Lessons Learned from the NGSS Early Implementer Districts: **Instructional Materials**

Introduction

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

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

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

The following sections focus on the districts' reflections regarding the instructional materials needed to implement the standards in hopes that their reflections can inform district and state leaders throughout the country as they also implement the NGSS. It should be noted that the state of California, and therefore the nine Early Implementer districts interviewed, have not yet adopted and the state has not yet recommended instructional materials for the NGSS. **Importantly, most districts stated that not only were they not ready as a district to adopt new materials, but they also had not yet seen materials that they felt were ready for serious consideration.[2]** In the absence of available, aligned materials to the NGSS,

[1] The interview methodology is described in detail here

[2] In November 2016, the California State Board of Education approved the California Science Curriculum Framework, making California the first state to produce a curriculum framework based on the NGSS for grades K–12. This framework is intended to guide instructional materials development and decisions and provide criteria for textbook publishers. The state is expected to release a list of recommended instructional materials in 2018.

districts have approached the transitional instructional materials challenge in a variety of ways that are instructive.

It's important for districts to have a transparent and broadly understood strategy for instructional materials transitioning to the NGSS; otherwise teachers may not feel that they have the necessary resources to transition to or fully implement the NGSS. In the report *America's Teachers on Teaching in an Era of Change: Teachers on the Common Core*, teachers were asked about the Common Core State Standards (CCSS) in 2013 and 2014. In 2014, even as teachers reported having more experience with the CCSS and feeling more enthusiastic about them than in 2013, the number of teachers reporting that implementation was challenging increased. Eighty-six percent of teachers identified instructional materials as a resource critical for implementing the standards. Furthermore, in a study from the Fordham Institute, more than 40 percent of teachers surveyed in 2016 felt that their instructional materials for mathematics were not aligned to the CCSS. Providing teachers with the resources they need will be critical to meeting the promise of the NGSS to improve science education for all students.

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

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

The nine school districts included in these interviews had differing approaches to transitioning their instructional materials as they began implementing the CA NGSS. The approaches include districts creating instructional materials, districts modifying instructional materials, teachers creating instructional materials, teachers modifying current instructional materials, or considering the purchase of commercially available materials. This report is meant to show the variety of approaches these districts have taken and highlight aspects of the work that they found meaningful and important. It is not meant to imply that particular approaches are better than others. Districts using these lessons learned should consider what aspects of these approaches make sense for their context and should consult existing research on instructional materials.

Other helpful resources include the National Research Council's Science Teachers' Learning Enhancing Opportunities, Creating Supportive Contexts; *the* Guide to Implementing the Next Generation Science Standards; and the Next Generation Science Standards District Implementation Indicators. More resources can be found throughout this document.

Approaches to transitioning instructional materials while implementing the NGSS

Because the NGSS are so different from previous science standards, districts have found that they are not able to use their current science instructional materials for NGSS implementation. As described in the National Research Council's *Guide to Implementing the Next Generation Science Standards*:

> *Developers need to recognize that most traditional approaches to curriculum materials, in which teachers or expository text present new ideas first, and then students apply them in labs or exercises, do not reflect the three dimensions of the NGSS, in which students engage in the science and engineering practices to develop and use the disciplinary core and crosscutting ideas with guidance from teachers. Attention to the practices students are expected to engage in and the ways in which teachers can support students in developing these capabilities are as important as attention to the disciplinary topics and ideas that are to be learned. Curricula will need to achieve a new balance between time spent in the productive struggle to investigate and explain phenomena or to design problem solutions and the number of topics addressed.* (Page 56)

Therefore, as districts have begun transitioning to the NGSS, they have begun to transition to the use of new instructional materials. To obtain these materials, districts have been using one or more of the five sources of materials described below:

- District-developed instructional materials;
- District-modified instructional materials;
- Teacher-modified instructional materials;
- Teacher-developed instructional materials; or
- Commercially developed materials.

These sources and approaches are not mutually exclusive, and some districts use a different approach for elementary materials than they use for middle school materials.

District-developed instructional materials

One approach is for a district to create its own full curriculum program. For example, Oakland Unified School District created a curriculum that includes course maps that lay out the standards and topics for each course, scope and sequences that organize standards and topics within each course, and the corresponding units and lessons for each course. Examples of the Oakland materials are in Appendix A.

A district leader said that the district preferred to use its time and funds to "look at the entire student learning experience and back map" to create resources down to the lesson level as opposed to "taking what already exists and aligning it to the NGSS." The leader stated that the district felt this approach would help create a more coherent experience for students.

This model has challenges. The districts shared that "[i]t would have been cheaper, easier, and faster to buy, but there was nothing [high-quality] out there so we had to invest the time and money." They also stated that it is "very difficult to create high-quality curriculum — it is significantly harder than we thought it would be." It should be noted that the developers did not feel as though the materials were finished once created. Instead, they iterated the materials over the course of three years.

Current California state law allows districts to officially adopt the curriculum they have created. Districts considering investing the time and resources to create new materials should consider their local and state guidelines. In addition, districts should ensure that those involved in development have deep content knowledge of the NGSS and that they use tools such as The Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric for lessons and units and PEEC-Alignment: NGSS Publishers Criteria for textbooks, textbook series, and comprehensive science programs to guide their development and ensure that the materials are high quality and aligned.

District-modified instructional materials

Another approach to obtaining materials is modifying and using existing curriculum. Districts can take the best curriculum that they have and modify it to make it more closely aligned to the NGSS. Due to their participation in the Early Implementation Initiative, districts that chose this strategy were given access to selected materials. One of the Early Implementer districts chose this approach and began by analyzing its existing materials to decide "where to expand [on the existing materials] and where to condense" based on alignment and time constraints.

The district members who modified the materials considered how to deepen the level of understanding with prompts and through the use of student science notebooks, which can be used as learning (e.g., opportunities to write, make models) and assessment tools, eliciting evidence of student learning. To ensure the materials were accessible to all students, they also considered whether the lesson was relevant to students and, if not, how it could be modified to be more relevant. They worked to connect the materials to English language arts (ELA), including building in explicit approaches to teach reading, scaffolds for struggling readers, and opportunities to talk and write about science. They also created and embedded formative assessments throughout the curriculum — including expected responses, scaffolds, and prompts for discussion and notebooks.

These modifications were made by individuals who worked at the district level, starting with grade 3–5 materials and iterated over multiple years. Teachers who were implementing the standards used the materials in a pilot phase and provided feedback. One teacher said, "There have been changes based on our feedback; it's nice to see iterations as a result of our comments." In addition to seeking feedback from teachers, district-level personnel interviewed students about what their experiences with science lessons and assessments. As final changes were being made to the 3rd to 5th grade instructional materials, kindergarten to 2nd grade materials were modified and piloted.

Teacher-modified instructional materials

In many districts, teachers who are implementing the standards early are working on their own to modify existing lessons to make them more aligned to the NGSS. As one teacher said, "We are looking at how we can use the materials we have to transition to NGSS."

Districts have encouraged this approach to varying degrees. For example, one district said it asked its teachers to try modifying their materials to include more practices or crosscutting concepts, while others encouraged more extensive modifications. One district focused on having teachers add engineering into the materials. Another district is focusing on having teachers add more engaging and effective phenomena that can reframe existing lessons with some modifications.

Districts stated multiple advantages to this approach. A benefit mentioned by multiple districts was the flexibility of not being tied to a particular curriculum. One teacher from Palm Springs Unified said, "We have a lot of resources that I can piecemeal together and adapt or modify to be better aligned NGSS." Districts felt that this gave teachers flexibility and that teachers felt more comfortable putting the curriculum together in the way they wanted than when given materials that do not need to be adapted. There are also disadvantages, however: Districts worried whether the resulting curriculum would be incoherent.

Educators from multiple districts shared the idea that engaging in the process of adapting materials increases teachers' understanding of the standards and their ability to discern high-quality materials. A teacher said that modifying materials has increased her confidence with the NGSS and that "it's scarier doing it this way, but it is creating a critical eye for when people try to sell us something." Modifying materials is seen as "getting into messy learning," according to one teacher who also drew a parallel between this work for teachers and the opportunities provided to students: "Exploring, making mistakes, and struggling together [as teachers modifying materials] gives us the ability to trust students to do the same and to ask them to be critical problem solvers." Another teacher reflected that working on instructional materials helped teachers know the materials well enough to be able to be flexible when need be. For example, teachers felt better equipped to ask good questions and prompt students during instruction, even when that required deviating from the materials.

Multiple districts that had teachers modify instructional materials emphasized the importance of giving teachers a generous amount of time to collaborate and sharing the adapted work with other teachers. One district lead said that the teachers who had implemented the standards early, shared the materials they adapted with teachers who were new to the standards and that this provided concrete models of what transitioning to the NGSS looked like (e.g., the inclusion of practices and crosscutting concepts, engineering, or engaging phenomena). Such a system creates trust and a culture of sharing within a school or district.

Teacher-developed instructional materials

High Tech High, a network of K–12 charter schools, asked its teachers who were implementing the standards to work together to develop lessons from scratch. The schools in the network think of their teachers as "designers." The charter network noted that it used some of the funds it would have spent to purchase materials to instead provide teachers with the time to collaborate and create instructional materials. Additionally, it used funds to purchase other tangible supplies needed for lessons.

High Tech High sees the approach of creating its own resources as allowing it to design materials that provide students with opportunities to explain phenomena that are truly relevant, meaningful, and timely. For example, kindergarteners and 1st graders explain phenomena specific to tide pools because this habitat is locally relevant. (More about the kindergarten unit on tide pools and about High Tech High's approach to curriculum development can be found in Appendix B.) The materials also allow for some flexibility. For example, phenomena can change yearly if necessary based on access to different resources and student interest, or some lessons can change over time while the phenomena to be explained stay the same. The teachers and district lead saw this ability to modify materials over time as a dynamic and flexible process that benefited students. Learning driven by the need to explain relevant phenomena is "a way better approach [to instruction and materials] than 'students must know certain content.'"

> *"It is likely, as has occurred with Common Core State Standards, that many of the most rapidly available textbooks and related resources claiming alignment to the NGSS will be superficially rather than deeply aligned and will not have been substantially redesigned (see Herold and Molnar, 2014)."*
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> NRC's Guide to Implementing the Next Generation Science Standards, p. 57

Commercially developed instructional materials

According to the 2012 National Survey of Science and Mathematics Education, most teachers use commercially published materials and cover more than half of the materials. However, the districts did not yet know of commercially published materials that were fully designed for the NGSS. One district lead cautioned that instructional materials, even from reputable organizations, can be touted as aligned to the NGSS, but upon careful inspection no evidence supports such a claim.

On the whole, the districts expect that commercially developed materials will eventually be available and will be adopted. As mentioned previously, districts believed that engaging in the work of modifying instructional materials helps create a critical eye for when the district is ready to adopt materials. The same can be said for when teachers design materials or even when they use high-quality, aligned materials that have been created at the district level. In the view of many districts, one advantage of implementing the standards early is that by the time materials are ready to be purchased and adopted, educators at the school and district levels will know what to look for based on their experience. Educators also report that these experiences deepen their knowledge of the NGSS and their ability to confidently teach the new standards.

In addition, districts noted other activities that they felt would prepare them to adopt materials in the future. A couple of districts were piloting commercial materials to get a sense of what existed before purchasing or adopting them. Another district had an individual serve on a state-level committee focused on instructional materials, and the district felt that this experience provided it both insight and a voice regarding California's future process for approving NGSS aligned instructional materials.

And finally, one district reflected that even when it is ready to adopt instructional materials, teachers may still need to modify them to meet the needs of students and local contexts, which requires providing professional development for teachers to be able to make such adjustments.

> "We are giving science to all students so that all kids have the chance to think critically, understand their world, and dream about their futures and what problems they will be able to solve."
> Elementary Teacher, Palm Springs Unified

Criteria for instructional materials

Districts did not determine explicit criteria for adopting, modifying, or creating the instructional materials they would use for NGSS implementation. However, all districts had implicit criteria, meaning they wanted instructional materials to have particular features regardless of whether they were adopting, modifying, or creating the materials. The implicit criteria districts referred to were that instructional materials should:

- **Be written with all students in mind.** For districts, this criterion included everything from including engaging phenomena that all students could find relevant to their lives to using everyday language that students could access before introducing scientific language.

- **Include specific strategies to engage and support diverse learners.** Districts emphasized including specific supports for English language learners.

- **Include opportunities to elicit evidence of student learning.** This criterion can include daily student work such as a written explanation or a model in their journal. Evidence of learning can also be elicited through tools such as pre-assessments and summative assessments. The important thing is that the opportunity is carefully designed to produce specific evidence that students have learned the three dimensions at hand and that this evidence is used to make decisions about how to continue to use and modify learning opportunities.

- **Provide an opportunity for students to have a voice.** Having a voice had a variety of meanings within and across districts including students having an opportunity to be creative, to express themselves, and to share their thinking or explanations. To some it also meant allowing students to have a say in what they learned about or to direct their own learning.

- **Have a primary focus on the phenomena.** The districts saw the chance for students to explain phenomena as what makes science compelling and exciting. Local phenomena can be especially relevant and engaging for students since they have questions about how their world works. When possible, instructional materials should include opportunities to experience phenomena firsthand.

- **Include opportunities for students to make sense of phenomena in their own way.** This criterion often requires activities that are not as rigid as those that may have been used in the past. This is not to say that activities are not structured, just that they are designed to allow for this flexibility. An example may be allowing students to record their initial thinking about a phenomenon in their journal using whatever method of recording they choose. One teacher reflected that this approach helped her better understand what students were thinking and that drove the learning experience she was able to provide: "We are moving away from barreling through daily learning goals by listening to what students are saying."

- **Be aligned to the NGSS.** One district noted that it sometimes focused so much on identifying interesting phenomena and creating engaging learning experiences for students that it forgot to consider if it was providing students opportunities to use and learn the three dimensions so that they could demonstrate their understanding of the performance expectations at the end of the learning experience. The district felt that instructional materials could be both aligned and engaging and that it needed to prioritize both.

- **Explicitly include crosscutting concepts.** Multiple districts noted that there was a risk of the crosscutting concepts being included in materials only implicitly — if at all — and therefore students would not have an opportunity to use and learn them in the same way they use and learn the disciplinary core ideas and practices. While crosscutting concepts are not more important than the other two dimensions, they are singled out in this list because they have historically lacked explicit reference in instructional materials.

- **Include connections to the mathematics and ELA standards.** Districts pointed out the CA NGSS and CCSS, which California adopted for both math and ELA, work well together and that the necessary shifts for each set of standards complement one another as do practices such as constructing arguments.

- **Integrate science with other subjects.** One district lead noted that integration in grades K-8 can be very superficial and that it strived to instead integrate materials only when integrated instruction was real and relevant. Another district noted that integration can be misinterpreted as including science in other subjects. For example, students may read about science in ELA, and while this can be an effective integration of the two subjects, it should not be seen as a sufficient science experience because students would not have an opportunity to engage in all of the practices.

- **Provide opportunities to read and write about science.** According to one district, there are several opportunities for authentic writing because students have lots of ideas to capture and update with evidence. A teacher from another district said, "Kids are naturally interested and engaged — they want to read and write about science because they want to understand."

- **Give students the chance to make claims, choose evidence, and build on the ideas of others.** The materials should be structured so that students are the ones engaging in three-dimensional learning and meaning making as opposed to the educator doing this work.

- **Be structured to move students along in their conceptual understanding.** While it is important that students have fun exploring phenomena, they should be doing more than just having fun; they must be using their understanding of the three dimensions to explain the phenomenon.

- **Include opportunities for all students to talk and share their thinking as part of the sense-making process.** After visiting a classroom where the NGSS were being implemented, one district leader stated that he was impressed with the conversations he heard, saying, "All students could access the ideas and were using language to explain their thinking, and they adjusted their thinking as they went." A teacher from another district said that the students could spend a whole class talking and that they were working at a higher level than expected.

- **Include opportunities for hands-on activities.** While multiple districts appreciated these opportunities, one also cautioned that hands-on activities still needed to be carefully analyzed to determine whether they are well-designed, aligned and support students in learning the three dimensions. Simply including hands-on activities does not make a curriculum high quality or aligned to the NGSS.

- **Provide students opportunities to look back at their work and understanding and to reflect on both including how they changed over time.** Time for reflection is also seen as another opportunity to address the nature of science.

> *"The greatest weakness of elementary science lessons was in the area of giving students the time and structure needed for sense making and wrap-up."*
>
> Science Teachers' Learning Enhancing Opportunities, Creating Supportive Contexts, p. 57

- **Provide students opportunities to revise their work as they have new experience and gain new understanding and abilities.** For example, students can create explanations and models based on what they know, but as their understanding and abilities change, they should revise their explanations and models.

- **Be written so that they can be shared.** Sometimes when individuals or groups modify or create materials for their own use, the materials are not written in such a way that they can be shared. If possible, including more details and being explicit about assumptions increases the likelihood that another teacher will be able to use the materials effectively, especially teachers who have less experience with the NGSS.

Ideally, districts will add to the above list explicit objective criteria to evaluate the quality of instructional materials and their alignment to the NGSS. When considering what features to look for within instructional materials, the list above may serve as a starting place to identify criteria that *teachers value*. The EQuIP Rubric and PEEC, as previously mentioned, also contain peer-reviewed and tested criteria that can be used for this purpose. Furthermore, collectively determining criteria for lesson study — an activity all districts in the Initiative participated in consisting of a group of teachers and a facilitator creating a learning sequence, studying an extant lesson, and/or modifying a lesson — will allow teachers to have a common understanding of what to look for, making conversations more productive and increasing buy-in.

Other considerations

No matter where districts and teachers obtain their instructional materials — whether locally developed or not — it is recommended that they use research- and practitioner-informed criteria to evaluate materials to determine if they are designed for the NGSS and can support diverse students. Therefore, developers as well as personnel involved in the decision-making process of adoption will need training on the NGSS and on the use of criteria for high-quality materials.

If new instructional materials are being provided to teachers, the materials should also be accompanied by some form of educator support. As one district leader said, teachers need opportunities to "digest curriculum through paid planning time or professional learning." A district leader shared that even when instructional materials are provided, "they need to be modified for the needs of the students" in each classroom. Teachers need time and training to be able to make these modifications.

In addition to lessons and units, districts need physical materials, including some that need to be refurbished each year or more frequently. One district said that it already had a lot of these resources in its labs that were not being used. Other districts had science kits that they could deconstruct, and then they could repurpose the materials in new lessons. Other districts set aside materials for supplies or shifted funds that would otherwise have been used to adopt curriculum to ensure that teachers and students had the supplies necessary to carry out experiments and solve engineering problems.

To address these issues and give teachers the support they need as they transition to the NGSS, it is important for districts to have a strategic plan for instructional materials. Without a plan, teachers may not feel that they have the necessary resources to transition to or fully implement the NGSS. Ongoing support from schools and districts is essential in these standards transitions.

Conclusion

The nine Early Implementer districts are taking different approaches to obtaining transitional instructional materials, including using district-created instructional materials, district-modified instructional materials, teacher-created instructional materials, teacher-modified instructional materials, or commercially developed materials. Districts use an implicit set of criteria that reflect their need to have high-quality instructional materials aligned to the NGSS as well as their values and expertise.

This collection of implementation strategies is not meant to serve as a recommendation of these approaches but as a snapshot of the work being done in the nine districts. It is also not meant to serve as a recommendation of the included criteria. Approaches to transitioning materials and criteria for materials should be based on the capacity and context of each district as well as the priorities and values of the educators in the district.

It is recommended that districts have a transition plan to accommodate immediate needs for instructional materials; to develop and/or use research- and practitioner-informed criteria such as EQuIP and PEEC to determine alignment to the NGSS and the features of instructional materials that make them high quality and able to best support diverse students; to use the criteria in the development, modification, and adoption of instructional materials; and to train educators on the use of new materials.

Achieve would like to thank the educators and district leaders who participated in the interviews, survey and review of these papers. This work would not have been possible without the districts' commitment to science education as well as the leadership of the K-12 Alliance and its leader, Kathy DiRanna. Achieve has been pleased to be a partner with Kathy and her team in this important work. The lessons learned from the Early Implementers will benefit not only other districts in California but others across the nation committed to improving science education. This work and the work of the K-12 Alliance was made possible by generous support from the S. D. Bechtel, Jr. Foundation.

Appendix A: Oakland Unified School District's instructional materials

While the Early Implementation Initiative focus is on grades K–8, Oakland Unified School District (OUSD) has created a full secondary curriculum, which includes course maps that lay out the standards and topics for each course, scope and sequences that organize standards and topics within each course, and the corresponding units and lessons for each course. The first section below gives an example of one unit to show (1) the organization of the unit, (2) types of teacher and student materials, and (3) how a phenomenon and problem can be used throughout a unit. The second section highlights aspects of the curriculum that are important to the district and/or highlighted within this document.

Example unit

This particular unit first presents students with the problem that they will have a chance to solve at the end of the unit: designing a delivery drop system that could be used to drop food and/or equipment, including delicate materials, to remote locations around the world or in space. This problem is written such that it can be easily modified to be more specific; for example, the context of current events could be used to specify the location and supplies that need to be dropped. By presenting this problem early, students are able to connect their learning through the unit to the problem they eventually hope to solve. This connection provides a purpose for the learning experiences throughout the unit.

The unit also has an anchoring phenomenon that students try to explain and model at the beginning of the unit; they have opportunities to refine their thinking throughout and then revise their explanations. The anchoring phenomenon in this unit, presented through a video, is a skateboarder flipping his board. Below is an excerpt from a student handout that scaffolds the process of model and explanation revision throughout the unit. The unit overview suggests presenting students with the question of how understanding this phenomenon will help them solve the delivery drop problem. Such questions will help facilitate the students' ability to make connections between their daily learning, the anchoring phenomenon, and the final problem they are trying to solve, and these connections create a coherent learning experience for students.

8.1.U - RRR   Name: ________________ Period: ___ Date: ________

Anchor Phenomena: Skateboard Jumping

Focus Question: How does a skateboarder flip their board?

Construct a model and written explanation to explain the phenomena.
Provide an example to clarify your explanation/model.

REFINE Your Thinking...

Source	Notes	How does this help me understand the phenomena?
Entry Task: Tablecloth Challenge		
Anchor Text - Baseball: From pitch to hits The ballpark brings home plenty of science		

An excerpt from a student handout that scaffolds the process of model and explanation of revision throughout the unit.

All OUSD units include teacher materials, unit and task overviews, and student materials, such as the handout found above. This unit consists of five tasks, including an entry task and a summative task. Each task requires multiple class periods (other districts might refer to these as lessons). Each task overview addresses the connection to the larger unit, the three dimensions included in the particular task, and a description of the task broken down by day. Throughout the overview are links to tools that are both required for the task (e.g., student sheets, academic discussion scaffolds) and supportive of the task (e.g., possible accommodations, additional resources for teacher background, a form for teachers to provide feedback on the task). An excerpt from the entry task overview for this unit can be found below; it shows the description of the first of five days of instruction for this task.

8.1.0 Table Cloth Challenge

Guiding Question: How can a tablecloth be pulled off a set table - without breaking anything?

Day 1 Prep:

- Prep a space in the classroom for the demonstration.
- Gather materials for the demonstration.
- Gather materials for each group.

Day 1 - Tablecloth pulling

1. 5 min - Engage - Warm Up: What comes to mind when you think about the term *force*?
   a. Students have individual time to answer the question. Students pair-share their answers. Teacher calls on students to share out.
2. 5 min - Engage: Demonstrate pulling the tablecloth and students make an initial model using Technical Writing Tools (TWT's) of what they observed
3. 5 min - Explain: Students use the Academic Discussion Scaffolds to discuss what they think is causing objects to move when the tablecloth was pulled AND what caused objects to not move when the tablecloth was pulled.
   a. Which objects moved more than others? What characteristic about the object caused it to move?
   b. Why did the objects fall in some cases?
   c. Which objects stayed put? What characteristic about the object prevented movement?
4. 10 min - Explore: Teams try the investigation (Task Card) using Group Roles.
   a. As teams investigate, they should change just one variable at a time for each trial.
5. 10 min - Elaborate: Students revisit their initial model to add their new findings. Class data is collected on a chart or display.
6. 15 min - Evaluate: Teams analyze data to identify patterns. Class discusses results. Students revise their models.
7. 5 min Exit Ticket: How did force play a role in the tablecloth activity?

Day 1 Follow-Up:

- Visual representation of force. The use of arrows to show force, direction, and movement.
- Why did some objects behave the way they did and how does that related to friction?
- What is friction? Are there different kinds of friction?

In addition to task overviews, these materials also provide teachers with unit overviews. Unit overviews include the central phenomenon and problem that can be explained or solved at the end of the unit. The unit overviews also include the content learning objectives and the three dimensions for each task. This information allows educators to see how the tasks fit together across the six weeks of learning.

Unit 8.1 Force and Motion - 6 Weeks - Table of Contents

Essential Question: How can we air drop delicate materials to land safely on the ground?

UNIT OVERVIEW

This 6 week unit investigates force and the motion of objects. The unit culminates with a design challenge, team storyboard, and an individual model. Teams design a prototype to reduce the amount of energy transfer through iterative testing that meets the criteria using evidence based reasoning in an annotated model.

Individuals will describe and model the effects distance has on the prototype's potential energy using sequence words to recount the investigation and data to justify changes to the prototype in a storyboard format.

Student Storyline: You are an engineering designing a drop delivery system. The application of your system could be used to drop food and/or equipment to remote locations around the world or in space.

Unit Resources

- **Unit Rubric** - The Unit Rubric assesses the 3-dimensions in the summative. Strands of the Unit Rubric will be pulled out and used to assess each task. The goal is to assess the 3-dimensions throughout the unit rather than just at the end of the unit.
- **RRR Log/Sheet** - The phenomenon is someone jumping on a skateboard. The person makes the jump the first attempt but falls during the second attempt. How can we explain this phenomenon with our knowledge of force and motion? How can this phenomenon help us with our summative?
- **Anchor Texts** -
  Anchor Text 1: Ornes, S. (2013, August 21). *Baseball: From pitch to hits The ballpark brings home plenty of science* [Scholarly project]. In *Science Student*. Retrieved June 28, 2016, from https://student.societyforscience.org/article/baseball-pitch-hits
  Anchor Text 2: *Combining Forces* [Scholarly project]. (2016). In *CK-12*. Retrieved June 28, 2016, from http://www.ck12.org/physical-science/Combining-Forces-in-Physical-Science/lesson/Combining-Forces-MS-PS/

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8.1 1 OUSD Science

Curriculum features

Below are excerpts from units that were selected to highlight a variety of features of the OUSD curriculum. While these are not the only notable features of this curriculum, these excerpts and the features they represent were chosen because they are important to the district and/or highlight ideas within this document. All of these features are not necessarily present in every lesson and unit.

The phenomena are relevant to students' lives.

This 9th grade task centers on the idea that "you are what eat" and explores this concept by asking students to create an explanation and model for the phenomenon that you can tell that students ate corn by examining their hair (see student handout below). This phenomenon is used to support students in the process of understanding that "as matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products" (Disciplinary Core Idea LS1.C, *A Framework for K-12 Science Education*). The task also uses students' favorite foods; meals offered in the OUSD school cafeteria; and nutrition labels of foods such as Coca-Cola, orange juice, carrots, chicken strips, Sriracha, and Hot Cheetos as the context. By connecting to foods that students likely know of, possibly consume regularly, and/or have assumptions about (e.g., that all juice is healthy), the task is providing an opportunity for the disciplinary core idea to be more meaningful than it would have been without relevant phenomena and context. It should be noted that teachers in OUSD are also encouraged to modify the materials to make them more relevant to students if necessary. For example, if a teacher knew that many students liked a particular food, the digital materials could easily be modified to provide a better connection for students.

9.3 - RRR Name: ________________ Period: ___ Date: _______

Anchor Phenomenon: Prevalence of Corn in Food System

Essential Question: How do my food choices affect my health and the environment?

Construct a model and written explanation to explain the **DATA** and addresses the questions:

- How does carbon from corn end up in human hair?
- What would cause differences in the percentage of carbon in human hair?

DATA	
% of Carbon from Corn in Human Hair	
Hair Sample	**% of Carbon from Corn**
Cheney, Ian	>50%
Dawson, Todd	5%
Gupta, Sanjay	69%

Data Compiled From:

Bellows, S. (n.d.). The Hair Detective: For Professor Stephen Macko, a simple strand of hair can be surprisingly revealing. Retrieved from http://uvamagazine.org/articles/the_hair_detective/

Gupta, Sanjay. (n.d.). *If we are what we eat, Americans are corn and soy.* CNN. Retrieved from http://www.cnn.com/2007/HEALTH/diet.fitness/09/22/kd.gupta.column/

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9.3 1 OUSD Science

Nutrition Facts

Serving Size: [redacted] (92g)

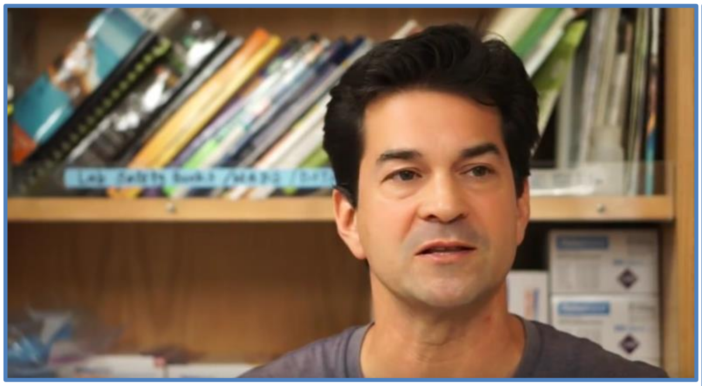
Amount Per Serving		
Calories 200	Calories from Fat 90	
		% Daily Value*
Total Fat 10 g		**15%**
Saturated Fat 2 g		**10%**
Trans Fat 0 g		
Cholesterol 30 mg		**10%**
Sodium 520 mg		**22%**
Potassium		
Total Carbohydrate 13 g		**4%**
Dietary Fiber 1 g		**4%**
Sugars 0 g		
Sugar Alcohols		
Protein 16 g		
Vitamin A 0 IU		0%
Vitamin C 0 mg		0%
Calcium 0 mg		0%
Iron 0 mg		0%

4

?

Students have a chance to see real scientists and data and reflect on the nature of science.
In this 9th grade task, students watch videos of local scientists describing their work. For example, the first scientist mentioned in the task, Ari (shown below), describes a phenomenon he and a team investigated in Panama: birds eating insects that are escaping ant swarms. He then describes the

experiment they used to answer the question: What kinds of vocal cues, or information, do birds use to find ant swarms? The video contains footage of Ari being interviewed in an office, of the phenomenon under investigation, and of Ari in Panama.



Students then have an opportunity to see the data generated from the experiment. The teacher materials provide questions to engage students in a discussion about the data such as: How can the data be analyzed? Which hypotheses do the data support and/or refute? What conclusion can we draw? What claim can we make?

Point	Treatment	Type of Vocal Cue			All Species that Responded	Conspecific Individuals	Heterospecific Species	Heterospecific Individuals	Total individuals
	Species and # used in vocal cue	Diversity	Group Size	Dependency		*"species that are the same as vocal cue species"*	*species different from vocal cue species*	*species different from vocal cue species*	
6	CYPH(2)	Low	Small	Occasional	0	0	0	0	0
5	CYPH(2)	Low	Small	Occasional	0	0	0	0	0
3	CYPH(2)	Low	Small	Occasional	0	0	0	0	0
2	CYPH(2)	Low	Small	Occasional	0	0	0	0	0
1	CYPH(2)	Low	Small	Occasional	CYPH(3)	3	0	0	3
4	CYPH(2)	Low	Small	Occasional	0	0	0	0	0
4	CYPH(8)	Low	Large	Occasional	0	0	0	0	0
1	CYPH(8)	Low	Large	Occasional	FOAN	0	1	1	1
6	CYPH(8)	Low	Large	Occasional	CYPH(3)	3	0	0	3
2	CYPH(8)	Low	Large	Occasional	0	0	0	0	0
3	CYPH(8)	Low	Large	Occasional	CYPH(4)	4	0	0	4
5	CYPH/HYPE(2)	High	Small	Occasional	TRVI	0	1	2	2
6	CYPH/HYPE(2)	High	Small	Occasional	THAT,DEFU, CYPH	1	2	2	3
4	CYPH/HYPE(2)	High	Small	Occasional	0	0	0	0	0
3	CYPH/HYPE(2)	High	Small	Occasional	0	0	0	0	0
1	CYPH/HYPE(2)	High	Small	Occasional	CYPH(2), SCGU	2	1	1	3
2	CYPH/HYPE(2)	High	Small	Occasional	HYPE, PIME	1	1	1	2

Students are asked to discuss: Why does this study matter? What can we do with these results? If you had the resources, could you replicate Ari's experiment? Would you want to? Why or why not?

Finally, students are asked to reflect on "how this research reveals the nature of science and the scientific practices." This lesson has a lot of opportunities to reflect on the practices and nature of science including that "science investigations use diverse methods and do not always use the same set of procedures to obtain data" and that "scientific knowledge is a result of human endeavor, imagination, and creativity" (NGSS Appendix H).

This lesson also provides the opportunity for students to see what a scientist and real data look like, to view what a scientist does, and to imagine themselves as scientists when they think about whether they would replicate this experiment. This experience is important for making the field of science seem accessible to students.

Science is used to better understand ourselves as individuals and our society.

In this 9th grade task, students can explore the relationship between race and biology as well as the perception of this relationship. They first reflect on their own thinking by agreeing or disagreeing with statements about the relationship and stating why they agreed or disagreed. Students have an opportunity to go through this process again at the end of the task.

9.2.3 - Output Sheet 1 Name: ________________ Period:____ Date:________

Race: The Power of an Illusion

Statement	What I think (Pre)	*I agree or disagree because...*	What I think (Post)	*I agree or disagree because...*
Your genes determine who you are.	Agree or Disagree		Agree or Disagree	
Your genes determine your race.	Agree or Disagree		Agree or Disagree	
It is easy to determine someone's race.	Agree or Disagree		Agree or Disagree	
Human beings are one of the most genetically diverse species.	Agree or Disagree		Agree or Disagree	
Human beings can be grouped into different races.	Agree or Disagree		Agree or Disagree	
People from the same race more are genetically similar than people from different races.	Agree or Disagree		Agree or Disagree	

9.2.3 1 OUSD Science

Throughout the task, students engage in a variety of experiences that address genetic variation including calculating the genetic variation of two individuals, which allows students to see that genetic variation among humans is fairly small.

9.2.3 - Resource Page 1

Beta Globin Gene Comparison

Person A	Person B
ATG GTG GAC CTG ACT CCT GAG GAG AAG TCT GCC GTT ACT GCC CTG TGG GGC AAG GTG AAC GTG GAT GAA GGT GGT GTT GAG GCC CTG GGC AGGTTGGTATCAAGGTTACAAGACAGGTTTAAG GAGACCAATAGAAACTGGGCATGTGGAGACAGAGAAGACTCTTGGGTTTCTGATAGGCACTGACTCTCTCTGCCTATT GGTCTATTTTCCCACCCTTAG G CTG CTG GTG GTC TAC CCT TGG ACC CAG AGG TTC TTT GAG TCC TTT GGG GAT CTG TCC ACT CCT GAT GCT GTT ATG GGC AAC CCT AAG GTG AAG GCT CAT GGC AAG AAA GTG CTC GGT GCC TTT AGT GAT GGC CTG GCT CAC CTG GAC AAC CTC AAG GGC ACC TTT GCC ACA CTG AGT GAG CTG CAC TGT GAC AAG CTG CAC GTG GAT CCT GAG AAC TTC AGG GTGAGTCTATGGGACGCTTGATGTTTTCTTTCCCCTTCTTTTCTATGGTTAAGTTCATGTC ATAGGAAGGGGAGAAGTAACAGGGTACAGTTTAGAATGGGAAACAGACGAATGATTGCATCAGTGTGGAAGTCTCA GGATCGTTTTAGTTTCTTTTATTTGCTGTTCATAACAATTGTTTTCTTTTGTTTAATTCTTGCTTTCTTTTTTTTTCT TCTCCGCAATTTTTACTATTATACTTAATGCCTTAACATTGTGTATAACAAAAGGAAATATCTCTGAGATACATTAAG TAACTTAAAAAAAAACTTTACACAGTCTGCCTAGTACATTACTATTTGGAATATATGTGTGCTTATTTGCATATTCAT AATCTCCCTACTTTATTTTCTTTTATTTTTAATTGATACATAATCATTATACATATTTATGGGTTAAAGTGTAATGTT TTAATATGTGTACACATATTGACCAAATCAGGGTAATTTTGCATTTGTAATTTTAAAAAATGCTTTCTTCTTTTAATA TACTTTTTTGTTTATCTTATTTCTAATACTTTCCCTAATCTCTTTCTTTCAGGGCAATAATGATACAATGTATCATGC CTCTTTGCACCATTCTAAAGAATAACAGTGATAATTTCTGGGTTAAGGCAATAGCAATATTTCTGCATATAAATATTT CTGCATATAAATTGTAACTGATGTAAGAGGTTTCATATTGCTAATAGCAGCTACAATCCAGCTACCATTCTGCTTTTA TTTTATGGTTGGGATAAGGCTGGATTATTCTGAGTCCAAGCTAGGCCCTTTTGCTAATCATGTTCATACCTCTTATCT TCCTCCCACAG CTC CTG GGC AAC GTG CTG GTC TGT GTG CTG GCC CAT CAC TTT GGC AAA GAA TTC ATC CCA CCA GTG CAG GCT GCC TAT CAG AAA GTG GTG GCT GGT GTG GCT AAT GCC CTG GCC CAC AAG TAT CAC TAA GCTCGCTTTCTTGCTGTCCAATTTCTATTAAAGGTTCCTTTGTT CCCTAAGTCCAACTACTAAACTGGGGGATATTATGAAGGGCCTTGAGCATCTGGATTCTGCCTAATAAAAAACATTTA TTTTCATTGCAATGATGTATTTAAATTATTTCTGAATATTTTACTAAAAAGGGAATGTGGGAGGTCAGTGCATTTAAA ACATAAAGAAATGATGAGCTGTTCAAACCTTGGGAAAATACACTATATCTTAAACTCCATGAAAGAA	ATG GTG GAC CTG ACT CCT GTG GAG AAG TCT GCC GTT ACT GCC CTG TGG GGC AAG GTG AAC GTG GAT GAA GGT GGT GTT GAG GCC CTG GGC AGGTTGGTATCAAGGTTACAAGACAGGTTTAAG GAGACCAATAGAAACTGGGCATGTGGAGACAGAGAAGACTCTTGGGTTTCTGATAGGCACTGACTCTCTCTGCCTATT GGTCTATTTTCCCACCCTTAG G CTG CTG GTG GTC TAC CCT TGG ACC CAG AGG TTC TTT GAG TCC TTT GGG GAT CTG TCC ACT CCT GAT GCT GTT ATG GGC AAC CCT AAG GTG AAG GCT CAT GGC AAG AAA GTG CTC GGT GCC TTT AGT GAT GGC CTG GCT CAC CTG GAC AAC CTC AAG GGC ACC TTT GCC ACA CTG AGT GAG CTG CAC TGT GAC AAG CTG CAC GTG GAT CCT GAG AAC TTC AGG GTGAGTCTATGGGACCCTTGATGTTTTCTTTCCCCTTCTTTTCTATGGTTAAGTTCATGTC ATAGGAAGGGGAGAAGTAACAGGGTACAGTTTAGAATGGGAAACAGACGAATGATTGCATCAGTGTGGAAGTCTCA GGATCGTTTTAGTTTCTTTTATTTGCTGTTCATAACAATTGTTTTCTTTTGTTTAATTCTTGCTTTCTTTTTTTTTCT TCTCCGCAATTTTTACTATTATACTTAATGCCTTAACATTGTGTATAACAAAAGGAAATATCTCTGAGATACATTAAG TAACTTAAAAAAAAACTTTACACAGTCTGCCTAGTACATTACTATTTGGAATATATGTGTGCTTATTTGCATATTCAT AATCTCCCTACTTTATTTTCTTTTATTTTTAATTGATACATAATCATTATACATATTTATGGGTTAAAGTGTAATGTT TTAATATGTGTACACATATTGACCAAATCAGGGTAATTTTGCATTTGTAATTTTAAAAAATGCTTTCTTCTTTTAATA TACTTTTTTGTTTATCTTATTTCTAATACTTTCCCTAATCTCTTTCTTTCAGGGCAATAATGATACAATGTATCATGC CTCTTTGCACCATTCTAAAGAATAACAGTGATAATTTCTGGGTTAAGGCAATAGCAATATTTCTGCATATAAATATTT CTGCATATAAATTGTAACTGATGTAAGAGGTTTCATATTGCTAATAGCAGCTACAATCCAGCTACCATTCTGCTTTTA TTTTATGGTTGGGATAAGGCTGGATTATTCTGAGTCCAAGCTAGGCCCTTTTGCTAATCATGTTCATACCTCTTATCT TCCTCCCACAG CTC CTG GGC AAC GTG CTG GTC TGT GTG CTG GCC CAT CAC TTT GGC AAA GAA TTC ATC CCA CCA GTG CAG GCT GCC TAT CAG AAA GTG GTG GCT GGT GTG GCT AAT GCC CTG GCC CAC AAG TAT CAC TAA GCTCGCTTTCTTGCTGTCCAATTTCTATTAAAGGTTCCTTTGTT CCCTAAGTCCAACTACTAAACTGGGGGATATTATGAAGGGCCTTGAGCATCTGGATTCTGCCTAATAAAAAACATTTA TTTTCATTGCAATGATGTATTTAAATTATTTCTGAATATTTTACTAAAAAGGGAATGTGGGAGGTCAGTGCATTTAAA ACATAAAGAAATGATGAGCTGTTCAAACCTTGGGAAAATACACTATATCTTAAACTCCATGAAAGAA

Throughout the task, parts of the [PBS documentary "RACE: The Power of an Illusion"] are used to provide information about the perceptions of race, biology, social constructs, and the relationships among them.

Race could be a topic that teachers feel wary of addressing in class. A well-structured task can help educators feel more comfortable and confident in addressing race or other sensitive topics. Basing the conversations in evidence, having supports such as guiding questions and norm-setting structures for classroom discussions, and using carefully selected resources such as the PBS documentary all make the task more accessible to teachers and students and provide a rich learning opportunity on the important subject of race.

Assessments are engaging tasks.
OUSD instructional materials include a variety of assessment opportunities (e.g., formative, summative) throughout tasks and units. Assessments are designed to be tasks that allow students to engage in and demonstrate evidence of understanding of the three dimensions.

Courses also include semester benchmarks. According to district personnel, "OUSD NGSS Science Benchmarks are designed to be authentic assessments of students' ability to synthesize and apply their understanding and skills of the three dimensions of the NGSS. Each benchmark will focus on the skills and content of the previous semester, while asking students to engage with a novel problem. As an authentic assessment and learning experience, the task will contain both group and individual activities."

In this excerpt of the second day of a 6th grade benchmark, students watch a video of fog rolling in and out of the San Francisco Bay in late afternoon, a novel phenomenon within the curriculum. Throughout the task, students work individually and together to create a model and explanation of this phenomenon. Then students are given additional information about the fog and asked to individually write an explanation for how the phenomenon would change if a variable changes.

Day 2 Prep:
- Make copies of the materials
- Gather materials

Day 2
1. 5 min - Warm-up/Engage: Show the phenomenon. Why does fog roll in from the ocean in the late afternoon?
2. 22 min - Explain: Give groups their task card which will lead them through the quiet brainstorm strategy to make a model explaining this phenomenon. Why does fog roll in from the ocean in the late afternoon? Explain why the fog does not roll in throughout the day.
    a. Students create their individual model on their individual erase boards.
    b. Students can use their notebooks and only their notebooks to help with their models and explanations. Hopefully students apply what's happening in the phenomenon to something learning experiences that took place earlier in the semester.
    c. Groups come to a consensus model and explanation.
3. 30 min - Explain: Students are given a resource sheet describing why fog rolls in from the ocean in the late afternoon. Given this new information, students individually explore the idea of how might this weather phenomenon change due to climate change?
    a. Give students their individual output sheet
    b. Students write a CER to answer the prompt
4. 5 min - Exit Ticket: Explain how you think you did and give reasoning.

Day 2 Follow-Up:
- Teacher(s) grade the benchmark using the benchmark rubric.

Appendix B: High Tech High's curriculum development

As teachers at High Tech High develop new instructional materials, they strive to make their lessons and units:

- Focus on big ideas;
- Provide opportunities for students to collaborate;
- Provide opportunities for students to be in the community and experience science;
- Be interdisciplinary, specifically with language and math (one teacher noted appreciating the chance to work with others who have more expertise outside of science);
- Explore phenomena firsthand;
- Be project oriented;
- Use phenomena that need to be investigated for an extended period of time to be explained;
- Include engineering;
- Have a context that lends itself to learning dimensions of more than one performance expectation or a bundle of performance expectations;
- Use the crosscutting concepts to connect ideas both within science and to other disciplines; and
- Include a local phenomenon so that it can be experienced, which creates relevancy and connects to students' lives and encourages students to wonder about things outside of school.

High Tech High sees many of the above elements of instructional materials as critical for equity. According to one designer, "We design with all students in mind; we focus on project and field work [that can] engage all students in authentic scenarios and provide experiences that are accessible."

One example of a unit the designers have developed is the kindergarten unit on tide pools. Kindergarteners in the classes implementing the standards early engaged in a unit on tide pools to eventually answer the question: How can we, as animal experts, teach others how to protect the animals that live in the tide pool habitat? To answer this question students, at the very least, need to learn about the local habitat of tide pools, animals that live in the tide pools, the relationship between the animals and the tide pool, and how humans can help protect this relationship. Such a context provides an opportunity for students to demonstrate understanding by using observations to describe patterns of what plants and animals (including humans) need to survive (K-LS1-1); using a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live (K-ESS3-1); and communicating solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment (K-ESS3-3).

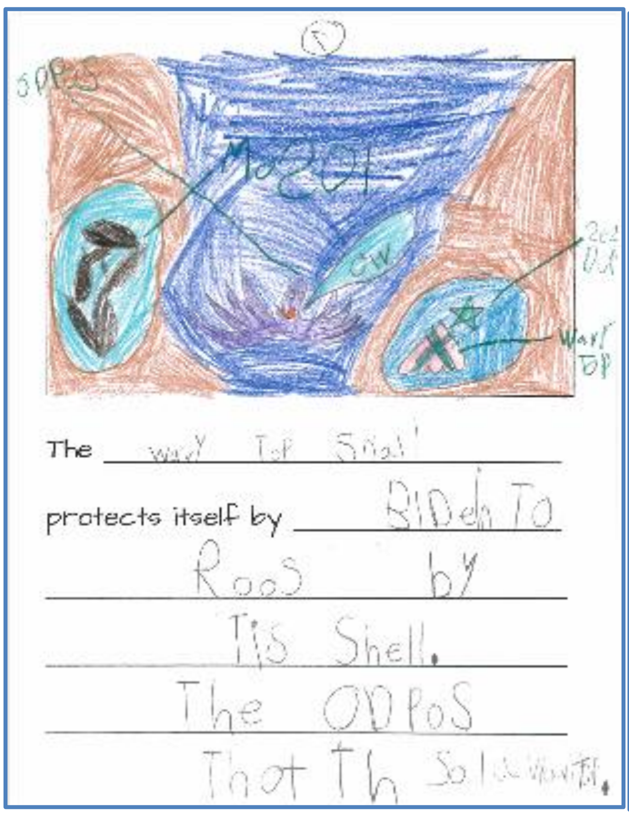
In addition to this bundle, or set, of performance expectations, the unit designers also included another performance expectation: Make observations to determine the effect of sunlight on Earth's surface (K-PS3-1). Depending on the length and storyline of the unit, they could also have included additional performance expectations, as well as additional practices and crosscutting concepts. Ideally, additional practices and crosscutting concepts included would be specific. For example, instead of saying that students will "analyze and interpret data," what students are expected would be more clear if the expectations cited one of the grade band-specific bullets from NGSS Appendix F, such as "analyze data from tests of an object or tool to determine if it works as intended."

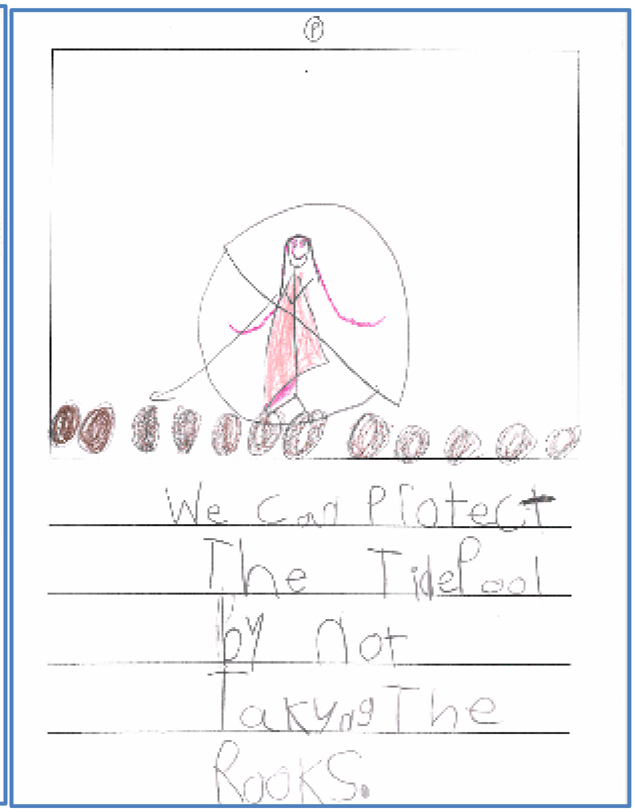
The context of this unit not only provides an opportunity to demonstrate multiple performance expectations, but it also provides the opportunity for students to experience a variety of phenomena firsthand and to develop explanations for those phenomena. For example, students can explore a relatively narrow phenomenon related to the tide pool, like a barnacle obtaining food, as they work to be able to explain the relationship between the needs of living things and the places they live. Due to the use of a local phenomenon, students were able to go to the tide pool and observe the phenomena firsthand.

This unit also has connections to other subjects, including math and ELA. For example, the unit designers also included ELA standards such as the CCSS W.K.2: Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. And in math, students can classify objects (e.g., those found in the tide pool) into given categories (e.g., plants, animals, nonliving objects), count the numbers of objects in each category, and sort the categories by count (K.MD.B.3). These are just a couple examples of the CCSS included in the unit.

Students produced many artifacts, both individually and collectively, during this unit, including a book created individually about a particular animal found in the tide pool, a mural of the tide pool created collectively, and conservation posters created individually.

The images below are of one student's book about a particular animal found in the tide pool, the wavy top snail. The book provides information on the top snail such as how it moves and protects itself and what eats the wavy top snail. The book also has information about the tide pool and how humans can help protect it.





This book can serve as evidence that this student can communicate a solution that will reduce the impact of humans on the local environment.

The following images are of the tide pool mural students created as a group. As shown in Tide Pool Mural Images 1 and 2 below, the mural includes the beach, the tide pool, the ocean, the sky, and the animals that live in each of those locations. Such a mural can be used to discuss the needs of plants and animals and the relationship between living things and their habitat. Students could also discuss what would happen if something changed; for example, they could predict what would happen if the sand and rocks that create the tide pool were no longer there. If students use a mural to predict, show, or explain such relationships, they are engaged in the practice of modeling.

In Tide Pool Mural Image 3, students indicated the need to zoom in to be able to see plankton by drawing a circle around the plankton. Such a device indicates relative scale, showing that the plankton are relatively small compared to the other animals in the mural. When students use the mural to show relative scale, they are engaged in the practice of modeling (Appendix F, Modeling Grade K–2: Develop and/or use a model to represent amounts, relationships, relative scales [bigger, smaller], and/or patterns in the natural and designed world[s]).

Tide Pool Mural Image 1

Tide Pool Mural Image 2

Tide Pool Mural Image 3