs in Years 1 to 4?
- How did Early Implementer districts modify the original lesson study configuration in Year 5?

1 The Summer Institutes were weeklong professional learning events that kicked off each year of the Initiative. (See Glossary for a full definition of this and other specialized terms associated with the Initiative.)

2 All teachers participating in the Early Implementers Initiative received professional learning in leadership and were referred to as Teacher Leaders. (See Glossary for a full definition of this and other specialized terms associated with the Initiative.)

- What gains and losses have participants attributed to the different lesson study adaptations in Year 5, compared to the Year 1 to 4 model?
- What are the most important ways administrators can support implementation of lesson studies?

Like the entire evaluation series for the NGSS Early Implementers Initiative, this report aims to be useful to school and district administrators, leaders of science professional learning, and state policymakers by sharing the Initiative’s learnings in understandable and replicable ways — and through that, to help inform those leaders’ own policy, practice, and resource-allocation decisions. As described in Appendix A, this report’s findings are based on an extensive amount of data: evaluators’ observation of 27 TLCs; data from a dozen surveys; and over 100 interviews with teachers, administrators, district Project Directors, and K–12 Alliance Regional Directors.

The Teaching Learning Collaborative: The Early Implementer Lesson Study

What is the Initiative’s Teaching Learning Collaborative and where did the model come from? By the time staff from WestEd’s K–12 Alliance started planning the Early Implementers Initiative in 2012, they had spent almost 20 years facilitating their own type of lesson study with teachers of science. Beginning in 1995, when they discovered that many teachers were not implementing changes they had learned during summer professional learning, the K–12 Alliance team developed

a classroom-based activity — informed by what they knew was successful in coaching models — to reinforce participants’ summer professional learning. They called the strategy the Teaching Learning Collaborative, or TLC. This model particularly emphasizes the importance and value of building communities of practice around the improvement of teaching and learning (Lave & Wenger, 2001).

TLCs were a cornerstone professional learning activity for all Teacher Leaders participating in the first four years of the Initiative (Tyler & DiRanna, 2018). Beginning in Year 5, when professional learning became less centralized, districts implemented modifications of TLCs that will be described later in this report.

In the Initiative’s TLCs, a team typically comprised three to four grade-specific teachers from different schools in the district who met with a trained facilitator for two full school days. The first day is spent planning a lesson that will be taught by the team one to three weeks later, on the second day they meet.

- **Day one:** The **lesson planning** session begins with a brainstorm of what a student would need to understand in order to be able to explain a chosen phenomenon. The team then creates a “storyline” (aka “conceptual flow”) showing the flow of concepts in an order that would make sense for students to learn them. From there, the group zeros in on a chunk of the storyline that will be the focus of the lesson. Using a template based on the 5E instructional model,³ the team records specific teacher actions along with expected student responses and target concepts for each “E” stage (i.e., Engage, Explore, Explain, Elaborate/Extend, Evaluate).

³ 5E is an instructional model that is valuable for NGSS instruction because it prompts the instructor(s) to plan a student-centered, inquiry-based lesson based on how people learn (National Research Council, 2000). See Appendix B for a brief explanation of the 5E instructional model. For a more detailed description, see special evaluation report *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/>

- **Day two:** In the **teaching** session, participants co-teach the lesson twice with two different classes or groups of students while the facilitator records student and teacher actions. Between the teachings, the team considers evidence, including the facilitator notes and student work generated during the lesson (Darling-Hammond, 1998), as they revise the lesson for the second teaching. The teaching day concludes with a final debrief where evidence from the second lesson is discussed to evaluate the effectiveness of the revisions made to the first lesson. Participants reflect on what they learned from the experience and how they might use the lesson in their regular instruction.

Teachers often find TLCs to be a powerful professional learning strategy because they are:

- **Facilitated:** Trained leaders help the teams progress through the steps. The careful notes they take during the lesson provide useful evidence when evaluating the effectiveness of the lesson.
- **Collaborative:** Teachers find it easier to take risks in a safe space with others, and they find value in hearing one another's questions and ideas. This is particularly the case in the debrief, during which teachers review student work and use that evidence to evaluate the lesson.
- **Based in a real classroom:** Unlike most teacher professional learning, TLCs allow teachers to experience what it looks and feels like to practice new pedagogy in the classroom.

Most Critical Supports from Administrators

Early Implementer leaders discovered even at the outset of the Initiative in Year 1 just how important principal and central office administrator support was to successful NGSS implementation.

“As an administrator, I’m there to encourage teachers as they are taking new steps forward.”
[Elementary school principal]

As TLCs require teachers to be out of their classrooms for two full school days, the TLCs could not have taken place without critical supports from site and district administrators. In particular, administrators provided the following commitments and resources to make the TLCs a successful cornerstone of the Initiative.

Making science a core subject. When applying to join the Initiative, districts agreed to make science a core subject. Several districts established a minimum number of minutes of science instruction per week in elementary schools and prioritized science in districtwide professional learning. All districts allowed participating teachers to be released from class for four TLC days per year and made arrangements for substitute teachers available to cover their classes during that time.

Providing release time and funding. In order to participate in two TLCs each school year, teachers had to miss four full days with their students. While the Initiative grant provided funding to cover the costs of teachers participating in the TLCs, districts still had to find ways to execute release time and arrange and pay for the substitutes. Project Directors worked to participate in Local Control and Accountability Plan (LCAP) meetings, with those in smaller districts often having better success. In districts where they succeeded, Early Implementers enjoyed reliable funding for substitute teachers as well as supplies for NGSS lessons. For the most part, all eight districts did what was needed for Teacher Leaders to participate in their two TLCs during each of the first four years of the Initiative. Nonetheless, Project Directors in some of the districts where

NGSS implementation was not included in the LCAP found themselves having to continually make their case for district resources, especially substitute teachers.

Support from principals. In order to participate in TLCs, teachers must have the active and consistent approval of their principals. This was relatively easy to obtain when arrangements were negotiated months in advance. However, it sometimes took dedicated principal support to help protect a teacher's TLC attendance in the face of a conflict or last-minute issue. Although uncommon, it was not unheard of for a teacher to be called back to school after a TLC day had begun because his or her substitute teacher was needed for a "more important" purpose. For most teachers in this circumstance, there was no make-up TLC session.

In interviews, teachers and administrators reported that principals became more supportive

"[When I attended the TLC] I just sat with my teachers. We had already started the school year and we had already told them that they needed to have X amount of minutes per week of science. So, they were a little apprehensive in the beginning. But [after the TLC], they felt more comfortable with [teaching the NGSS], and so I felt like I was able to help support them and have their back in that process." [K-8 principal]

of teachers' participation in TLCs as the principals' understanding of the NGSS and the shifts required to teach them grew. By Year 3 of the Initiative, many site administrators made time to attend TLC planning and teaching days themselves — even, although less often, at schools other than their own. Even just the principals' presence at a TLC sent a strong message of approval and encouragement to teachers to participate in TLCs and to transition to NGSS instruction.

Benefits of the Early Implementer TLCs

A Vehicle for Teacher Motivation

To begin to implement the NGSS, most teachers must make major changes in their teaching. TLCs provide a safe space for teachers to try out new NGSS instructional practices as a member of a small, supportive team experiencing similar radical shifts in their practice. For elementary teachers, lesson studies provide an additional invaluable opportunity to learn about teaching science and to begin to understand that they need not have mastery of all the scientific content.

In surveys, Teacher Leaders at all grade levels reported feeling more confident about teaching the NGSS after spending two days with their TLC team and TLC facilitator. By having an active role in the planning, teaching, and evaluation of a three-dimensional NGSS lesson, participants realize that they can successfully adopt new NGSS teaching practices.

Teachers were apprehensive about the change in science teaching and required [minimum science instruction] minutes but time with other teachers showed them it was possible and that they had a community to support them. (Elementary school principal)

I like the opportunity it provided for me to collaborate and share/modify/try [NGSS] lessons. This experience really helps me

feel more comfortable with the standards, the process of planning, and the delivery of a 5E lesson sequence. (Third grade teacher)

I have increased my knowledge about lesson planning from our TLCs. I have learned how to revise and make our lesson more explicit both for the teacher as well as the student outcomes. It was a great way to collaborate, disagree with some things, and eventually come to an agreement. All this, done in a safe and welcoming environment, was amazing. (First grade teacher)

For middle school teachers, the NGSS have reallocated content across grades 6, 7, and 8, making it necessary for some to brush up on concepts they have not taught recently, or ever. The group TLC process can help these teachers get on board with this restructured content, as this middle school principal explains:

I've seen a real focus in teachers wanting to plan lessons. [They're] not saying, "Oh, yeah, I used to do this thing before NGSS so I'm still gonna do this thing and I'm gonna call it NGSS."... They're understanding how things have to change and they're excited about it. They want to create new units and new lessons. (Middle school principal)

Table 1. Percentage of survey takers who chose answer choices “Moderately” or “A lot” for survey question, “To what extent did your TLC experiences in this SCHOOL YEAR deepen your understanding of the following aspects of the NGSS?”

Aspect of the NGSS	Percentage choosing “Moderately” or “A lot” in 2015–16	Percentage choosing “Moderately” or “A lot” in 2016–17
Science Disciplinary Core Ideas (DCIs)	84%	84%
How to use a three-dimensional approach to help students understand a phenomenon	78%	78%
How to use Science and Engineering Practices (SEPs) to teach science and engineering	76%	79%
How to use the Crosscutting Concepts (CCCs) to teach science and engineering	78%	81%
How to use the engineering design process to develop student understanding of science and engineering	58%	63%
How to integrate the science disciplines (e.g., physical, earth & space, life) to increase student learning	69%	72%

Source: Retrospective TLC Survey administered to all Teacher Leaders by WestEd in spring 2016 (N=353) and spring 2017 (N=388).

Note: Other answer choices were “Not at all” and “A little.”

Understanding the Standards

In surveys administered at the end of their first and second years of participation in the Initiative, teachers were asked how much their TLC experiences had deepened their understanding of the three dimensions (i.e., science disciplinary core ideas, science and engineering practices, and crosscutting concepts) and other aspects of NGSS. As shown in Table 1, the high percentages

of teachers who reported their understanding was deepened “moderately” or “a lot” by their TLC experience stayed relatively consistent across the two years for all of the NGSS aspects (69–84 percent except for engineering design).

A likely reason that teachers said they gained less understanding about “How to use the engineering design process to develop student understanding of science and engineering” than other NGSS aspects is that engineering was not a component of many TLCs in the early years of the Initiative.⁴

⁴ Because the NGSS require many major shifts, the Initiative decided in early years to place an emphasis on most but not all aspects of the NGSS for elementary-level teachers to avoid overwhelming and deterring teachers’ interest.

Table 2. Percentage of survey takers who chose answer choices “Moderately” or “A lot” for survey question, “To what extent did your TLC experiences empower you to be able to use the following project tools and practices on your own (should you wish to use them)?”

Project tool	Percentage choosing “Moderately” or “A lot” in 2015–16	Percentage choosing “Moderately” or “A lot” in 2016–17
How to use the 5E instructional model to design and teach lessons	84%	84%
How to use phenomena to drive instruction	84%	87%
How to use questioning strategies (e.g., teacher-to-student, student-to-student discourse) to develop student understanding	83%	86%
How to look deeply and systematically at student work as evidence of student understanding	83%	85%
How to use science notebooks to elicit student sense-making	76%	79%

Sources: Retrospective TLC Survey administered to all Teacher Leaders by WestEd in spring 2016 (N=353) and spring 2017 (N=388).

Advancing NGSS Teaching

Teachers also rated the TLC experience highly when asked about its value in preparing them to adopt new teaching practices. Teachers were asked how much they felt their TLC experience empowered them to use the five main tools and processes they had learned in the TLCs: the 5E instructional model, phenomena, questioning strategies, reviewing student work, and notebooks.⁵ Teachers had been introduced to all of these tools and processes to different degrees during the Summer Institutes; TLCs demonstrated their use in a classroom setting. Across two school years, over 80 percent of respondents reported that their TLC experience had empowered their use of four out of the five

tools and processes either “moderately” or “a lot,” with over three quarters (76 percent) reporting that their TLC experience had empowered their use of the fifth tool, notebooks, “moderately” or “a lot” (as shown in Table 2). Interestingly, of these five tools, science notebooks was the tool that teachers learned the most about outside of the TLCs, as there were sessions devoted to them during each Summer Institute beginning in Year 2. This may account for the slightly lower ratings, since teachers already felt empowered to use notebooks.

Beyond these tools and processes, in surveys taken at the completion of each TLC during Year 2 and Year 3 of the Initiative (2016–17 and 2017–18), teachers were asked, “Please clearly describe one thing you learned from this TLC experience that you

⁵ See Appendix B for an explanation of these five project tools and practices.

plan to take back to your classroom.” Responses provide evidence that teachers not only understood the intent of the three-dimensional NGSS, but also that they had experienced the power of implementing the standards with students:

I love the questioning we did and the pushing back we did to get the students to think. We pushed them to look for evidence of their thinking rather than guiding them to a specific answer. I plan to use this tomorrow in my own classroom. I want the kids to think for themselves and not always search for the “right answer.”
(Third grade teacher)

We changed the assessment piece at the end of the lesson for the second time we taught it. It was interesting to see how much more the child was able to explain and think about with the second, more open-ended assessment worksheet. I know that I will be able to find out more about what my students know if they are given the chance to answer more open-ended questions that are there to uncover their thinking. (Kindergarten teacher)

I was impressed that some of my lowest students in math and reading are my top students that make the big connections. I also learned how to constructively critique student work so that I am able to move my kids to the next level. (Second grade teacher)

This being my first TLC, I learned the power of inquiry-based learning and

teaching practices. The effectiveness of asking questions of the students instead of telling them what you want them to know was explicitly clear during our lesson. When we practiced the lesson in the classroom, I was surprised at how much students were really able to connect their thinking and draw their own conclusions based on the evidence they observed in the investigation, without any direct instruction from the teacher. I noticed that the “teacher” role has transformed from information giver to facilitator of thinking processes. (First grade teacher)

The TLCs provided teachers with the opportunity to experiment and evaluate new instructional approaches with peers. The process of analyzing how well a lesson actually progressed student understanding changed many teachers’ perspective, as explained during interviews by these two Project Directors:

I think that the best thing that I’ve seen in a TLC is that teachers are starting to look at what didn’t work. They’re starting to think more about what the students are doing than just how to teach [the content].

When teachers come to their very first lesson study ever, it can blow their mind. It’s really hard for them sometimes to think about spending six and a half or seven hours to basically plan one lesson. They start to see how complex the NGSS really are and how much thought should go into doing it well. So, what’s made me really, really happy is when I have a team . . . If

I'm facilitating, they're almost all teachers brand new to the process, and their understanding is very fragile. And so, for them to sit here and plan a really thoughtful, complex lesson and for them to not underestimate their kids is amazing.

Over time, some teachers saw the value of having lesson studies in other subject areas and in applying lessons learned to other subjects, as articulated by the following interviewees:

There was so much positive feedback from the [TLC] experience that they now want to do that experience in other subject areas as well — math and ELA. (Elementary school principal)

The one thing that I have learned from this TLC experience is that I can take a lot of the teaching strategies back to my classroom and use them across the curriculum. For instance, to not tell the student that their answer is wrong in math but have them discover why it is wrong by asking probing questions that will help them discover a new way to solve the problem. (First grade teacher)

Benefits for Administrators

The Initiative has made a point of leveraging TLCs to help administrators understand the NGSS so that they may better support their teachers.⁶

⁶ Principals in Early Implementer districts have been strongly encouraged to observe teachers engage in the TLC process. Seeing the TLC lesson and the post-lesson debrief helps administrators understand the complexity of the NGSS and the shifts in pedagogy required to teach them. The crucial role of administrators in NGSS implementation is the focus of completed evaluation report #3, *Administrators Matter in NGSS Implementation: How School and District Leaders Are Making Science Happen*, available here: <https://www.wested.org/resources/administrators-matter-ngss-implementation/>. This topic will be revisited in upcoming evaluation report #10, slated for release in fall 2019.

When asked in a survey in spring of 2018 about the extent to which observing various experiences had impacted their understanding of the NGSS, principals reported that they found benefits in observing both days of the TLC, although the teaching day was more meaningful for them than the lesson planning day, as shown in Figure 1 on page 10.

In interviews, principals gave more specifics on what they had gained from their involvement in TLCs, for example:

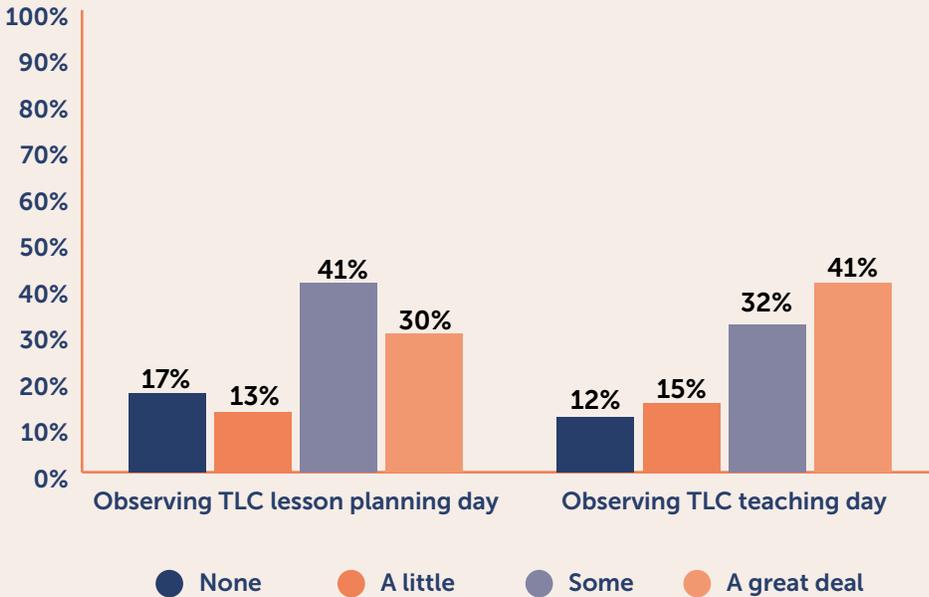
I have learned a lot from the TLCs, like how to build a conceptual flow . . . the 5E structure . . . notebooking and how that works. I feel like, as an admin, I have a strong knowledge of what the teachers do to implement the NGSS and how it's a new way of approaching teaching science. (Elementary school principal)

Of course, what principals generally care most about is how their teachers are doing, and their responses were very positive about what their teachers were learning.

I think there are many principals who are very happy with the Initiative. I think they're confident with teachers who are in the Initiative. [They're] happy that teachers are receiving a higher level of PD and collaboration within it. (Middle school principal)

Figure 1. How principals rated the level of impact of observing TLC planning and teaching days on their understanding of the NGSS

Principals: During the 2017–18 school year, how much of an impact did the following have on your understanding of NGSS?



Source: Principal Survey administered by WestEd in spring 2018 (N=77).

Teaching science is about building their capacity as a teacher. I think that learning how to [plan] an effective science lesson is just also helping you become a better teacher. So, I think it's hugely impactful because it goes past just teaching science.
(Elementary school principal)

up at because it was pretty phenomenal.
(Elementary school principal)

Bringing groups of teachers together from different schools to engage in professional learning based on collaboration and team-building for four years has inspired changes in the values and practice of not only the teachers directly participating in the TLCs, but their schools and districts as well.

Impact on Site and District Culture

It's just . . . so supportive to watch teachers learn from each other and support each other. I'd like to continue that method no matter what school site I end

The Initiative's TLCs reflect a "growth mindset" (Dweck, 2006) and model what teachers should do in their own classrooms. As described by an Early Implementer Core Teacher Leader in a California Science Teachers Association (CSTA) newsletter article, the learning process of students in an NGSS classroom parallels that of the teacher engaged in a TLC (Gallagher, 2018). For both

students and teachers, the experience prioritizes inquiry-based activities that allow each individual to jump in where they are and develop deeper or new understanding through exploration and discourse. The main goal of participating in the TLCs is not to determine what is “correct” or “incorrect.” Instead, everyone is simply on the path from their original understanding (which may be naïve, incorrect, or incomplete) to forming a conceptual framework that makes the most sense based on evidence. The more experience and investigation one engages in, the better one can form concepts that are consistent with evidence (DiRanna, Topps, Cerwin, & Gomez-Zwiep, 2009; Tyler & DiRanna, 2018). Through involving more teachers and administrators over time, the growth mindset culture of the Early Implementers Initiative has begun to permeate not only classrooms, but schools and districts as well:

They [the teachers participating in TLCs] are very collaborative. If they don't know an answer, they don't shut down. They know who to go to, they take risks. If they're not sure about what to do with their teaching, they tend to check in with each other and work on something, they don't shut down. So let's just say that they have a growth mindset, and that's a result of the Initiative. (Elementary school principal)

I think, when given the time [to collaborate], that they just have amazing ideas and plans. They can have this lesson and they can all share in teaching it. And then when they come back together, that's the very cool time. You know, they come back together and they're like, "Well, did you notice this? And I changed this . . ."

. . . I thought it was just fascinating how everyone is valued in what they're saying. And they can just share and there's none of the judgments on anyone. I was real pleased with the openness of people. And I think that's because we've been able to do this for a couple of years now . . . they're very comfortable with the process. (Elementary school principal)

The collaborative culture extends throughout the district. TLCs provide a context in which administrators can listen to teachers to learn about the standards and gain insight into the complexity of planning NGSS instruction. The focus is on learning as a process rather than one specific outcome. As they learn through their involvement with TLCs, administrators improve their understanding of how to support their teachers in teaching the NGSS, which further impacts district and school culture. District administrators share a common goal with teachers and principals: to support students in developing learning skills (e.g., inquiry, communication, metacognition) to construct a conceptual framework for making sense of phenomena and related concepts.

One of the biggest hurdles for the last four years is getting teachers to not worry about administrators coming in and judging them because they're at the beginning of a sequence, and kids have no background [so they may have misconceptions]. The teachers are kind of feeling out the kids for what they do and don't know. Things are gonna get tweaked [to meet the students' needs] so that they will understand the concept that's being taught. . . . The administrators understand that's

*what they're gonna see and it's okay.
(Middle school principal)*

[My role at the TLC] is really just to observe . . . I love when [the teachers] make a connection where they turn and ask me to help support with building a community partner, or bringing in an expert guest speaker. . . . They know that's something I can support with. But in terms of the actual lesson planning and instructional implementation, that's really . . . our Project Director leading the teachers, and the Teacher Leaders leading the teachers. As an admin, I just kind of sit and listen and wait for ways that I can help and support. (Elementary school principal)

It's funny, my boss, who comes and does walkthroughs in my classrooms, told me, "I love coming to your school because when I come here, I see joy on the kids' faces, joy on the teachers' faces." And

*she told me if she had to do it over again, she'd put her son in my school. It's just because [we have] this mindset that the kids need to be engaged and be thinking.
(Elementary school principal)*

Challenges

While feedback on the TLCs was overwhelmingly positive, there were also challenges. The most common challenges were logistical. District Project Directors were faced with the complex task of assigning dozens of teachers to teams of three or four members each; finding times and locations for each team to meet (twice in the fall and twice in the spring); and procuring and paying for substitute teachers so that teachers could be released from class for their TLCs. Some administrators were less than enthusiastic about teachers being out of the classroom.

Many of these challenges inspired modifications to the TLCs in Year 5, described in a later section of this report.

The TLCs of Years 1 to 4

As noted in the report's introduction, each TLC in Years 1 to 4 consisted of two days: a lesson planning day and a teaching day. Every Teacher Leader experienced two TLCs per year, one in the fall, and one in the spring, and individuals stayed in their grade-specific teams for the school year. TLCs in these first four years were facilitated by the Initiative's leadership, the K–12 Alliance, the district Project Directors, and the Core Teacher Leaders. Obviously, the TLCs require quite a time commitment — four full days over the course of the school year — and some teachers initially balked at the notion of spending two days that ultimately result in just one lesson. However, as observed by evaluators and described by a district Project Director in a California Science Teachers Association (CSTA) newsletter article, teachers quickly saw the value of the experience (as described in the Benefits of the Early Implementer TLCs section above) and, from there, moved to deeper professional concerns, such as how to continue and even expand application of the TLCs (Tupper, 2018).

Vignette: An Extended Example of a TLC in Year 2

To provide readers with a more vivid understanding of what TLCs are like in practice, the following vignette describes a grade 6 TLC from Year 2 that is representative of many of the TLCs that Early Implementer evaluators observed.⁷ This TLC

convened four teachers and a principal, representing five different schools, along with the district Project Director and the district's assigned Early Implementer Regional Director from the K–12 Alliance. The teachers were a mix of Core Teacher Leaders (in their second year of the Initiative) and Teacher Leaders (in their first year). The principal, a member of the Core Leadership Team, was not able to participate in the TLC consistently but acted as an occasional advisor.

Planning Day

The Regional Director introduced the lesson study process, beginning with a discussion on teacher participation norms for collaboration, discussion, and other processes. When the group moved to discussing the lesson to be taught, Teacher A, whose class they would be teaching, said she wanted to do the lesson on something related to cells, because it would fit with what the class was currently learning. After at least an hour of open discussion on potential specific lesson ideas, the Regional Director instructed everyone to close their books and think about what all students in grade 6 should know about cells by the end of the school year. Individually they made lists. They shared out ideas, creating a storyline, or "conceptual flow," of the instructional unit. The big ideas, in the order that students could learn them, were:

1. Living and nonliving things are different; living organisms have certain characteristics.

⁷ For another vignette of an Early Implementer lesson study, this one in Year 4 of the Initiative, see the article, "NGSS and the Teaching Learning Collaborative: It's About the Process" (Tupper, 2018) in *California Classroom Science* by an Early Implementer Project Director: <http://www.classroomscience.org/ngss-and-the-teaching-learning-collaborative-its-about-the-process>.

2. Living things are made of cells; cells are made up of parts that each have a function and structure; single-cell and multicellular organisms are different; not all cells are the same in a multi-cell organism.
3. Cells become organs and tissues; body systems are made of cells; some cells are specialized cells; there are differences between plant versus animal cells.

Teacher A had already started teaching about cell structure, and the process of creating the conceptual flow caused her to realize that she really should have covered the difference between living and nonliving things before introducing cells. The group decided that this would be an appropriate concept for a “5E” TLC lesson, which takes students through a series of learning experiences based on how people learn, also known as the five “Es”: Engage, Explore, Explain, Extend, and Evaluate.

The lesson would focus on the differences between living and nonliving things, with the goal of identifying the traits that *all* living things have and laying the groundwork for lesson(s) about cells. It would also set the stage for further learning, which would involve reading more information and revising the list of characteristics.

As the group discussed characteristics of living things that grade 6 students should learn, they considered potential phenomena to drive the lesson, which they would introduce in the very first part of the lesson (“Engage”). They decided to highlight one characteristic of living things, inheritance of traits, by kicking off the lesson with a comparison of a large and a small tree of the same species. Students would share prior knowledge of what distinguishes a living from a nonliving thing, such as inheriting traits from parents, and then engage in a sorting activity to further explore this concept.

One person asked about volcanoes: Would students think volcanoes were alive? The group brainstormed some obvious examples of living versus nonliving things, and then some less obvious examples. They decided to have students sort pictures of living and nonliving things for the first “Explore” part of the lesson.

When someone brought up the idea of using microscopes, the principal said she could make some available, but Teacher A said her students wouldn’t know how to use them. They decided to use two sets of pictures or, if needed, videos for students to sort. One set would be more obvious, while the other would include some trickier things for students to identify as “living” or “nonliving.” They brainstormed ideas. For the first set of pictures or videos to sort: ivy, pencils, a snake, a water bottle, a fly, a frog, a shoe, a basketball, a log, a rock, a mushroom, a shark, a tree, children. For the second set to sort: an anemone, a car, a feather, fire, a video of crystals that grow, a video of a volcano, a dinosaur, bacteria, driftwood, sun, water. They created a graphic organizer for students to record which items were living and which were not, as well as traits of living and nonliving things. This would be the student work collected at the end of the lesson.

After lunch, they started recording in the Lesson Plan template what the **Teacher Does**, what the **Student Does**, and what **Concepts** are covered.

The template they used prompted them to follow the 5Es, and their single-period lesson plan got through the first three (Engage, Explore, Explain), with three iterations of Explore and Explain in which students would use new information and ideas to develop and revise their explanations. While the group continued to plan, one teacher wrote in the template, while two others looked for an appropriate reading passage, and another teacher looked online for photos and videos to use in the lesson. They listed the characteristics of all

living things that they wanted students to know; the reading passage would need to include them all.

By the end of the planning day, they had identified the most relevant NGSS standard as well as the most relevant disciplinary content knowledge (DCI), science and engineering practices (SEPs), and cross-cutting concepts (CCCs). They had a lesson planned from start to finish, a reading passage that needed a bit of tweaking, and most of the photos/videos. The Regional Director kept track of who would prepare the reading passage, who would cut and laminate the cards, who would make copies of the graphic organizer, and who would put the videos into a PowerPoint.

Teaching Day

Two weeks later, the full group, including the principal, reconvened early in the morning for their teaching day. A reading passage had been prepared on "Living Versus Nonliving Things," the 5E template had been fleshed out and copies were provided for each participant by the Project Director, and a handout for students had been created. The team discussed who would teach each section of the lesson and how long each section should take.

First Teaching Session. Teacher A had a class of 32 students, which included an additional five that join the class for science. Students were seated in eight groups of four, and it was clear that they had plenty of practice working cooperatively in small groups. The first teacher led the class as they talked about what makes a tree get bigger. Then, a second teacher took the lead, and the class sorted the first round of pictures and videos in their groups, recording ideas in their graphic organizers. They shared as a whole class about characteristics of living versus nonliving things, with another teacher recording their ideas on the board. A third teacher led the next activity.

Students were given a new set of pictures and they watched videos of the crystals, the volcano, and the fire. The second sorting was a bit more difficult, and many groups incorrectly categorized at least one nonliving thing as a living thing, most typically the sun, the volcano, and/or the fire. Time was spent at the end of the class, led by the fourth teacher, on revisiting the list of characteristics of living things they had brainstormed after the first sorting activity. The students were given time to revise their graphic organizers. They would read the reading passage the following day and make further revisions to the list of characteristics.

The Debrief. The group discussed what they thought were more effective and less effective parts of the lesson and then read some student work. The work was distributed and teachers created "high," "medium," and "low" piles, reading aloud to each other student work that was or was not on track. They counted totals for each performance level and discussed features of the lesson that seemed to help and hinder student understanding.

The group felt that some parts of the lesson had worked pretty well:

- The graphic organizer kept students' focus and there were no questions about how to use it. They agreed that if there isn't an individual task, sometimes kids get off task.
- Sorting through the images of living and nonliving things was the most powerful thing students did. It was helpful for them to physically manipulate the pictures. The teachers could walk around and see where misconceptions were.
- Timing was good. Students stayed on task and kept moving through the task. One teacher noted, "Sometimes people say you can't do science if you don't have a huge chunk of time but look what we did in an hour!"
- The videos worked very well.

- The second sort elicited a lot of discussion. Team members noted: "Items in the second sort were great!" "The dinosaur in the picture was plastic, and maybe that was distracting." "Some were distracted, or debated [with each other], because something was no longer alive." "I heard a group saying that the sun needed energy." "I heard cells come up a lot." "Some students said everything has cells."
- It worked to have two rounds of sorting living and nonliving things. The first sort activity got students thinking, and that helped them do the second sort.
- The Regional Director noted that it was possible to see the influence of the Common Core State Standards in students' argumentation; they are getting more used to saying their thinking. Teacher A recalled that one of her students noted aloud that she really didn't know what gravity is: "It's really cool that we're getting kids to say what their thinking is, because I thought I knew, but I had no idea. And now kids are not only showing us what their deep understanding is, they are realizing what they themselves don't understand."

The group also recommended some changes to the lesson:

- Give students more room to write. They had to write full sentences and providing only two lines on the graphic organizer was limiting. One group member noted, "I saw one girl who had another idea. Why should I write that down? I'm done, my lines are full."
- Maybe the trees made students focus too much on plants. The group wondered whether they should include both plants and animals.

The next class period in which the group would teach this lesson was shorter. So, they decided that the initial Engage (looking at the small and large trees and thinking about how the tree got bigger)

could be cut, because it didn't really inform the main part of the lesson or the sorting activity.

Second Teaching Session. This class had 20 students, seated in five groups of four. The lesson was taught as before with the agreed-upon changes. The students were not as practiced with small-group cooperation, but the ideas they shared about characteristics of living things were on target. The second round of sorting elicited disagreements among students, some very heated. There was time for a final review and re-think of what the characteristics of living things were. The class ended with one teacher saying, "Maybe we need more information, maybe we should do some reading."

Second Debrief. The group talked about how good it was to emphasize to students that scientists classify and categorize. They noted that it might be necessary to reword the directions, as students were writing one characteristic for living things (e.g., they inherit traits) and then the opposite for nonliving (e.g., they do not inherit traits). They closed with an individual quick write on what they had learned over the course of the two teaching sessions and what they planned to take back to their own classrooms.

Developing Facilitators for More Widespread Implementation

As teachers learn the standards and advance their ability to teach them, they also become more willing and able to share what they know with their peers, which was an explicit expectation for all Teacher Leaders in the Initiative.⁸

⁸ See previous evaluation report on teacher leadership, *Investing in Science Teacher Leadership: Strategies and Impacts of the NGSS Early Implementers Initiative*: <https://wested.org/resources/investing-in-science-teacher-leadership-ngss-early-implementers/>



Table 3. Who was the primary facilitator of your TLC?

Primary facilitator of TLC	Fall 2015–16	Spring 2015–16	Fall 2016–17	Spring 2016–17
Regional Director	36%	28%	21%	17%
Project Director	40%	38%	37%	38%
Core Teacher Leader	25%	34%	38%	40%
Other	NA	NA	8%	4%

Sources: Post-TLC Survey taken by participants at the conclusion of their TLCs during the 2015–16 and 2016–17 school years (N=369 in fall 2015, 356 in spring 2016, 353 in fall 2016, 368 in spring 2017).

Notes: Respondents chose “Other” when the TLC was facilitated by someone other than the three leaders shown, or the facilitator’s role in the Initiative was unknown. “Other” was not an answer choice in 2015–16.

I see that confidence has grown, not only in understanding content, but also in being a Teacher Leader and presenting to each other, facilitating, and taking the initiative. . . . They had to present to each other, and they had to present at some of our . . . district professional learning community days where they present to everyone, to all of their peers, so that’s been great. (Elementary school principal)

I plan to continue to plan a scope and sequence of lessons using the conceptual flow plans that our TLC teams have created. I also hope to encourage, mentor, and support my grade-level team in teaching more science within their own classrooms. (First grade teacher)

In Year 1 of the Initiative, TLC participants included only the district Project Directors and the members of the Core Leadership Teams (approximately six to eight teachers and two to

five administrators per district) who each engaged in two TLCs that year. Groups of 30 to 70 Teacher Leaders in each district joined in Year 2, and they too participated in a TLC in the fall and another in the spring. By Years 3 and 4, some of the Teacher Leaders began to actively share what they were learning about the NGSS with teachers outside of the Teacher Leader groups.⁹ However, the TLCs were reserved only for direct participants of the Initiative.

As Core Teacher Leaders and Teacher Leaders gained expertise in the NGSS and experience with TLCs, the number of individuals in each district able to facilitate increased. Leadership trainings held twice a year for Core Leadership Team members regularly included sessions to help Core Teacher Leaders improve their TLC facilitating skills. In Year 1, all of the facilitators were Regional Directors from the K–12 Alliance, but by the spring Project Directors and some Core Teacher Leaders were “shadowing” in preparation to facilitate the following year. Table 3 illustrates how responsibility for facilitating TLCs gradually transferred from the Regional Director to the Project Director, and then to the Core Teacher Leaders.

⁹ This “spread” of NGSS learning was the ultimate goal of the Early Implementer work and will be the focus of an evaluation report to be released in late spring of 2020.



Modified TLCs in Year 5

As they planned Year 5, Early Implementer leaders in each district began to tailor professional learning to the unique needs of their district and their teachers. Two primary constraints prompted districts to modify their TLCs in Year 5:

- **Availability and cost of substitute teachers.** Most districts were already facing some degree of substitute teacher shortage, and paying for substitutes for many teachers is expensive. Concern about cost was accentuated by a reduction in Initiative funding to districts in Year 5 to encourage a transition to district self-sufficiency.
- **Time out of the classroom.** After four years of TLCs, district administrators were expressing dissatisfaction with the amount of time teachers had been spending out of their classrooms for both Early Implementer as well as other district trainings. Project Directors reported that some Teacher Leaders themselves were reluctant to continue participating in the Initiative over concerns about time out of the classroom for TLCs.¹⁰

Only one district chose to not continue with any form of lesson study. None of the districts continued with the TLCs exactly as they had been conducted in Years 1 to 4 (the district variations of TLCs in Year 5 are described below in the TLC Modifications section). However, three features of the original TLC model were preserved in all of the districts that chose to continue with TLCs:

- **Common purpose.** TLCs fulfilled three main goals during the first four years of the

Initiative; those goals were retained to some degree in the Year 5 TLCs. The TLCs fostered a culture of collaboration where learning and a growth mindset were emphasized over performance for both teachers and administrators. They reinforced the return of science as a core subject. Finally, they provided effective professional learning for teachers about the NGSS and how to implement them.

- **Facilitated group work and discussion.** When teachers were convened for TLC activities in Year 5, trained facilitators led them through the protocol at hand. As with TLCs in Years 1 to 4, teachers were able to ask questions and hear tips from individuals with firsthand NGSS instruction experience.
- **Planning, teaching, and debriefing.** All Year 5 TLC configurations included some form of each of the main TLC activities. Importantly, review of student work was always part of the debriefs.

TLC Modifications

Because of the factors described earlier — the cost of substitute teachers and the difficulty of securing multiple days for teachers to be out of the classroom — chances are that most districts will not have the resources to carry out TLCs according to the original Early Implementer model. In fact, as the districts experienced a reduction in grant funding in Year 5, they had to decide what modifications to make to their TLCs to meet their new realities.

¹⁰ One of these Project Directors, who had redesigned TLCs to accommodate these teacher requests, told evaluators that teachers later had a change of heart. This district did not have issues with substitute teachers and could have continued the original TLC configuration.

The sections below describe the five primary modifications that districts made when implementing their TLCs in Year 5. A vignette in Appendix C vividly describes one of the most dramatic reconfigurations of TLCs: grade 5 teachers doing planning, co-teaching, and debriefing of a lesson — all in a half day!

Less Time Out of the Classroom

To reduce the time teachers were spending in professional learning versus with their students, some districts used existing professional development structures, such as site-based professional learning community (PLC) time for planning. Protecting teacher time in the classroom meant that some TLC activities in most districts took place on Saturdays, during professional development days, and after school. One district offered TLC professional learning during the summer when teachers could co-teach the lessons to summer school classes. Other districts held the TLC planning during a morning or an afternoon within normal schooltime. Indeed, survey data indicates that 39 percent of TLC participants in Year 5 received some extra pay for their participation. Early Implementer funds were used to pay teachers for time outside of their regular contract hours. In many instances, however, some (but less than in Years 1–4) release time was still included as part of the TLC implementation.¹¹

Expanding Participation

A goal of the Initiative from the outset was that Early Implementer Teacher Leaders would share their growing NGSS expertise with their peers, so that all teachers of science in every district would eventually benefit from the professional learning

provided. Districts began to carry out this responsibility in earnest in Year 5 by inviting “expansion teachers” (i.e., teachers who did not participate in the Initiative in years 1–4) to TLCs and other Initiative professional learning opportunities. Most districts offered lesson studies exclusively to teachers of science, but some also involved resource teachers and special education teachers. One district invested extra funds to include every K–8 teacher of science as well as English language arts (ELA) and special education teachers. Schools that previously had been relatively untouched by the Initiative because they had had few, if any, Teacher Leaders, were assigned Core Teacher Leaders to facilitate their TLCs in Year 5.

Variations in the Planning Component

More districts retained the original TLC planning day model than the teaching day model. Three districts developed a conceptual flow during full-day planning sessions in Year 5, as all districts had done in Years 1 to 4. Two districts retained the development of conceptual flows and 5E lesson plans but did this in an abbreviated planning day of only a morning or afternoon.

Facilitators in three districts came with a prepared phenomenon, learning sequence, or a conceptual flow with which the team could develop a brand-new lesson, versus having teachers develop everything from scratch as had been the case in the Years 1–4. In three districts, teachers were given an existing lesson — often developed by a past TLC team — for teachers to learn and adapt. In other districts, planning was omitted for some groups of teachers. Instead, these teachers observed and debriefed demonstration lessons explicitly taught to illustrate what an NGSS lesson looks like.

11 In surveys, only a quarter of TLC participants (26 percent) reported that they had not needed any substitute time to participate in any part of their TLC in Year 5. Thirty-eight percent of respondents needed a sub for a full day, 22 percent for more than a full day, and 13 percent for less than a full day.

In some districts, full, tested lessons or learning sequences were provided. In these cases, binders of lessons and units were given to all teachers and they were provided with professional learning to help them implement them. This support was usually intended for larger groups of teachers from multiple sites. Teachers would convene to learn a part of the sequence together, go back to their classrooms to teach that lesson or set of lessons independently with their own students, and then reconvene to learn the next lesson or set of lessons in the learning sequence.

Variations in the Teaching Component

All of the districts reduced the amount of time teachers spent out of their classrooms by dropping the formal co-teaching portion of the TLC (with the exception of one district's "mini-TLC," in which the planning, teaching, and debrief all occurred in half a day — see Appendix C for a vignette of this model). Instead of co-teaching, teachers in Year 5 brought the lesson they had planned or learned with other teachers to their classroom and taught it to their students. Some individuals managed to either observe another teacher teach the lesson to their students or informally co-teach with a fellow teacher, but this was neither consistent nor required.¹² In districts in which observation of a demonstration lesson replaced the experience of planning and teaching the lesson, the experience was passive rather than active.

Variations in the Debrief Component

All modified TLCs in Year 5 included facilitated review of student work, which was identified by Early Implementer leaders as essential. However,

some districts scheduled less time for the debrief. In three districts, debriefing occurred after school, and in two others debriefing occurred on Saturdays. One district had debriefing activities both after school and on Saturdays.

Another variation in Year 5 was the nature of the work that occurred during the debriefing. When there was no lesson revision and reteaching, this aspect required less time. All modified TLCs in Year 5 still included some teacher review of student work with quick scoring or sorting of student work into categories such as high, medium, and low or "got it" and "didn't get it." Some districts spent debrief time developing a rubric as a group. Although the debrief component typically included a discussion of what parts of the lesson worked and, in some cases, how it could be improved, none of the Year 5 district models included a formal reteaching of the lesson.

Other Variations

Evaluators have anecdotal data that there were Teacher Leaders or site leaders who, at the school level, tried even more variants of TLC. In one school, for example, Teacher Leaders used the TLC format to provide site-based NGSS professional learning for teachers who had not participated in the Initiative and had limited understanding of the standards. The facilitators and the participants met after school to discuss and plan NGSS lessons, as this Core Teacher Leader reported:

We also had several Teacher Leaders that were facilitating their own lesson studies at their sites with [expansion] teachers. For example, two Teacher Leaders worked

¹² Evaluators heard of a kindergarten Core Teacher Leader in one district who co-planned a lesson with her school kindergarten team after school and during their prep period. The kindergarten teacher taught the lesson first and then observed and co-taught the lesson in each of the other teachers' classes. Each teacher had an individual debrief after teaching the lesson, and then the team held a debrief together at the end.

with the kinder team at [school name]. The teachers they were working with had very limited NGSS-focused training time previously. [Some] of those teachers . . . stayed after school, working with Teacher Leaders on several different days developing their lessons.

Vignette: One District's Year 5 Use of TLCs to Reach All Teachers

One Early Implementer district chose TLCs as the primary mechanism in its Years 5–6 funding to not only implement the NGSS, but also to share some of the most effective strategies and tools used by the Early Implementers Initiative with all teachers, across all subjects. This district had enjoyed a high level of district leader and site administrator support for science and the NGSS, and strong buy-in from the teachers, parents, and the community. The district broadened its TLCs to include all teachers in grades TK through 5 (including special education teachers). Further, middle school science and ELA teachers engaged in TLCs together to develop and teach coordinated lessons for their grade levels. The following vignette elaborates this district's Year 5 TLC implementation story.

Administrative and District-Level Support for Science as a Subject and for TLCs

The first key thing that this district did to implement its "lesson study for all" model was to harness support from its district leaders. Doing so allowed them to ensure funding and release

time for TLCs and created more accountability for teachers to participate. Central office support also created an environment that encouraged site administrators to be more open and supportive to the positive impacts that NGSS implementation can have on teachers and students.

The district superintendent had long been supportive of the NGSS work that teachers and administrators had done and felt strongly about building on that capacity: "If we don't capitalize on the opportunities the NGSS work provides for us, it would be the biggest missed opportunity in the history of missed opportunities!" The superintendent's strong support of science led district leadership to send a "clear message to teachers, administrators, and community members that science is a focus in [the district], one of the three [district] strands: science, arts, and languages" (Year 4 District Report).

As a result of strategic efforts by Initiative teachers and the district Project Director, district leaders' messaging, and firsthand observations of NGSS lessons that showed the impacts of the NGSS on student engagement, principals in this district came to "understand that the NGSS provide a space for language and math that can assist with the goal of student achievement on standardized assessment. . . . The more administrators understand about the NGSS, the more they are on board" (Year 4 District Report).

The combined administrator support at the district and school levels resulted in the following:

- A unified message that science is important
- Financial (via both district LCAP and site funds) and administrative support for release time for all TK through 5 teachers, middle school science teachers, and select ELA teachers to engage in two rounds of TLCs each during Year 5 of the Initiative

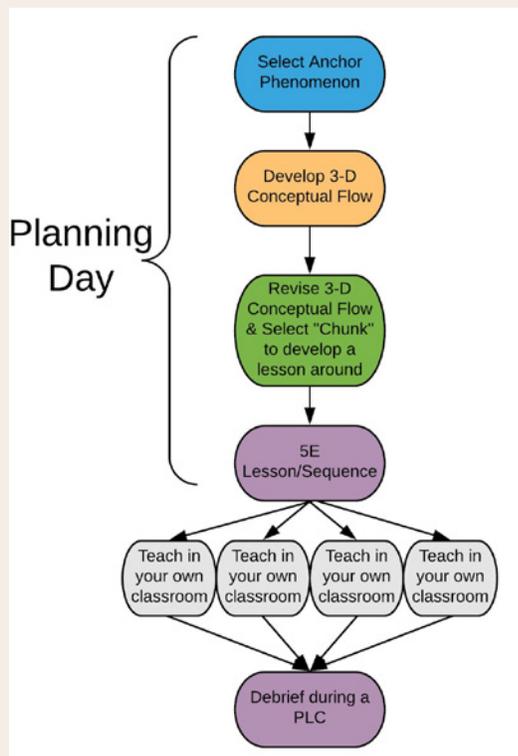
- Designation of two out of the four district-controlled PLC professional learning days for science TLC debriefs (these days have historically been used for initiatives or activities other than science)
- Expectation that *all* TK through 5 teachers, middle school science teachers (and select ELA teachers) would attend science TLCs (Year 5 District Report)

"Lesson Study for All" Model

One of the biggest shifts for this Early Implementer district in Year 5 centered on increasing the capacity and reach of their TLCs. They implemented a modified version of the Early Implementer TLC, while including as many teachers in the district as possible. Their model sought to accomplish several things:

- Leverage the leadership capacity and expertise of the Early Implementer Teacher Leaders and Project Director gained over the first four years of the Initiative
- Reduce the teachers' time out of the classroom, and the need for substitute teachers, by convening TLCs during time already designated for PLCs
- Reach all science "expansion teachers" in the district (including special education teachers) with this targeted and intensive NGSS professional learning experience
- Further collaboration across content areas, specifically ELA and science, to build coherence for students
- Provide a robust NGSS professional learning experience for teachers to "align their efforts and share strategies, and to provide a process and protocol for analyzing students' work and students' thinking in a purposeful way" (Year 4 District Report)

Figure 2. Graphic overview of an Early Implementer district's Year 5 TLC process



Source: District TLC Manual (2018–19)

In Year 5 of the Initiative, this district saw participation across all nine K–8 school sites. The district also added 115 new "expansion teachers" into their NGSS TLCs in Year 5. They had approximately 40 grade-level TLC teams in the district working together to develop NGSS-aligned lessons and reflect on their teaching and students' learning.

The district's Project Director developed a Year 5 TLC manual that broke down each step of the process (see Figure 2), provided tools and strategies for teachers to use, and ensured that teachers were thinking and acting in a way that put high-quality teaching of science at the forefront. While their TLCs were still quite rigorous and had most of the elements of the TLC used in Years 1 to 4 of the Initiative, there were a few

modifications made to suit this district's specific needs and constraints.

The primary modification this district needed was to reduce the time required for convenings. While the district did not want to compromise on having a full day for teacher planning, they did choose to preserve teacher time in the classroom by condensing the teaching and debriefing day. To do this, they asked all teachers to teach the TLC lesson on their own (though some co-taught with colleagues) in their own classrooms before coming back together later in the semester for a shared debrief session during their PLC time (an early-release day).

Another strategy that this Early Implementer district used was inviting all teachers to its Summer Institute, which was held immediately before the start of the school year. At the Institute, grade-specific lessons were developed that teachers could draw on during TLCs throughout the school year. This enabled the district to fully leverage the TLC process and ensure practical benefits for all teachers (including special education and middle school ELA teachers), while also saving some time. During the TLC planning day, many teachers would begin by looking at the work done in the Summer Institute; further flesh out the lesson sequence or unit, or constructing a more robust conceptual flow; and then continue to collaboratively plan an individual lesson that they would all teach in their classrooms.

This district is making a point of leveraging science as a context for engaging students and teaching other content, particularly ELA content, as recommended by both the NGSS and the Common Core State Standards.¹³ The following are example topics of integrated science and ELA

lessons developed by the middle school science and ELA teams during their TLCs, drawing on the collaborative work done during the Summer Institute:

- Grade 6
 - Science: water distribution and availability
 - ELA: *A Long Walk to Water*
- Grade 7
 - Science: ecosystems and engineering
 - ELA: *The Martian*
- Grade 8
 - Science: renewable energy
 - ELA: *The Boy Who Harnessed the Wind*

These science ideas (taught during science class) were reinforced by literature or nonfiction texts (taught in ELA class).

This inclusion of ELA teachers in both the Summer Institute work and the TLCs has allowed science ideas and content to infiltrate other content areas as teachers work to plan and revise cross-curricular sequences with science as the driver. . . . The coherence, extension, and application of science ideas provided through these sequences and those like them in middle school . . . certainly raise awareness around the idea of science helping to do some of the heavy lifting [of getting more science to students]. (Year 5 District Report)

¹³ Much has been written about the value of instruction that integrates and coordinates science and ELA. This integrated approach is discussed in Early Implementer 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/>

Overall, the district's modified TLC model worked well, and the district cited several successes:

The "lesson study for all" strategy was very successful in moving our expansion teachers forward, building on the Summer Institute, utilizing the leadership developed, beginning the systematization of a process for purposeful planning and analysis of student work, and helping all to get smarter about what NGSS and good instruction look like in the classroom. (Year 5 District Report)

Challenges to Lesson Study Implementation at the Districtwide Scale

The district's goal was to develop a method for TLCs that would be sustainable and effective, even beyond the Early Implementers Initiative. As such, district staff felt that some further modifications would make the process even better during Year 6 of the Initiative because of a few challenges that arose during Year 5. The main challenges the district faced within the Year 5 model were the following:

- Calendaring
- Facilitating
- Messaging

Calendaring. By including so many teachers across the district (a total of 170) in TLCs, and having each teacher participate in two full cycles in one year, the calendar was complicated, to say the least. While the full-day planning time was successfully tackled by timely planning and thoughtful arrangements with site administrators, secretaries, and the personnel department,

there were some complications with the teaching and debrief parts of the lesson study. Because teachers were asked to teach the planned lesson on their own, there were some instances that some teachers did not have time, or just had not taught the lesson before the debrief session. This meant that these teachers were not able to engage in the full lesson study process and reap the benefits from it.

In addition, teachers only had two PLC days per month during which they could hold their debrief sessions, which meant that there were many teams debriefing simultaneously across the district. This became an issue because the district Project Director was often asked to support teams during their debrief time (especially in the fall during the first round of TLCs), but he physically could not be in several places helping multiple teams at the same time.

In an effort to remedy the calendaring challenges faced in Year 5, and to ensure the highest quality lesson study experience for teachers, in Year 6 teachers in the district will participate in a single TLC modeled after the original version (i.e., a full release day for planning and a full release day for co-teaching, debriefing, and reteaching). The Project Director explained that this will ensure that "teachers are able to go through the full TLC experience as designed. That way, when we are on our own [after the Initiative ends in June 2020], we know what it is supposed to look and feel like."

Facilitating. As mentioned above, TLC teams that required additional support from the district Project Director or Core Teacher Leaders in the district sometimes weren't able to get this support in Year 5 because of the constrained calendar. As a solution, the district encouraged some teams to "self-facilitate" using the lesson study protocol and facilitator guide. While in most cases this was "effective and resulted in a productive learning

experience, in others it was less effective and could have contributed to less desirable habits of mind” (Year 5 District Report). To remedy this issue, in Year 6 the district plans to hold a “facilitator workshop or orientation to clarify the expectations around facilitation, resources, etc.” (Year 5 District Report).

Messaging. The last challenge that this district faced was related to the messaging that the new expansion teachers received regarding the rationale and intent of the TLCs. While much of the trepidation that first-time lesson study participants felt was expected and managed through the thoughtful facilitation process in the planning day, the debrief days were often weaker than intended:

While facilitators were ideally very clear about the debrief expectations, when left to their own devices and teaching the lesson in their own classrooms, many teachers deviated from or modified the lesson, which in some ways invalidated the “Study” component of the Lesson Study model. The effect could be magnified when there was no facilitator available for the debrief, thus the process lost some of its oomph. (Year 5 District Report)

Despite the above challenges, this Early Implementer district deemed its Year 5 TLC effort a considerable success and is working to further enhance the use of TLCs in Year 6 of the Initiative and beyond. “The leadership team decided to revert back to the prior, more authentic [TLC] model. . . . This would reduce the number of lesson study cycles a team goes through but increase the effectiveness by a wide margin” (Year 5 District Report).

Feedback on Year 5 Modifications

At the end of Year 5, district Early Implementer Project Directors were asked what they felt their district had gained and/or lost as a result of their Year 5 TLC modifications. Reported gains included:

- Laying the groundwork for sustainability after the grant concludes: “Supporting fiscally the amount of lesson studies we did made it easier to do for Year 6, and hopefully for Year 7 and beyond, particularly since we may be adopting instructional materials.”
- Providing NGSS professional learning to more teachers: “More teachers doing more lesson study, getting more practice in implementing NGSS, and finding out that it [planning a three-dimensional NGSS lesson based on a phenomenon] can be done and support of team helps.”
- Training more facilitators: “Leveraging Teacher Leadership in the district — Teacher Leaders facilitated over 20 teams between them.”
- Confirming that teachers with some degree of NGSS knowledge can collaboratively plan a lesson in a half day: “While it was challenging for some of the expansion teachers, the vast majority were familiar enough with the process and therefore took less time.”

One Project Director noted that the district had gained “a system for looking at student work . . . the kind of approach where we can start to say, ‘This is how we look at student work in [the district],’ and it applies across content areas.”

All of the Project Directors highlighted the co-teaching element of the original TLC as the most impactful loss, and they provided a variety of reasons:

- Loss of quality assurance: "Teachers left to their own devices may not have taught the lesson as designed, which impacts the work they bring to the debrief, and lessens the effectiveness of the debrief process." "Some teachers dialed back their expectations."
- Loss of collaboration: "Teaching on their own in their own classroom robs the teacher of the collaborative aspect of the lesson study. It can become a little less about the lesson we designed and more about individual teachers and their quirks/styles/biases."
- Loss of evidence for debriefs: "We lost a key line of evidence related to the debrief: the facilitator transcript of what the teacher said/did and what the kids said/did. That very often in the old model was a real eye-opener. It also served as corroboration (or not) for what the teachers thought had happened."
- Loss of depth in discussion: "The debriefs were shorter, so less depth was achieved, especially if everyone didn't teach the same lesson."
- Loss of proximity in time between teaching and debriefing: In Years 1 to 4, planning and teaching days were scheduled at the start of the school year. When teachers taught the TLC lessons on their own, "it was tough to project out a 'teach by' date as well as forecast a debriefing day that didn't conflict with other Wednesday obligations, staff meetings, 'teacher time,' other trainings, etc. So, often the teaching would be far removed from the planning."

In surveys, facilitators of TLCs were asked to compare the Year 5 lesson study configuration to the TLC configuration of Years 1 to 4 of the Initiative. About one third (34 percent) rated the Year 5 TLC "Worse" or "Much worse," while only 22 percent rated it "Better" or "Much better," as shown in Figure 3 on page 27.

Facilitators were also asked to explain at least one specific way the lesson study was better or worse than the previous TLC configuration in prior

years. A total of 129 comments were provided. Interestingly, these comments sometimes contradicted the rating an individual had provided and occasionally included ways Year 5 was both better and worse. Comments fell into a small number of categories, described below.

Co-teaching was missed in Year 5. Facilitators' most prevalent comment (n=68) mirrored that of the Project Directors': When participants did not teach the lesson together, the TLC was less effective. Most facilitators only lamented the loss of the co-teaching element, but some went on to explain the impact on the debrief process.

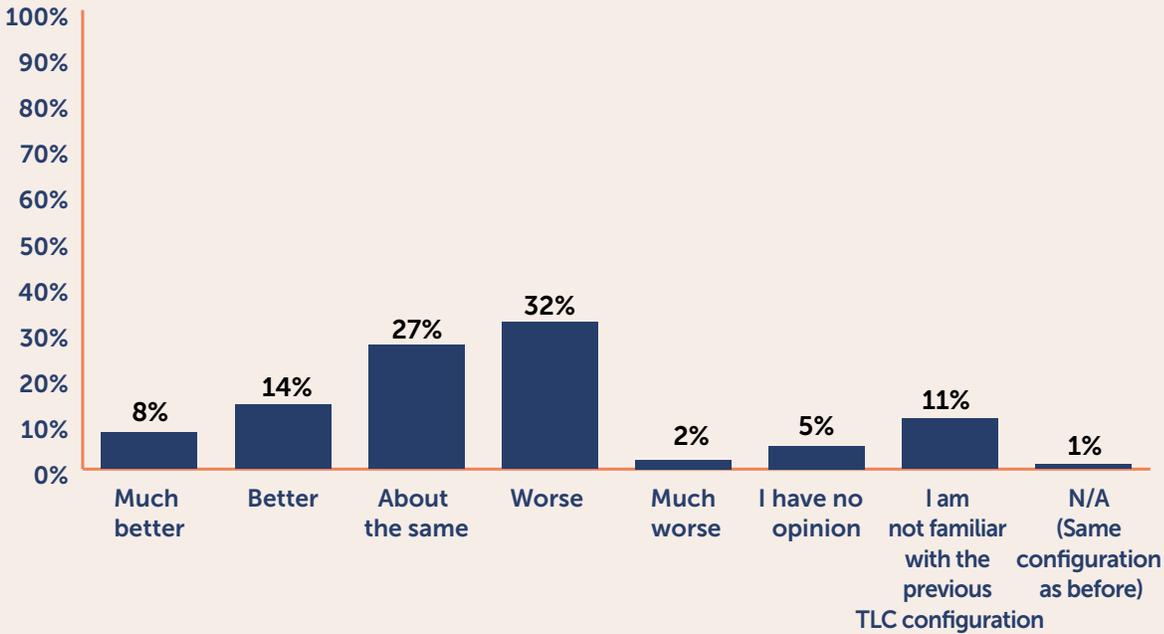
[The debrief was worse] without the opportunity to teach the lesson from a script with other teachers viewing, collecting, and evaluating student work, revising the lesson, and reteaching. . . . I feel like the power of the lesson study is lost doing it in this revised method.

When we didn't watch each other teach, we ended up having to explain to each other how things went and missed the nuances. It was even more critical to have student evidence, but even then, it was hard to tell how instructions may have been given slightly differently.

Not having the opportunity to co-teach during a release day teaching session and the midday conversations leading toward a revised lesson and teaching experience was a drawback. Need a release day to co-teach and debrief with a facilitator. Turning teachers loose after the planning is generally less effective, even with a solid plan.

Figure 3. Facilitator ratings of Year 5 TLCs compared to previous years

How would you compare this new lesson study configuration to the TLC configuration in prior years of the Early Implementers Initiative?



Source: Facilitator Post-Lesson Study survey administered by WestEd during the 2018–19 school year. (N=187)

Those last two parts [making changes to the lesson and reteaching it] were critical, and we lost them. It had been very useful to see the strengths and weaknesses in a lesson and immediately be able to respond.

Some of the teachers “deviated” some from the planned lesson so the student work was tougher to analyze in a common way.

Still, a few facilitators (n=4) found an upside to teachers not teaching collaboratively.

It allowed more time for teachers to implement lessons, teachers could make the lessons their own.

While it is difficult to not watch each teacher teach, this format does allow individual teachers to adjust parts to the lesson as they see fit for their students.

Shorter meeting times meant less depth in discussion. Many respondents (n=30) said the new configuration felt rushed; 22 of them, concentrated in the three districts that held half-day planning sessions in Year 5, specifically wanted more time for planning. A small number (n=5) mentioned inadequate time for debriefing.

Having only a half day to plan was VERY challenging. With new teachers who had not been through any training — it was very hard to get it done. In fact, we did

not, and I met with them again later after school.

A full planning day is always better to think deeper about the standard and fully plan out the lesson sequence instead of just parts.

We need more time to plan, teach, and reflect together.

We only had half a day to plan. Before we had a full day. It went well, but teachers would like a full day.

We were more rushed for time when planning. . . . I do fear that new teachers might not have the in-depth understanding of [the lesson planning] process that we had gotten in the past though.

Larger working groups resulted in richer discussions. Two districts brought larger groups of teachers together to review a provided lesson before going back to their classrooms to teach it. Fourteen of the facilitators in this situation commented that they thought having more participants was a benefit.

When debriefing, each teacher came with a different way of presenting and gathering data, where in the past teachers would teach together and have the same outcome.

The gain was that each teacher taught the lesson in her own classroom, which meant we had a greater variety of student work to review and a wider perspective on how the lesson worked with different groups of students.

Some preferred holding TLCs with just teachers at their school. Eleven facilitators noted that the reason they liked the lesson study configuration better in Year 5 was because it was site-based. One respondent explained that site-level collaboration brought a level of comfort and familiarity that was beneficial:

I like that it is at the site level and that grade levels get to work together to create the lessons. We are comfortable with each other and more willing to try new things. We were able to go at our own pace when learning about the standards, CCCs, etc.

Recommendations

Sending teachers to “NGSS 101” sessions should only be a first move of many. The steep learning curve to understand and teach the NGSS as intended necessitates providing intensive professional learning opportunities for teachers, such as the TLCs described in this report. Districts might send teachers to sessions where they hear about the basics and are introduced to the NGSS’s three dimensions and phenomena-driven instruction. While such “NGSS 101” presentations may be helpful starters, they are highly unlikely to prepare and empower teachers to implement the standards in ways that let students experience the much stronger learning that the NGSS make possible.

Consider establishing TLCs as professional learning that has the power to help teachers successfully transition to NGSS instruction. The changes in both content and pedagogy required to teach the NGSS are deep. It will therefore take deep learning experiences for teachers to understand the changes, try them, and gain the confidence and experience to succeed. Hopefully this report has shown that the benefits of TLCs, even in modified versions, are substantial. While TLCs are costly, the needs they meet and the benefits they deliver are high — that is, they require investment that pays dividends.

Attending to the “collaborative” part of Teaching Learning Collaboratives is important. The Early Implementers Initiative did not name the lesson studies “Teaching Learning Collaboratives” merely as a branding exercise. Because the instructional changes called for by the NGSS are substantial and can be intimidating (particularly for elementary

teachers), strong attention must be paid to the need for a collaborative and nonjudgmental safe space for teachers to try new things. Therefore, whatever professional learning is attempted, it must be well facilitated and establish effective norms for and realities of collaboration — including recognizing that collaborative processes require time and an environment conducive to experimentation and reflection.

Only using the planning component of TLCs will not move the needle very far; the teaching component is essential to professional learning. For cost or other reasons, leaders could be tempted to only institute the lesson *planning* component of TLCs. Through this component, teachers would get to discuss the standards and create new lessons. However, the real payoff of bringing teachers together for this planning will not happen unless participants also come together to teach, then debrief, the lessons. The opportunity to share perspectives on a lesson’s effectiveness, including examining the work done by students during the lesson, is powerful. These conversations prompt teachers to rethink their initial lesson plans and, most importantly, advance their understanding of how they and the NGSS can best prompt, facilitate, and support student learning.

Leverage TLCs to facilitate adoption of “NGSS-aligned” instructional materials; do not expect new curricula to stand in for professional learning. With new instructional materials for science available for adoption, it may be tempting to assume that the need for professional learning is reduced. The Initiative has examined available curricula and found that none richly encompass

three-dimensional, phenomena-driven instruction that will meet the needs of all districts. At a minimum, the NGSS require place-based learning sequences in which materials are suited to the local environment. Some Early Implementers are centering TLCs on new curriculum, both as continued NGSS training and as a way for teachers to familiarize themselves with the strengths

and gaps in the materials. Teachers convene to discuss a unit, individually try the materials in their classrooms, and then regroup to compare and analyze how things went. Their conclusions about how well the materials fit their district can then be applied to the next unit, with new rounds of reviewing, teaching, and debriefing.¹⁴

¹⁴ *Next Gen Toolkit for Instructional Materials Evaluation* is a resource developed by BSCS, Achieve, and WestEd's K-12 Alliance to support districts in selecting instructional materials that best meet their needs. "Next Gen TIME . . . provides educators with a transformative professional learning experience highly focused on the NGSS and the implementation of high-quality instructional materials." Trainings are available at county offices of education throughout the state of California.

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Appendix A. Evaluation Methods

Overview

This report primarily draws on the following Early Implementer evaluation data sources:

- Surveys:
 - Retrospective TLC Survey (2015–16, 2016–17) taken by Teacher Leaders at the end of the school year
 - Facilitator Post-TLC Survey (2016–17, 2017–18, 2018–19) taken by facilitators immediately after a TLC experience
 - Teacher Leader Post-TLC Survey (2016–17, 2017–18, 2018–19) taken by Teacher Leaders immediately after a TLC experience
 - Survey for K–8 principals, taken at the end of the school year by principals having at least one participating K–8 teacher of science (Teacher Leader and/or expansion teacher) at their school (2017–18)
 - Spring Survey 2019, taken at the end of the year by K–8 teachers of science (including both Teacher Leaders and/or expansion teachers)
 - Spring Survey 2019, taken by principals having at least one participating K–8 teacher of science (including both Teacher Leaders and/or expansion teachers) at their school (2018–19)
- Interviews with:
 - Each district Project Director (2015–16, 2016–17, 2017–18, 2018–19)
 - Twenty-two case study teachers across five of the eight participating districts (2016–17, 2017–18, 2018–19)
 - Two expansion teachers per district (2017–18, 2018–19)
 - Two administrators per district (2017–18)
 - Two Core Administrators per district (2018–19)
 - Two School site leaders per district with at least one participating teacher (2018–19)
 - Two district administrators per district (2018–19)
- Twenty-seven observations of lesson studies over Years 1 through 5 of the Initiative in all eight Early Implementer districts

Survey Questions Used for This Report

Retrospective TLC Survey (2015–16 & 2016–17)

1. How many different schools were represented in your TLC group (including yours)?
2. Who was the primary facilitator of your TLC?
3. To what extent did the TLC explicitly incorporate the review of student work that was produced during the lesson?
4. To what extent did your TLC experiences deepen your understanding of the following aspects of NGSS?
 - a. The Science Disciplinary Core Ideas (DCIs)
 - b. How to use Science and Engineering Practices (SEPs) to teach science and engineering
 - c. How to use Crosscutting Concepts (CCCs) to teach science and engineering
 - d. How to use a three-dimensional approach to help students understand a phenomenon
 - e. How to use the engineering design process to develop student understanding of science and engineering
 - f. How to integrate the science disciplines (e.g., physical, earth & space, life) to increase student learning
5. To what extent did your TLC experiences empower you to be able to use the following project tools and practices on your own (should you wish to use them)?
 - a. How to use phenomena to drive instruction
 - b. How to look deeply and systemically at student work as evidence of student understanding
 - c. How to use science notebooks to elicit student sense-making
 - d. How to use Claim, Evidence, and Reasoning (CER) to advance student thinking

6. Please pick the project tool or practice that you learned the most about from your TLC experiences.
 - a. Conceptual Flows
 - b. 5E Instructional Model
 - c. Phenomena
 - d. Questioning strategies to elicit student thinking
 - e. Looking at student work with colleagues
 - f. Student notebooking
 - g. Claim, Evidence, and Reasoning (CER)
7. Describe how the TLC experience helped you understand this project tool or practice.
8. Describe something specific you plan to do differently in your classroom next year as a result of your TLC experiences.
9. Would you recommend the TLC experience to other teachers?

Facilitator Post-TLC Survey (2016–17 & 2017–18)

1. What about this TLC went particularly well? Check all that apply.
 - a. Meaningful discussion/aha among students during lesson
 - b. Meaningful discussion/aha among participating teachers during planning or debrief
 - c. Teachers deepened their understanding of 3 dimensional instruction
 - d. Teachers practiced effective questioning strategies while interacting with students
 - e. Effective changes were made to the first lesson plan
 - f. Student notebooks effectively used for sense-making
 - g. Student work showed clear evidence of learning
 - h. Student work showed understanding of more than one dimension

2. Please explain or elaborate on the above.
3. What was challenging about this TLC? Check all that apply.
 - a. Poor collaboration among participating teachers
 - b. Students lacked expected prior knowledge
 - c. Lesson was not carried out as planned
 - d. Lesson did not work as planned (e.g., activities took longer than planned, questions did not elicit expected student response)
 - e. Student work did not show adequate evidence of learning
 - f. Not enough time to review student work
4. Please explain or elaborate on the above.
5. Please describe 1 or 2 things you learned from this TLC experience.
8. For how many hours did the group convene to debrief?
9. For this lesson study, what did the group do during the debrief? (Select all that apply.)
 - a. Shared what worked and did not work when teaching the lesson
 - b. Reviewed or discussed student work
 - c. Developed a scoring rubric to review student work
 - d. Had a facilitated scoring session of student work
 - e. Discussed how to revise the lesson as a group
 - f. Revised the lesson as a group
 - g. Planned or discussed a new lesson
 - h. Other (please specify):

Facilitator Post-TLC Survey (2018–19)

1. How many teachers in each grade level participated in this lesson study?
2. Were all of these teacher participants from the same school site?
3. Did the lesson study group convene for planning (i.e., to discuss how to develop a new learning sequence or how to implement/modify an existing learning sequence)?
4. For how many hours did the group convene for planning?
5. For this lesson study, which most closely applies to the teaching the group did?
 - a. Teachers co-taught the lesson TWO times
 - b. Teachers co-taught the lesson ONE time
 - c. Teachers taught the lesson on their own
6. For how many hours did the group convene for teaching? (Please choose "0" if teachers taught on their own.)
7. Did the group convene to debrief?
10. What about this lesson study went particularly well? (Select all that apply.)
 - a. Meaningful discussion/learning among students during lesson
 - b. Meaningful discussion/learning among participating teachers during planning or debrief
 - c. Teachers deepened their understanding of 3 dimensional instruction
 - d. Teachers deepened their understanding of instruction that integrates science disciplines
 - e. Teachers deepened their understanding of instruction that integrates engineering
 - f. Teachers deepened their understanding of instruction that integrates environmental education
 - g. Teachers practiced effective questioning strategies while interacting with students
 - h. The group identified potential improvements to the first lesson plan
 - i. Student notebooks were effectively used for sense-making
 - j. Student work showed clear evidence of learning

- k. Student work showed understanding of more than one dimension of the NGSS
- 11. Please explain or elaborate on the above.
- 12. Please describe any noteworthy successes not listed above.
- 13. What was challenging about this lesson study?
 - a. No challenges
 - b. Poor collaboration among participating teachers
 - c. Students lacked expected prior knowledge
 - d. Lesson was not carried out as planned
 - e. Lesson did not work as planned (e.g., activities took longer than planned, questions did not elicit expected student response)
 - f. Student work did not show adequate evidence of learning
 - g. Not enough time to review student work
- 14. Please explain or elaborate on the above.
- 15. Please describe any noteworthy challenges not listed above.
- 16. How would you compare this new lesson study configuration to the TLC configuration in prior years of the Early Implementers Initiative?
 - a. Much better
 - b. Better
 - c. About the same
 - d. Worse
 - e. Much worse
 - f. I have no opinion
 - g. I am not familiar with the previous TLC configuration
 - h. N/A (Same configuration as before)
- 17. Please explain at least ONE specific way the lesson study was better or worse than the previous TLC configuration.
- 18. Please describe 1 or 2 things you learned from this lesson study experience.

Teacher Leader Post-TLC Survey (2016–17 & 2017–18)

- 1. Please clearly describe one thing you learned from this TLC experience that you plan to take back to your classroom.

Teacher Leader Post-TLC Survey (2018–19)

- 1. Did you need a substitute to cover your class when you participated in any part of this lesson study? (Choose the total amount of time a substitute covered your class in order for you to participate in all parts of the lesson study.)
 - a. Yes, for more than one full day
 - b. Yes, for one full day
 - c. Yes, for less than a full day
 - d. No
- 2. Did you receive any extra pay (e.g., stipend or compensation on top of your regular teaching salary) for participating in any part of this lesson study?
- 3. To what extent did your lesson study experience deepen your understanding of the following aspects of the NGSS?
 - a. Science Disciplinary Core Ideas (DCIs)
 - b. How to use Science and Engineering Practices (SEPs) to teach science and engineering
 - c. How to use the Crosscutting Concepts (CCCs) to teach science and engineering
 - d. How to use a three-dimensional approach to help students understand a phenomenon
 - e. How to use the engineering design process to develop student understanding of science and engineering
 - f. How to integrate the science disciplines (e.g., physical, earth & space, life) to increase student learning
 - g. How to address environmental education in a science unit (e.g., human impacts)

4. To what extent did your lesson study experience empower you to be able to use the following project tools and practices on your own (should you wish to use them)?
 - a. How to use a conceptual flow of science concepts to design and/or teach science lessons
 - b. How to use the 5E instructional model to design and teach lessons
 - c. How to use phenomena to drive instruction
 - d. How to use questioning strategies (e.g., teacher-to-student, student-to-student discourse) to develop student understanding
 - e. How to look deeply and systematically at student work as evidence of student understanding
 - f. How to use science notebooks to elicit student sense-making
 - g. How to use Claim, Evidence, and Reasoning (CER) to advance student thinking
 - h. How to modify a lesson based on student work.
5. Would you recommend the lesson study experience to other teachers?
6. Please choose up to 3 things you learned from this lesson study experience that you plan to take back to your classroom.
 - a. The importance of using a phenomenon for student engagement
 - b. How to access students' prior knowledge at the beginning of the lesson
 - c. How to create and implement a lesson that is student centered
 - d. Importance of providing students with hands on experiences
 - e. How to use the SEPs or CCCs in my teaching
 - f. How to promote student-to-student discourse and interaction
 - g. The importance of building into lessons time for student thinking and reflection

- h. The understanding that lessons may not work as planned
- i. Other (please specify):

Survey for K–8 Principals (2017–18)

1. During the 2017–18 school year, how much impact did the following have on your understanding of NGSS?
 - a. The 2017 Early Implementers Summer Institute
 - b. TLC Plan Day
 - c. TLC Teach Day
 - d. Evidence of Learning Protocol (outside of TLC)
 - e. Science Walk-Through
 - f. Professional learning (PL) within the district
 - g. Professional learning (PL) outside of the district

Spring Survey for Science Teachers (2018–19)

1. During the 2018–19 school year, how many science TLC (lesson study) sessions did you attend as a participant, NOT a facilitator? Lesson studies are facilitated meetings that involve planning, teaching, and/or debriefing a specific new or existing lesson with other teachers. The debrief sessions often include review of student work.
 - a. Number of TLC plan sessions you attended
 - b. Number of TLC teach sessions you attended
 - c. Number of TLC debrief sessions you attended
2. To what extent did your lesson study experience deepen your understanding of the following aspects of the NGSS?
 - a. Science Disciplinary Core Ideas (DCIs)

- b. How to use Science and Engineering Practices (SEPs) to teach science and engineering
 - c. How to use the Crosscutting Concepts (CCCs) to teach science and engineering
 - d. How to use a three-dimensional approach to help students understand a phenomenon
 - e. How to use the engineering design process to develop student understanding of science and engineering
 - f. How to integrate the science disciplines (e.g., physical, earth & space, life) to increase student learning
 - g. How to address environmental education in a science unit (e.g., human impacts)
3. To what extent did your lesson study experience empower you to be able to use the following project tools and practices on your own (should you wish to use them)?
- a. How to use a conceptual flow of science concepts to design and/or teach science lessons
 - b. How to use the 5E instructional model to design and teach lessons
 - c. How to use phenomena to drive instruction
 - d. How to use questioning strategies (e.g., teacher-to-student, student-to-student discourse) to develop student understanding
 - e. How to look deeply and systematically at student work as evidence of student understanding
 - f. How to use science notebooks to elicit student sense-making
 - g. How to use Claim, Evidence, and Reasoning (CER) to advance student thinking
 - h. How to modify a lesson based on student work.
4. What leadership role(s) did you have with the Early Implementers Initiative this year? (Check all that apply.)
- a. Site lead at my school

- b. Facilitator of lesson study-related meetings
- c. Facilitator of other professional learning for teachers
- d. Core Teacher Leader
- e. Teacher Leader
- f. Other (please explain)

Spring Survey for Administrators (2018–19)

1. How many science TLC (lesson study) sessions did you attend during the 2018–2019 school year?
- a. Number of TLC plan sessions you attended
 - b. Number of TLC teach sessions you attended
 - c. Number of TLC debrief sessions you attended
2. During the 2018–2019 school year, how much impact did the following have on your understanding of NGSS?
- a. The 2018 Early Implementers Summer Institute
 - b. Lesson Study Plan Session
 - c. Lesson Study Teach Session
 - d. Lesson Study Debrief Session
 - e. Evidence of Learning Protocol (outside of TLC)
 - f. Science Walk-Through
 - g. Professional learning (PL) within the district
 - h. Professional learning (PL) outside of the district

Interview Questions Used for This Report

Project Director Interview #3 (March 2017)

1. Another opportunity for leadership growth, especially for Core TLs, is the TLC. How do you think CTLs are doing in the role of TLC facilitator?
 - a. How did they prepare to facilitate?
 - i. Did each one have similar prep?
 - b. Are all CTLs taking on this role?
 - i. If not, are some opting to not facilitate TLCs or have only a subset of CTLs had the opportunity to shadow/facilitate?
2. Have you been tracking who or how many of the K-8 principals have attended/observed TLCs?
 - a. Optional: Have you gotten feedback from them regarding TLCs?

Project Director Interview #5 (June 2018)

1. Is there a story about TLCs in your district?
 - a. Will all expansion teachers get same exposure/PL?
 - b. How is site-based PL dealing with expansion teachers in grade levels outside the TL grade levels? Will they get TLCs?

Project Director Interview #6 (October 2018)

1. Is your district implementing TLCs or lesson studies this year?
 - a. If so, are they site-based or cross-site?
 - b. How many have already happened so far this year?

- c. Were you in attendance at any of them? (Probe: How did the lesson study compare to the EI TLCs in years 1–4? What did the facilitator do well? What did the facilitator struggle with? How would you describe the level of participant engagement and learning?)
2. Are lesson studies in your district the same or different as the Early Implementer TLCs from years 1–4?
 - a. If different, what is the primary reason for modifying the Early Implementer model?
3. What are the configurations in your district for planning the lesson? (Probe: Where are lesson ideas coming from?)
 - a. For teaching the lesson?
 - b. For debriefing the lesson? (probe re review of student work)
 - c. Are all sites following the same configuration?
4. Is there any **other** way that lesson studies in your district this year are different from the Early Implementer TLCs from years 1–4?
5. Who is participating in lesson studies?
 - a. Are any TLs participating (not as facilitators) or is it all expansion teachers?
 - b. How much variation in levels of participation is there across teachers in the **district**? That is, will some teachers do only one lesson study while others will do several?
 - c. What does the variation across the **district** depend on?
 - d. Are all teachers at each **site** participating at the same levels?
 - e. If not, what does the variation within a **site** depend on?
6. Who is facilitating the lesson studies?
 - a. Did all of this year's teacher facilitators facilitate a TLC last year?

- b. Are any of this year's facilitators brand new to the Early Implementers (i.e., they joined the Initiative in spring/summer of 2018)?
- 7. If yes to 5b: What kind of **initial** training or support are inexperienced facilitators getting?
 - a. What kind of **ongoing** support, if any, are they getting?
 - b. Are they shadowing an experienced facilitator? (Probe: Who are they shadowing: RD, PD, CTL, TL? How many times? For one or more parts of the lesson study?)
 - c. Are **experienced** facilitators getting any ongoing support?
 - d. How, if at all, do new and/or experienced facilitators get feedback on their facilitation?
- 8. Is there a push to involve administrators in lesson studies this year?
- 9. If administrators are involved, please describe how (i.e., what kinds of things are they doing during lesson studies, and who is asking them to be involved in the lesson studies?)
- d. How would you describe the level of participant engagement and learning?
- 5. Have you had a chance to collect any feedback from participants or principals that have participated in or observed lesson studies this year?
 - a. If so, can you share it? What was said?
- 6. Some districts are experimenting a bit with lesson studies. Are there plans for any new or different configuration(s) of lesson study meetings this year?
- 7. Do you have a plan in mind for lesson studies next year?

Case Study Teacher Interview #1 (December 2016–January 2017)

- 1. Have you participated in any additional science-related professional development events this year or last year that were not part of project (e.g., other initiative in the district, conference)?
- 2. What are some of the most impactful things you have learned from the Early Implementer project? How have they affected your teaching?

Project Director Interview #7 (January–February 2019)

- 1. Do you have any updates or corrections to the information about lesson studies that was in the transcript or the table we sent you?
- 2. Is there any new information from your district relating to lesson studies? (For example, are you involving more administrators?)
- 3. (If you want to ask about gaps and clarifications, do so now.) I have some clarifying questions for you about lesson studies. . .
- 4. How many lesson studies have you attended this year?
 - a. What was the best thing you've seen in a lesson study?
 - b. What have you seen facilitators do well?
 - c. What have facilitators struggled with?

Case Study Teacher Interview #2 (June 2017)

- 1. What EII events did you participate in since our last interview and what are some of the most impactful things you learned from them? How did they affect your teaching this year?

Case Study Teacher Interview #3 (November–December 2017)

- 1. Have you attended or engaged in any professional learning on science since the end of last school year?
 - a. If so, what were they? EII events? District/school events? Other events (e.g.,

conferences)? Other methods of professional learning (e.g., online)?

- b. What were the most impactful things you learned?
- c. How did or might this PL affect your teaching this year?

Case Study Teacher Interview #4 (May–June 2018)

1. Were you a teacher participant or a shadower or a facilitator? (If facilitator or shadower, how many times before had you had that role?)
 - a. If yes: Tell me about that experience.

Case Study Teacher Interview #5 (October–November 2018)

1. Who will you be mentoring or sharing your NGSS expertise with this year, and in what context? (Probe whether site-based vs district-wide.)
 - a. Expansion teachers? Teacher Leaders?
 - i. PLCs?
 - ii. Lesson studies?
 - iii. Other professional learning?
 - b. Administrators?
 - i. Learning walks?
 - ii. Lesson studies?
 - iii. Presenting at an admin meeting?
 - iv. Other professional learning?

Case Study Teacher Interview #6 (April–May 2019)

1. What training or experience has been the most valuable in helping you gain the understanding and confidence you need to implement these NGSS features?

Expansion Teacher Interviews #1 and #2 (May–June 2017 and May–June 2018)

1. Have you received formal PD about NGSS from your school or district?
 - a. Tell me about that (How many times? For each: When was it? Who led it? How long did it last? How did you find out about it? Was it required? Did you get paid to be there? Was it grade-specific? Activity or presentation?)
 - b. What did you think of it?
 - c. What did you learn?
 - d. Were you empowered or inspired to try something new in your classroom as a result? If yes, tell me more about that.
2. What support or conditions do teachers need in order to teach the NGSS? (Note how many of these they include: time to plan, time/opportunity to collaborate with other teachers, permission to experiment, access to NGSS-aligned curriculum/lessons, access to materials to use in class)
3. Has your principal been supportive of you learning about or trying out NGSS in your classroom? If yes, how so? (Probe examples: permission to experiment, provided resources or materials, opportunities for training, opportunities for collaboration)

Expansion Teacher Interview #3 (Spring 2019)

1. What training or experience has been the most valuable in helping you gain the understanding and confidence you need to implement these NGSS features?
 - a. What type of training or experience was it? (Probe: When was it? Formal or informal? Was it required? Did you get paid to be there? Was it grade-specific? Activity or lecture?)

- b. Who led it or who shared their expertise with you?
 - c. Why was it valuable? What did you learn? What did you do differently or try in your classroom as a result?
2. What other training or experience — if any — has been valuable in helping you gain the understanding and confidence you need to implement these NGSS features?
- a. What type of training or experience was it? (Probe: When was it? Formal or informal? Was it required? Did you get paid to be there? Was it grade-specific? Activity or lecture?)
 - b. Who led it or who shared their expertise with you?
 - c. Why was it valuable?
 - d. What did you learn? What did you do differently or try in your classroom as a result?
3. What support or conditions do you need in order to implement (more) NGSS instruction in your classroom? (Note how many of these they include: time to plan, time/opportunity to collaborate with other teachers, permission to experiment, access to NGSS-aligned curriculum/lessons, access to materials to use in class)
4. How has your principal supported your NGSS teaching? What has been most valuable?

Administrator Interview #1 (May–June 2017)

1. Which of these project events have you attended?
 - a. TLCs (Probe: What was your role at the event? What do you remember/what did you learn from it?)
2. Are any of the teachers at your school on the CLT? Are there any TLs? If yes:
 - a. How many?
 - b. What, if any, impact from the Initiative have you seen on these individuals? (Probe

re leadership, instructional practices, collaboration.)

- c. Have you heard other admins talking about the impact of NGSS on teachers or students?

Administrator Interview #2 (June–July 2018)

1. Did you attend any TLCs during the 2017–18 school year?
 - a. What was your role at the event?
 - i. What specifically did you observe?
 - ii. How, if at all, did you participate?
 - iii. Did you use an Evidence of Learning protocol? (if so, how?)
 - b. What did you learn from this experience?
 - c. How, if at all, did this experience/information received influence your behavior on the job?
2. How many teachers at your school are participating with the Early Implementers grant?
 - a. What, if any, impact from the Initiative have you seen on these individuals this year? (Probe re leadership, instructional practices, collaboration.)
 - b. Can you give me any specific examples?
 - c. Have you heard other admins talking about the impact of NGSS on teachers?

Core Administrator Interview #1 (May–July 2019)

1. How many times in all have you **observed** any part of a TLC or lesson study in science?
 - a. Was it a plan day, a teach day, or just a debrief session?
 - b. How many times did you **participate** in some way versus just observe? How did you participate (e.g., contributed to the discussion or debrief)?

- c. Were any other administrators there and did they observe or participate?
 - d. Would you say this was effective professional learning for you or for the other administrators? If no, why not? If yes, what did you learn?
2. What changes have you observed in teachers' ability to teach the NGSS?

Site Leader Administrator Interview #1 (May–July 2019)

1. Have you had any teachers serving as teacher leaders in the Early Implementers Initiative at your school?
- a. (If yes) About how many Teacher Leaders over the course of the Initiative and at what grade levels?
 - b. (If yes) How, if at all, have they played a leadership role at your school? (Probe: presented to staff, worked with grade level team)
2. Have you attended any other Early Implementer PD specifically for administrators?
- a. (If yes) What kind of PD was it? (Probe: Admin Academy activity? Presentation at an admin meeting? TLC?)
 - b. When was it?
 - c. Did you feel it was a worthwhile use of your time? (If not, what would have made it more worthwhile? If so, what stands out in your memory about the experience? What did you learn?)
 - d. Did it impact your behavior at your site? (Probe: Did it cause you to do anything new to support NGSS implementation?)

District Administrator Interview #1 (May–July 2019)

1. Have you attended any NGSS professional development in the district for **administrators**?
- a. How many times? (If more than one time) Let's talk about the one that you feel had the most impact.
 - b. Who led the PD? (Make sure it is connected to the Initiative.)
 - c. When was it?
 - d. What kind of session was it? (How long? Districtwide? Site-based? TLC? Summer Institute? Walkthrough?)
 - e. Who attended? (Which administrators: All? Elementary? Middle school?)
 - f. What was the purpose?
 - g. How did it go? (What worked well? What could have been better?)
 - h. How, if at all, did it impact administrator support for NGSS in the district?
2. How, if at all, have Early Implementer participants, such as the teacher leaders or the district's Project Director, influenced the district's prioritization of science or promotion of science as a core subject?
3. To what extent would you say the district is spreading NGSS implementation to all teachers (i.e., beyond the Teacher Leaders)?
- a. What strategies have worked best so far to advance this effort?
 - b. What funding avenues, if any, have been explored to support this effort?
 - c. What have been the biggest barriers or challenges?
 - d. What expectations have been communicated to principals, if any?
 - e. What still needs to be done to bring all teachers who should be teaching science up to speed on the NGSS? Are there plans to do this in the near future?

Appendix B. Explanation of Five Project Tools and Practices

This appendix describes five key tools and practices that are central in the professional learning provided through the NGSS Early Implementers Initiative to teachers and administrators in the participating districts. For more detailed descriptions of these five tools and practices, as well as others, please see the report, *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/>).

Sense-Making Science Notebooks

Science notebooks are a centerpiece of NGSS implementation that Early Implementers have been learning about since the first Initiative convening. The primary purpose of notebooks is for students to record their thoughts, wonderings, observations, findings, and evolving understanding. The secondary purpose is for teachers to see evidence of that understanding to help inform their planning of classroom activities that elicit student thinking and advance student learning. Early Implementers learn that the purpose of notebooks is not student evaluation. The notebook belongs to the student, just as a scientist's notebook belongs to the scientist.

Four "essences" of sense-making notebooks should regularly be recorded by the student:

- *Prior knowledge.* I think, I predict, I hypothesize
- *Gathering data.* I saw, I observed, I measured
- *Making sense of data.* I think ___ because. . . ; The data graph shows. . . ; Based on the evidence. . .
- *Metacognition.* helped my thinking because. . . ; I wonder. . . ; My thinking has changed. . .

Questioning Strategies

Teachers are coached to be very aware of the way they facilitate discussion to elicit productive student talk. Early Implementers learn questioning strategies to keep instruction inquiry-based, so that students are prompted to actively construct meaning for themselves. That is, rather than provide answers to student questions, teachers respond with their own thought-provoking questions, such as, "What do you think could be going on?" "How do you know?" "Do you agree with X? Why?" "How could you find out about that?" Besides fostering meaningful student engagement with the content, this questioning strategy encourages increased and improved teacher–student and student–student discourse.

5E Instructional Model

Based on the constructivist approach to learning, which says that learners build new ideas on top of old ideas, the 5E instructional model¹⁵ is driven by student questioning and discussion. At each stage of the lesson — Engage, Explore, Explain, Elaborate/Extend, Evaluate — students practice and develop literacy skills. They record and discuss their prior knowledge of a phenomenon; share ideas with peers; conduct investigations; read texts, watch video clips, or otherwise take in new information; and revise and articulate their new thinking.

Defining Phenomena

The Early Implementers Initiative defines phenomena as “occurrences in the natural and human-made world that can be observed and cause one to wonder and ask questions.” Focusing instruction on phenomena “requires students to use the science and engineering practices (SEPs), crosscutting concepts (CCCs), and disciplinary core ideas (DCIs) in concert to explore, investigate, and explain how and why phenomena occur” (Brown et al., n.d.). The NGSS do not specify which phenomena to use in science instruction, “because phenomena need to be relevant to the students that live in each community and should flow in an authentic manner” (California Department of

Education, 2016). Instead, teachers are encouraged to select phenomena that will engage their students, taking into consideration the local context as well as student ability levels, interests, and previous experiences.

Looking at Student Work in a Teaching Learning Collaborative

In the Teaching Learning Collaborative (TLC) process, as teachers design the lesson, they create “expected student responses” to teacher prompts. These expected student responses are used to create the descriptions of high-quality student work. After the first time teaching the lesson they collaboratively designed, the TLC teams use the expected student responses and preliminary rubrics that they created based on the expected student responses to sort student work into performance levels. Groups sort student work by high, medium, and low performance. The teams then identify the characteristics of the lower-performance work to see where student learning might be improved. For example, if the characteristic indicates a common misunderstanding of a science SEP or limited use of a literacy skill, the team can discuss and agree upon ways to change the instruction to address the misconception.

15 Originally developed by Biological Sciences Curriculum Study (BSCS; Bybee et al., 2006).

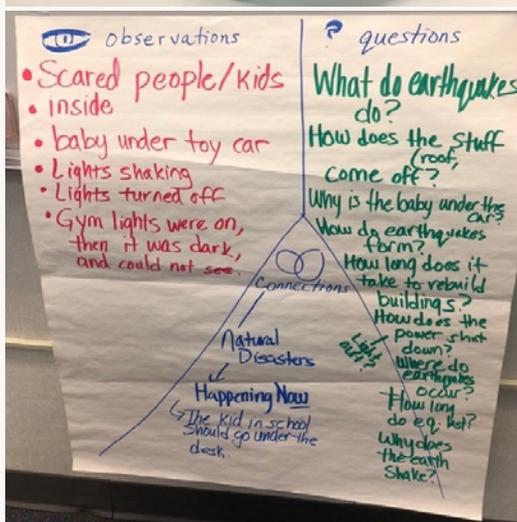
Appendix C. Vignette of a Year 5 “Mini-TLC”

In Year 5 of the Initiative, one of the Early Implementer districts developed a “mini-TLC.” In this setup, small teams of same-grade teachers, led by two experienced facilitators, planned, co-taught, and debriefed a lesson in a half day. The following vignette describes in detail one such modified TLC session that was observed by a WestEd evaluator during Year 5 of the Initiative.

Planning

Three grade 4 teachers met with two Core Teacher Leader facilitators early in the morning. The session began with an overview of the shifts in pedagogy required by the NGSS. For instance, facilitators began by reviewing key principles in *How People Learn* (National Research Council, 2000). The group then examined a 5-E planning template, which prompted the group to record the phenomenon to be addressed in the lesson and to fill out the “What Teacher Does” and “Expected Student Response” columns.¹⁶

In order to expedite the lesson planning process, the facilitators had brought in a partially filled out template that included a suggested phenomenon: earthquakes. They asked the teachers to add to or modify the lesson plan. One facilitator noted that the lesson plan was, “Purposefully blank — not a full-blown 5E. Fill in the rest with your expertise.” The other facilitator added, “You know your kids better than we do, please let us know if there’s anything you want to change.”



Top Photo: Materials used during the teaching portion of the TLC to simulate an earthquake (e.g., shake table).

Bottom Photo: Fourth grade students’ observations, questions, and connections recorded during the lesson.

Facilitators and teachers reviewed a series of earthquake videos, thinking that students would watch one to start the lesson “without sound so they focus on what they see.” One facilitator

16 For a fuller description of the 5E instructional model and how it is used during TLC planning, see the special Early Implementer evaluation report, *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/>

encouraged teachers to think about student responses to the video and use that to frame their instruction: "If they were writing down their observations, what do you think they would say they saw? So as we go through this sequence, think of how you would word it. How would you dissect this lesson as you teach it?"

Then, they discussed the flow of the lesson: Students will watch the earthquake video twice, and record their observations, questions, and connections. Afterwards, students will engage in an "Explore" activity with a shake table that would help them simulate an earthquake and observe the effects on a building. They will conclude by creating a model of what they saw and use it to explain properties of waves.

Throughout the lesson planning portion of the TLC, facilitators and teachers engaged in dialogue around what students might know (or not know) and how that could inform their instruction. Referring to students' background knowledge, a teacher expressed some concern that watching a video of a Richter scale before this lesson might be leading students too much. Another teacher was unsure that students would know how to draw a wave, so asked, "If kids aren't sure how to make a wave, do we ask them to draw a picture of what a giant earthquake would look like, and then a smaller earthquake?"

In addition, facilitators reminded teachers of the lesson goals. For example, through the "Engage" activity, "[Students] become the earthquake. We're trying to get kids to understand that there are wave properties, amplitude." When asked by a teacher if vocabulary should be reviewed beforehand, a facilitator responded that the activity provides context that words can be attached to, and that students might understand the "concept but not the word," or vice-versa. The facilitator added, "When they get the experience, it gives them the content to

hopefully make it stick." Then, the "Explain" portion of the lesson connects to the NGSS Performance Expectation: "The Performance Expectation is asking kids to develop a model of waves to see patterns of amplitude and wavelength."

Before heading into the classroom, teachers divided up the lesson and discussed who was teaching what instructional segments. They practiced using the shake table and a facilitator encouraged them to manipulate the magnitude of the "earthquake" during their instruction: "When you model it, show different amounts of energy while shaking." Teachers planned to have students work in groups. Students would have different roles: shaking the table, holding the paper, gripping the pencil, and monitoring the time. Students would simulate earthquakes first without a building and then with a building.

Teaching

The teaching portion of the TLC began with students watching a video of an earthquake with no sound. Then, they watched the video a second time and were instructed to write down what they saw, specifically their observations, questions, and connections. A teacher clarified that the questions are *their* questions, and connections are what students thought of as they watched the video. Students shared out the following responses and a teacher recorded them on chart paper:

- "I observed they were mostly inside."
- "Question — what does the earthquake do?"
- "How does the stuff come off? The roof."
- "Lights. They were like shaking."
- "How do earthquakes form?"
- "How did the power shut down?"
- "Where do earthquakes occur?"

- "How long do earthquakes last?"
- "Why does the earth shake?"

A teacher categorized students' responses into observations and questions. After many students shared out, a teacher asked, "Does anyone have a connection?" A student said that earthquakes are natural disasters. Another student added that they are happening now. A third student stated that he did not see someone under the desk but should have. After the share-outs, a teacher collected student work.

A teacher modeled how to use the shake table with a volunteer and provided instructions for how students should record their data. They would count the number of spaces every 10 seconds. A teacher asked students to "experiment with tiny movements and larger movements." When asked what the wave drawing looked like, a student responded, "a thing from the hospital."

Students in groups of three or four experimented with the tables. First, they just used the board and then they added blocks to it. On their worksheets, students drew the waves with their pencils, as well as the arrangement of the blocks on their boards.

Teachers instructed students to hand in the materials and turn over their worksheets. A teacher asked students to make a model that showed their understanding of what they learned during the lesson. Students had the options of recording their thinking using words or numbers. Students had just a few minutes to draw what they saw and what they thought. They were asked to include only a few words.

The Debrief

One of the facilitators posed the following question at the very beginning of the ten-minute debrief: "Based on what you experienced, what

would you have done differently?" One teacher said that at the beginning they should have explained a little more about what they would do during the lesson. Another teacher thought they should have asked students what they know about waves. The third teacher responded to this teacher by asking, "If they knew we were studying waves, would it be a different outcome?" The second teacher answered, "But you did say it," so students were aware of the content focus of the lesson.

The facilitator recommended changing the frequency of data recording from 10-second to 5-second intervals and noted that multiple trials with the shake table should be encouraged.

In terms of what went well, a teacher "was impressed [students] worked in groups as well as they did," and another teacher noted good student engagement. The first teacher also remarked that she appreciated the open-ended nature of the lesson because students were free to pursue their own wonderings.

There was a very brief review of student work. One of the facilitators asked whether the teachers had studied earthquakes already with their students, and a teacher responded that they had.

The teachers said that they would like the facilitators to come back for another TLC. In response, a facilitator suggested they talk to their principal, as LCAP money had been allocated for science. Even though this TLC experience was considerably shorter than the TLCs in Years 1–4 of the Initiative, it is apparent that it was helpful to teachers in planning their NGSS-aligned instruction.

A possible limitation of the TLC in a nutshell experience was that facilitators predetermined what standards would be covered and the phenomenon that students would experience, which prevented TLC participants from developing the lesson from scratch.

Glossary

California Science Teachers Association (CSTA)

— A nonprofit organization dedicated to promoting high-quality science education and representing the interests of science educators at the state policy level. Several Early Implementer leaders have taken roles in CSTA, and many Early Implementer Teacher Leaders have presented at the association's annual California Science Educator Conference.

Conceptual Flow — Tool developed by the K–12 Alliance for mapping the storyline of three-dimensional NGSS instruction. A conceptual flow can be constructed for a six- to eight-week instructional unit or a year-long program, depending on the complexity of the anchoring phenomenon and how many of the grade-level performance expectations are incorporated.

Core Leadership Team (CLT) — Group of 3–5 administrators and 5–8 teachers established at each district at the beginning of the Initiative. The CLT meets with their Project Director regularly during each school year to plan and lead all Early Implementers Initiative activities. They meet with their K–12 Alliance Regional Director for six Technical Assistance Days each school year.

Core Teacher Leader (CTL) — Teacher member of the Core Leadership Team. Provides professional learning to Teacher Leaders, other teachers, and/or administrators in their district or at project-wide events such as the Summer Institute.

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 includes three dimensions: Disciplinary Core Ideas (what scientists know), Crosscutting Concepts (how scientists make connections among the sciences), 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 National Research Council's Framework for K–12 Science Education, disciplinary core ideas are the important concepts in each of four domains: physical sciences; life sciences; Earth and space sciences; and engineering, technology, and applications of science.

Expansion Teacher — Teacher who has not directly received significant professional learning or support from the Initiative but who is benefiting through the shared expertise of those who have. In larger districts, expansion teachers are typically in schools with at least one Teacher Leader.

K–8 NGSS Early Implementers Initiative — 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 California State Board of Education, California Department of Education, and Achieve, the Early Implementers Initiative builds capacity of participating local education agencies to fully implement the NGSS in grades K–8.

The K–12 Alliance — A WestEd program of science education leaders and professional learning providers who plan and deliver all project-wide activities for the Early Implementers Initiative.

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

Lesson — Three-dimensional (3-D) NGSS phenomenon-based instruction lasting for a single class period, typically 45 to 90 minutes, but potentially longer.

NGSS — A set of K–12 science content standards developed by 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.

Norms — Agreed-upon productive behaviors and mindsets that guide a group when working together.

Phenomena — Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. There are two types of phenomena, anchoring and investigative.

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

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 — Weeklong professional learning event held every summer to kick off the new Early Implementer school year. In Years 1 through 4, these were regional, typically one in the north and one in the south, and were 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, a separate Summer Institute was held in each district that was open to any interested principal or teacher of science.

Teacher Leader (TL) — One of 30–70 teachers in each district who joined the Early Implementers Initiative in Year 2, one year after the Core Teacher Leaders. Teacher Leaders attend annual Summer Institutes and participate in two TLCs each school year (one in the fall and one in the spring) and other district-level professional learning.

Teaching Learning Collaborative (TLC) — Lesson-study activity of Years 1 to 4 of the Early Implementers Initiative. Each TLC brings together three to four same-grade Early Implementers Initiative teachers from different schools within the district. Teachers plan and teach a lesson to two classrooms of students and debrief after each lesson is taught during which they examine student work from the lesson. Each Teacher Leader participates in two TLCs per year.



Collaborative Lesson Studies

Powerful Professional Learning for Implementing the Next Generation Science Standards

EVALUATION REPORT 8

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