NEW MEXICO
Public Education Department

New Mexico Instructional Scope
First Grade Science Guide

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New Mexico STEM Ready! Science Standards Implementation Guide

Overview

A Framework for K-12 Science Education marks a leap forward in how we think about science education and captures the advancements made in understanding how students best learn science that have been made over the last 30 years. The New Mexico Public Education Department and New Mexico public school teachers worked together over the course of June 2021 to construct an Instructional Scope document for the New Mexico STEM Ready! science standards. There are many public schools where high quality instructional materials (HQIM) are present, and these should be used in the teaching of science. In public schools where HQIM may be absent, the New Mexico Instructional Scope for Science (NMIS Science) should be used in conjunction with the New Mexico STEM Ready! science standards to plan science instruction.

The following describes the layout of the NMIS Science document and how it has been designed to be implemented. New Mexico science teachers worked collaboratively to identify and construct sample phenomena, classroom assessment items, common misconceptions, multi-layered systems of supports (MLSS), and culturally and linguistically responsive (CLR) instructional strategies for each performance expectation in the New Mexico STEM Ready! Science Standards. The best practice of bundling related standards together to capture multiple aspects of a single phenomenon was not done, as local public schools should determine how best to bundle New Mexico STEM Ready! science standards based on their needs.

The standards

What: Each performance expectation begins with links to the *Next Generation Science Standards* and a snapshot of the performance expectation with the relevant Science and Engineering Practices (SEP), Disciplinary Core Ideas (DCI), and Cross Cutting Concepts (CCC). Also captured are the connections across the grade level or band (horizontal), connections across grade levels or bands (vertical), and connections to the *Common Core State Standards* (CCSS) in math and English language arts.

The Performance Expectation describes what a student is expected to be able to do at the completion of instruction. They are intended to guide the development of assessments, but they are not the assessment as such. They are not instructional strategies or instructional objectives, but they should influence and guide instruction. Most performance expectations contain a clarification statement and an assessment boundary statement to provide clarity to the performance expectation and guidance to the scope of the expectation, respectively.[1]

The foundation box, which is located below the performance expectation, contains the learning goals that students should achieve and that will be assessed using the performance expectations. The three parts to the foundation box are the science and engineering practices, the disciplinary core ideas, and the crosscutting concepts. The information contained in the foundation box is taken directly from *A Framework for K-12 Science Education*. Also included in the foundation box, where appropriate, are connections to engineering, technology, and applications of science as well as connections to the nature of science. These supplemental goals are related to the other material in the foundation box and are intended to guide instructions, but the outcomes are not included in the performance expectation.

The connections box identifies connections to other disciplinary core ideas at this grade level that are relevant to the standard, identifies the articulation of disciplinary core ideas across grade levels, and identifies connections to the *Common Core State Standards (CCSS)* in mathematics and in English language arts and literacy that align to this standard. The connections box helps support instruction and development of instructional materials.

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[1] Pratt, Harold (2013) *The NSTA Reader's Guide to the Next Generation Science Standards.*

Why: The first step of any teacher in planning instruction is to deeply understand the end result that is required. The standards section of the NMIS Science document is placed first so that teachers have quick access to these requirements. The *NGSS* describe the essential learning goals and how those goals will be assessed at each grade level or band.

How: It is generally accepted that planning for instruction begins with the selection of the endpoint, or desired results of the instruction, and working backward through an instructional sequence to the beginning knowledge students have coming into the instruction. The description of such a process has been documented by Wiggins and McTighe in *Understanding by Design* (1998).

For the purpose of the NMIS Science document, a process for moving from the New Mexico STEM Ready! Science Standards to classroom instruction should minimally include the following[2]:

- Read the performance expectation, clarification statement, and assessment boundary.
- Read the disciplinary core idea in the foundation box.
    - Read the applicable disciplinary core idea essay in *A Framework for K-12 Science Education*, located in chapters 5, 6, 7, and 8. As you read, consider the following questions:
        - What are some commonly held student ideas about this topic?
        - How could instruction build on helpful ideas and confront troublesome ideas?
        - What prior ideas or concepts do students need to learn to understand this core idea?
        - What level of abstractness is expected of students?
        - What are some phenomena and experiences that could provide observational or experimental evidence that the DCI is an accurate description of the natural world?
        - What representations or media would be helpful for students to use in making sense of the core idea?
- Read the science and engineering practices associated with the performance expectation.
    - Read the applicable SEP essay in *A Framework for K-12 Science Education* located in chapter 3, consider the following questions:
        - While the PE describes one SEP to be used, others will be needed in the instructional sequence, which ones and in what order will you use them?
        - How will each SEP be used to develop an understanding of the DCI?
        - What practices could students engage in to explore phenomena?
- Read the crosscutting concept associated with the performance expectation.
    - Read the applicable CCC essay in *A Framework for K-12 Science Education* located in chapter 4, consider the following questions:
        - How will the CCC indicated in the PE support the understanding of the core idea?
        - Are there other CCC that could also support learning the core idea?

[2] Bybee, Rodger W. (2013) *Translating the NGSS for Classroom Instruction.*

- Read the connections box
    - When reading the connections to other DCI at this grade level that are relevant to the standard, consider the following question:
        - How can instruction be designed so that students note the connections between the core ideas?
    - When reading the articulation of DCI across grade levels that are relevant to the standard, consider the following questions:
        - Examine the standard at earlier grade levels, do they provide an adequate prior knowledge for the core ideas in the standard being reviewed?
        - Examine the standard at later grade levels, does the standard at this level provide adequate prior knowledge for the core ideas in the later standards?
    - When reading the *CCSS* in mathematics and English language arts (ELA), consider the following questions:
        - Should students have achieved these mathematics and ELA standards to engage in the learning of science, or could they be learned together?
        - In what ways do the referenced mathematics and ELA standards help clarify the science performance expectations?
        - Can any of the science core ideas be included as examples in the mathematics or ELA instruction?
- Create one or more descriptions of the desired results or learning goals for the instruction integrating the three dimensions in the foundation box.
- Determine the acceptable evidence for the assessment of the desired results.
- Create the learning sequence
    - The NMIS Science document includes sample phenomena, classroom assessment items, common misconceptions, general and targeted supports, and CLR considerations that can be used to assist with this process.
- Create the summative assessment and check its alignment with the performance expectation.

Sample Phenomena

What: Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. The goal of building knowledge in science is to develop general ideas, based on evidence, that can explain and predict phenomena. Engineering involves designing solutions to problems that arise from phenomena and using explanations of phenomena to design solutions. In this way, phenomena are the context for the work of both the scientist and the engineer.

Why: Despite their centrality in science and engineering, phenomena have traditionally been a missing piece in science education. Anchoring learning in explaining phenomena supports student agency for wanting to build science and engineering knowledge. Students are able to identify an answer to “why do I need to learn this?” before they even know what “this” is. By centering science education on phenomena that students are motivated to explain, the focus of learning shifts from learning about a topic to figuring out why or how something happens. Explaining phenomena and designing solutions to problems allow students to build general science knowledge in the context of their application to understanding phenomena in the real world, leading to deeper and more transferable knowledge. Students who come to see how science ideas can help explain and model phenomena related to compelling real-world situations learn to appreciate the social relevance of science. They get interested in and identify with science as a way of understanding and improving real-world contexts.

Learning to explain phenomena and solve problems is the central reason students engage in the three dimensions of the *NGSS*. Students explain phenomena by developing and applying the DCI and CCC through use of the SEPs. Phenomena-centered classrooms also give students and teachers a context in which to monitor ongoing progress toward understanding all three dimensions. As students are working toward being able to explain phenomena, three-dimensional formative assessment becomes more easily embedded and coherent throughout instruction.

How: We use phenomena to drive instruction to help students engage in practices to develop the knowledge necessary to explain or predict the phenomena. Therefore, the focus is not just on the phenomenon itself. It is the phenomenon plus the student-generated questions about the phenomenon that guides the learning and teaching. The practice of asking questions or identifying problems becomes a critical part of trying to figure something out.

There could potentially be many different lines of inquiry about the same phenomenon. Teachers should help students identify different aspects of the same phenomenon as the focus of their questions. Students also might ask questions about a phenomenon that motivates a line of investigation that isn’t grade appropriate or might not be effective at using or building important disciplinary ideas. Teacher guidance may be needed to help students reformulate questions so they can lead to grade appropriate investigations of important science ideas.

It is important that all students – including English language learners and students from cultural groups underrepresented in STEM – are supported in working with phenomena that are engaging and meaningful to them. Not all students will have the same background or relate to a particular phenomenon in the same way. Educators should consider student perspectives when choosing phenomena and should prepare to support student engagement in different ways. When starting with one phenomenon in your classroom, it is always a good idea to help students identify related phenomena from their lives and their communities to expand the phenomena under consideration.

Not all phenomena need to be used for the same amount of instructional time. Teachers could use an anchoring phenomenon as the overall focus for a unit, along with other investigative phenomena along the way as the focus of an instructional sequence or lesson. They may also highlight everyday phenomena that relate investigative or anchoring phenomena to personally experienced situations. A single phenomenon doesn’t have to cover an entire unit, and different phenomena will take different amounts of time to figure out.

The most powerful phenomena are culturally or personally relevant or consequential to students. Such phenomena highlight how science ideas help us explain aspects of real-world contexts or design solutions to science-related problems that matter to students, their communities, and society. An appropriate phenomenon for instruction should help engage all students in working toward the learning goals of instruction as described by the DCIs, SEPs, and CCCs in the foundation box of the standard.

The process of developing an explanation for a phenomenon should advance students’ understanding. If students already need to know the target knowledge before they can inquire about the phenomenon, then the phenomenon is not appropriate for initial instruction. Students should be able to make sense of anchoring or investigative phenomena, but not immediately, and not without investigating it using sequences of the science and engineering practices. Phenomena do not need to be flashy or unexpected. Students might not be intrigued by an everyday phenomenon right away because they believe they already know how or why it happens. With careful teacher facilitation, students can become dissatisfied with what they believe they already know and strive to understand it in the context of the DCI that the teacher is targeting.[3]

Classroom Assessment Items

What: Classroom assessments (sometimes referred to as internal assessments) is used to refer to assessments designed or selected by teachers and given as an integral part of classroom instruction. This category of assessment may include teacher-student interactions in the classroom, observations of students, student products that result directly from ongoing instructional activities, quizzes tied to instructional activities, formal classroom exams that cover material from one or more instructional units, or assessments created by curriculum developers and embedded in instructional materials for teacher use. [4]

Classroom assessments can be designed to guide instruction (formative purposes) or to support decisions made beyond the classroom (summative purposes). Assessments used for formative purposes occur during the course of a unit of instruction and may involve both formal tests and informal activities conducted as part of a lesson. They may be used to identify students' strengths and weaknesses, assist students in guiding their own learning, and foster students' sense of autonomy and responsibility for their own learning. Assessments for summative purposes may be administered at the end of a unit of instruction. They are designed to provide evidence of achievement that can be used in decision making, such as assigning grades, making promotion or retention decisions, and classifying test takers according to defined performance categories. The results of all these assessments are evaluated by the teacher or sometimes by groups of teachers. These assessments play an integral role in students' learning experiences while also providing evidence of progress in that learning.

Why: In *Developing Assessments for the Next Generation Science Standards*, the National Research Council shared the following conclusions regarding assessing three-dimensional learning:[5]

- Measuring the three-dimensional science learning called for in the framework and the NGSS requires assessment tasks that examine students' performance of scientific and engineering practices in the context of crosscutting concepts and disciplinary core ideas. To adequately cover the three dimensions, assessment tasks will generally need to contain multiple components. It may be useful to focus on individual practices, core ideas, or crosscutting concepts in the various components of an assessment task, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given performance expectation.

- The Next Generation Science Standards require that assessment tasks be designed so they can accurately locate students along a sequence of progressively more complex understandings of a core idea and successively more sophisticated applications of practices and crosscutting concepts.

- The NGSS places significant demands on science learning at every grade level. It will not be feasible to assess all the performance expectations for a given grade level with any one assessment. Students will

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[3] Penuel, W. R., Bell, P., Neill, T., Morrison, D., & Tesoriero, G. (2018). *Selecting Anchoring Phenomena for Equitable 3D Teaching*. [OER Professional Development Session from the ACESSE Project] Retrieved from http://stemteachingtools.org/pd/sessione

[4] National Resource Council. (2014). *Developing Assessments for the Next Generation Science Standards.* Committee on Developing Assessments of Science Proficiency in K-12. Board on Testing and Assessments and Board on Science Education, J.W. Pellegrino, M.R. Wilson, J.A. Koenig, and A.S. Beatty, *Editors*. Division of Social Sciences and Education. Washington, DC: The National Academies Press.

[5] National Research Council. (2014). *Developing Assessments for the Next Generation Science Standards.* Committee on Developing Assessments of Science Proficiency in K-12. Board on Testing and Assessment and Board on Science Education. J.W. Pellegrino, M.R. Wilson, J.A. Koenig, and A.S. Beatty, *Editors*. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

need multiple – and varied – assessment opportunities to demonstrate their competence on the performance expectations for a given grade level.

- Effective evaluation of three-dimensional science learning requires more than a one-to-one mapping between the NGSS performance expectations and assessment tasks. More than one assessment task may be needed to adequately assess students' mastery of some performance expectations, and any given assessment task may assess aspects of more than one performance expectations. In addition, to assess both understanding of core knowledge and facility with a practice, assessments may need to probe students' use of a given practice in more than one disciplinary context. Assessment tasks that attempt to test practices in strict isolation from one another may not be meaningful as assessments of the three-dimensional science learning called for by the NGSS. (Developing assessments for NGSS, NRC, pp.44-46)

How: The amount of information that has been generated around designing and creating three-dimensional assessment tasks to meet the conclusions laid out above by the National Research Council has been overwhelming. The following free resources are available through STEM teaching tools to help you navigate this flood of information and translate it into your classroom. You should start by familiarizing yourself with the following STEM Teaching Tools[6]:

- Practice Brief 18 on how teachers can develop formative assessments that fit a three-dimensional view of science learning.
- Practice Brief 26 on how to design formative assessments that engage students in three-dimensional learning.
- Practice Brief 30 on integrating science practices into assessment tasks
- Practice Brief 41 on integrating cross cutting concepts into assessment and instruction
- Practice Brief 33 on designing assessments for emerging bilingual students

In general, one can use the following process to develop classroom assessment tasks:

1. Identify specific learning goals for the desired assessment
2. Brainstorm assessment scenarios that involve phenomena that clearly foreground the identified learning goals
3. Prioritize and select a scenario that best fits the following criteria:
    a. it should allow students from non-dominant communities (e.g., ELLs, students from poverty-impacted communities) to fully engage with the task,
    b. it should involve a compelling phenomenon related to one or more of the DCIs being assessed—and not feel like a test-like task,
    c. it should be quickly understandable by students, and
    d. it should lend itself to a broad range of science and engineering practices.

[6] STEM Teaching Tools (n.d.), http://stemteachingtools.org/tools accessed on July 7, 2021

4. The task formats (practice briefs 30 and 41) provide detailed guidance on how to design assessment components that engage students in the science and engineering practices. Identify the practices that relate to the scenario and use the task formats to craft assessment components
5. Write hypothetical student responses for each prompt: some that reflect limited, partial, and full levels of understanding
6. Share tasks with colleagues and ask for feedback about the alignment of goals, scenarios, and hypothetical student responses

Common Misconceptions

What: This planning support identifies some of the common misconceptions students develop about a scientific topic.

Why: Our brains are highly advanced cause and effect reasoning machines. From birth, we begin to analyze effects to determine causes and provide some sort of reasoning for the whole event. The more events that support our reasoning, the stronger that learning becomes. So, every student in your classroom brings their own unique background knowledge into your classroom. Some of this is aligned to scientific understanding and some of this is misaligned to scientific understanding but aligned to that student's personal experiences. As science educators, we must always create space for students to bring their current understanding about a topic into our classroom so that we can begin to address understandings that are misaligned to scientific understanding. Some of these misunderstandings are not unique to a single student; rather, they are common to many students.

How: When planning with your HQIM look for ways to directly address with students some common misconceptions. The planning supports in this document provide some possible misconceptions and your HQIM might include additional ones. The goal is not to avoid misconceptions, they are a natural part of the learning process, but we want to support students in exploring the misconception and modifying incorrect or partial understandings.

Multi Layered System of Supports (MLSS)

What: The Multi-Layered Systems of Support (MLSS) is designed to support teachers in planning instruction for the needs of all students. Each section identifies general supports (layer 1) for supporting pedagogically sound whole class science instruction and targeted supports (layer 2) for supporting those scholars that teachers identify as not understanding the topic. We recognize there is a need for intensive support (layer 3) for those students needing longer duration or otherwise more intense support with a given topic; however, this was not part of the NM IS Science 1.0 work.

Why: MLSS is a holistic framework that guides educators, those closest to the student, to intervene quickly when students need additional support. The framework moves away from the "wait to fail" model and empowers teachers to use their professional judgement to make data-informed decisions regarding the students in their classroom to ensure academic success with grade level expectations of the New Mexico Science Standards.

How: When planning with your high-quality instructional materials (HQIM) use the suggested universal supports embedded in the sequence of instruction. If you do not have access to HQIM in your school, the universal (layer 1) support in this document can be used in planning your instruction.

Culturally and Linguistically Responsive Instruction

What: Culturally and Linguistically Responsive Instruction (CLRI), or the practice of situational appropriateness, requires educators to contribute to a positive school climate by validating and affirming students' home languages and cultures. Validation is making the home culture and language legitimate, while affirmation is affirming or making clear that the home culture and language are positive assets. It is also the intentional effort to reverse negative stereotypes of non-dominant cultures and languages and must be intentional and purposeful, consistent and authentic, and proactive and reactive. Building and bridging is the extension of validation and affirmation. By building and bridging students learning to toggle between home culture and linguistic behaviors and expectations and the school culture and linguistic behaviors and expectations. The building component focuses on creating connections between the home culture and language and the expectations of school culture and language for success in school. The bridging component focuses on creating opportunities to practice situational appropriateness or utilizing appropriate cultural and linguistic behaviors.

Why: Student understanding of science is shaped by their interactions with phenomena throughout their lives. Science educators must intentionally and purposefully legitimize the home culture and languages of students and validate their ways of knowing and understanding. In addition, create connections between the cultural and linguistic behaviors of the students' home culture and language and the culture and language of scientific understanding.

How: When planning instruction it is critical to consider ways to validate/affirm and build/bridge from your students' cultural and linguistic assets. There has been an overwhelming amount of guidance within STEM education about CLRI. The following STEM teaching tools can be a good place to start wrapping your mind around this topic.[7]

- Practice Brief 15: Promoting equity in science education
- Practice Brief 47: Promoting equitable sensemaking
- Practice Brief 54: Building equitable learning communities
- Practice Brief 11: Indigenous ways of knowing and STEM
- Practice Brief 27: Engaging English language learners in science and engineering practices
- Practice Brief 71: Advancing equity and justice in science education
- Practice Brief 53: Avoiding pitfalls associated with CLRI

The planning supports for each performance expectation provide an example of how to support equity-based teaching practices. Look for additional ways within your HQIM to ensure all students are included in the pursuit of scientific understanding in your classroom.

[7] STEM Teaching Tools (n.d.), http://stemteachingtools.org/tools accessed on July 7, 2021

STANDARDS BREAKDOWN				
Life Science From Molecules to Organisms: Structures and Processes 1-LS1-1 1-LS1-2 Heredity: Inheritance and Variation of Traits 1-LS3-1	Earth and Space Science Earth's Place in the Universe 1-ESS1-1 1-ESS1-2	Physical Science Motion and Stability: Forces and Interactions 1-PS4-1 1-PS4-2 1-PS4-3 1-PS4-4	Science and Society Science and Society 1-SS-1	Engineering Design K-2 ETS1-1 K-2 ETS1-2 K-2 ETS1-3

Students who demonstrate understanding can:

1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Use materials to design a device that solves a specific problem or a solution to a specific problem.	**LS1.A: Structure and Function** • All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **LS1.D: Information Processing** • Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs.	**Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). - - - - - - - - - - - - - - - - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering and Technology on Society and the Natural World** • Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **4.LS1.A** ; **4.LS1.D** ; **4.ETS1.A**

Common Core State Standards Connections:
ELA/Literacy -
W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS1-1)

Grade	NGSS Discipline
1	Life Science 1.1
1.LS1-1	Sample Phenomena

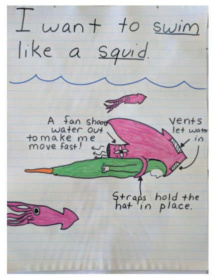
When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.

- Swimsuits mimic shark skin.
- Velcro mimics Bur plants hooks.

Classroom Assessment Items

When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available.

- Option 1: Students are presented with a human problem and they need to show an animal solution.



Examples of human problems:

- The weather is cold outside. How can we stay warm while outside?
- You are playing hide and seek. Is there a place you can hide where you will blend in more?
- A river is flowing too fast to get water. How can we make it slow down and fill up in an area?

Question: How did you solve your problem like an animal?
Draw it out! And label your drawing.

My animal solution...	From my animal...

- Option 2: *(Inspired by StemScopes: Grade 1 Bundle 1: Design from Nature, Mission Task: Action Plan)*

Design a tool for a hardware company that uses plant or animal external parts or behaviors.

- Your tool should be useful for humans.
- It should mimic the behavior or physical parts of a plant or animal.

Draw how you would design the tool, label the parts.
Answer some questions about your tool:

- What does your tool do?
- What plant or animal did you copy this trait from?
- What materials would you need to construct this tool?
- Why did I choose this plant or animal?

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and	• These should be small group or 1:1 depending on student needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information

talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary
- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Create and hang anchor charts for students to refer back to
- Define and discuss vocabulary with visual examples in context: materials, design, solution, mimic, external, parts, survive, grow, and needs.
- Model how this mimicry can be applied to help humans using hands-on materials when possible
- Present students with many examples from nature.

- Peer tutoring (teacher-selected partners) to support students in learning
- Provide opportunities for reflection and revision of their work when possible
- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest
- When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- Use visuals and examples of how plants/animals stay safe in nature.
- Explicitly teach about specific external parts on different plants and animals as needed, lots of visuals and examples.
- Give students specific human problems to solve. Be intentional with your selection of problems. Give them a limited number of plant/animal solutions to choose from.
- Have students justify their thinking in a small group.

Common Misconceptions

- Students may be able to name structures in animals and plants but not understand the function. (*Animal and plant structures each serve a purpose, for example, legs for walking, flowers for reproduction, arms or claws for climbing, mouths for eating, wings for flying, roots for absorbing water, eyes for seeing, strong back legs for running, etc.Students may think animals' structures function in the same way.Not all structures function in the same way (for example, eagles have good eyesight for hunting prey, but bats do not)).*
- Students may have a hard time distinguishing between physical and behavioral adaptations. (*For behavioral adaptations, make sure that students know what this means, scientifically, for animals (e.g., opossums playing dead to avoid predators, being nocturnal, hibernating, migrating, etc.). Physical adaptations are changes in body parts (legs, wings, fins, etc.)).*
- Students may not think that certain things are considered plants or are parts of plants or recognize that plants are alive. (*Plants are organisms that make their own food through the process of photosynthesis. Trees, grasses, and shrubs are plants. All fruits and vegetables either are plants themselves or a part of a*

plant. For example, celery is a stem of a plant, pumpkins are a fruit of a plant that holds the seeds, cabbage is the leaves of a plant, and carrots are the roots of a plant.)

- Students may have a difficult time grasping why the same plant part looks so different on different plants. (*The leaves on a cactus look much different than the leaves on an oak tree. Each plant part has a specific purpose, even though it looks different from what we commonly see.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Discuss the difference between a need and a want. Discuss experiences or background knowledge students have with plants and animals and how they survive. Listen and affirm students' ideas and beliefs. This will help the teacher understand misconceptions students may have.

Ask: Have you seen an animal meet a need? How did the animal meet that need? What did they do? What did they use? Did they use a part of their body to help them?

Build and Bridge: What experiences will your students need to correct misconceptions and build a more complete mental model? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life? Discuss how there are many different solutions to problems. Students may lack schema of animal solutions to human problems. Use visual examples for students who may not have seen this in nature, in the home, or at the zoo.

Ask: Do humans have the same problems as animals/plants? How can humans use animal/plant solutions to solve problems? Can you think of an animal solution humans have used to solve a problem?

Students who demonstrate understanding can:

1-LS1-2. **Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.** [Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. • Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. --- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world.	**LS1.B: Growth and Development of Organisms** • Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	**Patterns** • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:

3.LS2.D

Common Core State Standards Connections:

ELA/Literacy -

RI.1.1	Ask and answer questions about key details in a text. (1-LS1-2)
RI.1.2	Identify the main topic and retell key details of a text. (1-LS1-2)
RI.1.10	With prompting and support, read informational texts appropriately complex for grade. (1-LS1-2)

Mathematics -

1.NBT.B.3	Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols >, =, and <. *(1-LS1-2)*
1.NBT.C.4	Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning uses. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. *(1-LS1-2)*
1.NBT.C.5	Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. *(1-LS1-2)*
1.NBT.C.6	Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. *(1-LS1-2)*

Grade	*NGSS Discipline*
1	**Life Science 1.2**
1.LS1-2	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● Shrews form a line to travel from place to place.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Inspired by StemScopes: Grade 1: Bundle 2: Parents and Their Offspring, Scope 1: Protecting the Young, Open Ended Response Assessment

Kira has been watching a family of birds in a nest in her backyard. She sees the adult bird fly away and come back a few times each day. She hears the baby birds chirping and sees them open their mouths wide when the adult bird comes back. She wonders how the bird knows when to come back.

How does a baby bird let its parent know it needs something?

What would happen if the baby birds could not communicate their needs to their mother bird?

https://app.acceleratelearning.com/scopes/14926/elements/670739

Universal Supports	Targeted Supports
- Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) - Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) - Explicit introduction and modeling of Tier 2 vocabulary - Use picture cues and sentence stems to support students in acquiring new vocabulary - Provide opportunities for students to explain their thinking - As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment - Use real objects and photos as much as possible to give students common understandings - Allow students who are not able to write academically to draw their answers and explain verbally - Create and hang anchor charts for students to refer back to - Define and discuss vocabulary with visual examples in context: text, media, determine, patterns, behavior, parents, offspring, and survive. - Model while reading text and/or media, how to determine patterns of behavior that are important for survival of offspring. - Texts and media should be scaffolded from simple to complex.	- These should be small groups or 1:1 depending on student needs. - Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information - Peer tutoring (teacher-selected partners) to support students in learning - Provide opportunities for reflection and revision of their work when possible - Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest - For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. - For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. - If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. - Discuss specific examples of patterns of behavior in parents and offspring. Scaffold from more simple patterns to more complex patterns. Use visuals in your examples. - Utilize media for students or text to speech if needed. Help students to determine patterns of behavior in media and text. - Practice finding these patterns of behavior, highlight them in the text or media.

Common Misconceptions

- Students may have a difficult time understanding why parents in certain species don't take care of their offspring. (*Many may assume animals are anthropomorphised, like they see in cartoons and assume parents love their offspring. Reasons why some parents abandon their young include predators waiting to attack, harsh environments, and no maternal instincts.)*
- Some students may not view protecting their young as making shelter, as in building a den. (*Animals need shelter to survive, and some offspring are not old enough to build it.)*
- Students may not know that a lot of animals stay with their parents for a long time for protection.
- Students may not understand animals don't have an actual language like humans. (*They may struggle to understand why the baby animals can't directly ask for what they want.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Discuss experiences or background knowledge students have with parent/offspring animals in their own lives. Ask: How does your family take care of you? How do your parents keep you safe? How do you let an adult know you need them?

Build and Bridge: What experiences will your students need to correct misconceptions and build a more complete mental model? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life? Students may lack schema of animal/plant offspring and parents. Use visual examples for students who may not have seen this in the home, nature, or at the zoo.
Ask: Have you seen a baby animal with its mother? How does the mother keep it safe? How does the baby animal ask for help? (see phenomena)

Students who demonstrate understanding can:

1-LS3-1. **Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.** [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [*Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	**LS3.A: Inheritance of Traits** • Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. **LS3.B: Variation of Traits** • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	**Patterns** • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
3.LS3.A ; **3.LS3.B**

Common Core State Standards Connections:
ELA/Literacy -

1.RI.1	Ask and answer questions about key details in a text. (1-LS3-1)
W.1.7	Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-LS3-1)
W.1.8	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

Mathematics -

MP.2	Reason abstractly and quantitatively. *(1-LS3-1)*
MP.5	Use appropriate tools strategically. *(1-LS3-1)*
1.MD.A.1	Order three objects by length; compare the lengths of two objects indirectly by using a third object. *(1-LS3-1)*

Grade	*NGSS Discipline*
1	**Life Science 3.1**
1.LS3-1	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don’t have local instructional materials available. ● Puppies can all be from the same mom and dad but look different.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don’t have local instructional materials available. Inspired by StemScopes: Bundle 1: Scope: Animal Trait Inheritance and Variation, Evaluate: Claim, Evidence, Reasoning Billy saw some kittens with their mother. He saw that most of the kittens were the same color as her, but one was not. He wondered where that fur color came from. If you think like a scientist, where do you think the other color of fur came from? Do the following tasks below: ● Answer the question: Where did the other color of fur come from?

- How do you know? Provide evidence in your answer.
- Draw a picture of the mom, dad, and baby kitten. Label your drawing with the traits seen in the parents and offspring.

https://app.acceleratelearning.com/scopes/14927/elements/670768

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create and hang anchor charts for students to refer back to • Use visuals and written names of animals and their offspring to show and model examples of how the parents and offspring look. • Define and discuss vocabulary with visual examples in context: observations, evidence based accounts, parents, offspring. • Utilize hands-on activities such as matching cards of parents to offspring of both plants and animals to give concrete examples.	• These should be small group or 1:1 depending on student needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Model and discuss what traits the students have inherited from their own family, draw a picture of the students' family to showcase inherited traits. Focus on individual traits one at a time. • Small group instruction with lots of modeling. • Repetition of activities to gain understanding. • Scaffolding from observing one trait in plants and animals to more than one trait. • Use sorting cards for students to categorize traits and use process of elimination to match parents to offspring based on traits. (Show examples of both plants and animals) • Do not talk about students' biological parents unless everyone in the class is comfortable with the topic. Use your own family as an example if needed.

Common Misconceptions

- Students often believe events that happen after birth to the parents, such as the loss of a limb, chipping a tooth, etc., can be inherited traits. (*Inherited traits are traits you get from your parents. You are born with them. They are not acquired after birth).*
- Students often believe offspring that have traits that are different from their parents' didn't inherit those traits. (*Unless there is a physical abnormality, traits are inherited from a relative, whether those traits are apparent in the parents or not.)*
- Students often believe a single type of plant will always look exactly like a parent plant. *(For example: all tulips look exactly alike, all roses look exactly alike.)Plants sometimes do not look like their parent plants, because their genetic material is recombined during reproduction, resulting in an appearance different from their parent's appearance.*
- Students may think a variation in color means a variation in plant/animal species. (*Plant color is not a variation in plant species, just like skin color on humans is not a variation in species.)*
- Student's may think that babies/children are supposed to look just like their parents. (*If mom has dark hair and brown eyes and olive skin so should their children.)*
- Student's don't understand that plants have parents/offspring. (*Because plants don't move and take care of their offspring, students may not see them as parents and children.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Discuss animal offspring and parents and if they look the same or different. Listen and affirm students' thoughts about why there are similarities and differences to understand any misconceptions. Discuss plants and their offspring. If students do not know that plants have offspring, provide visual examples.

Ask: Animals: Look at the picture of puppies in the phenomena, do all of these puppies look the same? Do all of the puppies have the same mom and dad? Plants: How do plants grow? And do plant offspring look like their parents? What are the similarities and differences?
Do not talk about students' biological parents unless everyone in the class is comfortable with the topic.

Build and Bridge: What experiences will your students need to correct misconceptions and build a more complete mental model? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life? Students may lack schema of animal/plant offspring and parents. Use visual examples for students who may not have seen this in nature, in the home, or at the zoo. Draw a picture of parent animals or plants, and how the offspring could look. Is there more than one way to draw the offspring?

Ask: Should a baby animal or plant look exactly like its parents? Why or why not? Could a baby animal have different traits than its parents? Why or why not? Use your observations from the unit to answer.

Students who demonstrate understanding can:

1-ESS1-1. **Use observations of the sun, moon, and stars to describe patterns that can be predicted.** [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [*Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	**ESS1.A: The Universe and its Stars** • Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.	**Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes natural events happen today as they happened in the past. • Many events are repeated.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
3.PS2.A ; **5.PS2.B** ; **5.ESS1.B**

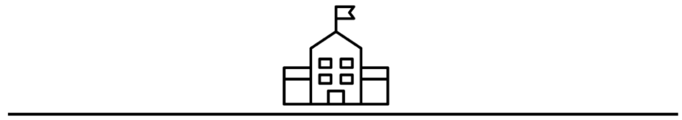
Common Core State Standards Connections:
ELA /Literacy -
W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-ESS1-1)
W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-ESS1-1)

Grade	*NGSS Discipline*
1	**Earth and Space Science 1.1**
1.ESS1-1	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● A sundial is a simple tool that uses the sun to tell time with an upright stick. ● Star Trails are a type of photography in which a camera's shutter is left open for a long period of time to capture the apparent movement of stars due to Earth's rotation.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. ● Option 1: Draw your school. Show how the Sun appears when you come to school, have lunch recess and when you go home.

Position of the Sun During the Day

Draw the sun in the sky at

- ☐ Morning
- ☐ Lunch
- ☐ Afternoon



A possible template provided by The Wonder of Science at [*https://thewonderofscience.com/1ess11*](https://thewonderofscience.com/1ess11)

- Option 2: Draw a picture of what you think the sky will look like today during the day and what you think it will look like at night.

My Day Sky and Night Sky Worksheet

Name:___________________________________

Draw a picture of the sky during the day and a picture of the sky at night.

Day Sky	**Night Sky**

A sample graphic organizer from STEM Gauge.

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings	• These should be small groups or 1:1 depending on the student's needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's

- Allow students who are not able to write academically to draw their answers and explain verbally
- Create and hang anchor charts for students to refer back to
- Define and discuss vocabulary with visual examples in context: sun, moon, stars, rotation.
- Read a story or nonfiction reading that deals with lunar patterns like *Papa, Please Get the Moon for Me* by Eric Carle and work with students to match visuals of the moon phases.

aide or keep them close to the teacher - giving single step directions.

- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- Students can observe and track the placement of the moon over the course of a day, to address misconceptions and develop additional practice noticing and recording patterns. Keep in mind you will need to plan this for a day in between the new and full moons, as the moon is not visible during the day at these times.
- Students may benefit from drawing or cutting/gluing images of the sun's position at specific times onto a diagram while reflecting on the patterns visible if they are struggling to predict how the sun, moon or stars might look.

Common Misconceptions

- Students may believe the Moon can only be seen at night. (*The moon can be seen during the day.)*
- Students may think that the Sun moves because it changes its place over the day. (The Sun appears to move because the Earth is rotating, changing which side is facing the sun over the course of a day. When the Earth is facing the Sun, it is day in that part of the world, and night on the other half.)
- Students may think that the amounts of daylight and night are the same throughout the year. (*The Earth's access is tilted and in the Northern hemisphere we point towards the sun during the summer, increasing the length of our day, and in the winter we point away from the sun, leading to a shorter day.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: What cultural stories does your area have about the astrological bodies? What observations have your students already made?

No student comes to this standard as a blank slate. Everyone has witnessed the sun moving across the sky and looked at the moon and stars at night. Your job is to use questioning strategies to get each student reflecting on what they have seen and what their families have talked about in regards to the astrological bodies. Remember all observations are equally valid and should receive affirmation. Even if a current experience creates a misconception this will help you plan activities that let students incorporate what they already know with observations that help them build a more complete idea.
Ask: Does your family tell any stories about the sun, moon or stars? Has your family used the sun, moon or stars as a tool? (Prompt as needed: sun dial, time, finding direction, constellations.)

Build and Bridge: What experiences will your students need to correct misconceptions and build a more complete mental model? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life?
Ask: What do you think happens to the sun, moon or stars when you can't see them? What did you notice about our sundial? What shapes did you see in the star trails? What shape was our sundial? Why do you think they make these shapes? How do people use these patterns? Why are these patterns important?

Students who demonstrate understanding can:

1-ESS1-2. **Make observations at different times of year to relate the amount of daylight to the time of year.** [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [*Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Make observations (firsthand or from media) to collect data that can be used to make comparisons.	**ESS1.B: Earth and the Solar System** • Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
5.PS2.B ; **5.ESS1.B**

Common Core State Standards Connections:
ELA /Literacy -

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-ESS1-2)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-ESS1-2)

Mathematics —

MP.2 Reason abstractly and quantitatively. *(1-ESS1-2)*

MP.4 Model with mathematics. *(1-ESS1-2)*

MP.5 Use appropriate tools strategically. *(1-ESS1-2)*

1.OA.A.1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations to represent the problem. *(1-ESS1-2)*

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. *(1-ESS1-2)*

Grade	*NGSS Discipline*
1	**Earth and Space Science 1.2**
1.ESS1-2	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● On the Solstice, the sun always rises over the main altar at Stonehenge. ● The Aztec Sunstone correctly predicts modern eclipses.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Anna's mom woke her up to get ready for school and it's still dark outside. She ate her breakfast and it is still dark! What season do you think it might be? What clothes do you think Anna should wear today? Write or draw a picture. We made observations about differences between Winter and Summer. What season has the most daylight to play outside? What season will have the most daylight next year?

A version of this question appears in the STEMscopes open response questions.
https://app.acceleratelearning.com/scopes/14931/elements/670873

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create and hang anchor charts for students to refer back to • This unit is about long term patterns. You will need to plan a short session on this standard each month for the duration of the school year. • Provide historical context with a story or video about how ancient culture (prehistoric England, ie Stonehenge, or Aztecs) tracked the sun and used this knowledge as part of their culture. • Define and discuss vocabulary with visual examples in context: sun, rotation, light, dark, seasons, months.	• These should be small groups or 1:1 depending on the student's needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Students may need additional vocabulary support on Seasons, Months of the Year depending on previous experience. • Students may benefit from color coding their observations (color daylight boxes yellow and night boxes blue) to help them identify patterns. • Sentence starters or other scaffolds may be useful for students in developing their conclusion. *In ________ the day is longer and the night is shorter. In _______ the day is shorter and the night is longer.*

Common Misconceptions

- Students may think that the amounts of daylight and night are the same throughout the year. (*The Earth's access is tilted and in the Northern hemisphere we point towards the sun during the summer, increasing the length of our day, and in the winter we point away from the sun, leading to a shorter day.)*

- Students may think that the Sun moves because it changes its place over the day. (*The Sun appears to move because the Earth is rotating, changing which side is facing the sun over the course of a day. When the Earth is facing the Sun, it is day in that part of the world, and night on the other half.)*
- Students may think that it is colder in the Winter because we are farther away from the Sun. (*Winters are colder not because we are farther away from the Sun, but because our days are shorter and we receive less sunlight.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: What cultural stories does your area have about the astrological bodies? How can you leverage this and your student experts to hook students?

No student comes to this standard as a blank slate. By first grade all students have observed the seasons change several times. Your task will be to help them organize their current knowledge, make the patterns explicit and draw their own conclusions about amounts of relative daylight. Since we are closer to the equator our differences in amounts of daylight are much more subtle than in the Northern latitudes. You may want to leverage knowledge from students that have lived or visited these areas.
Ask: Why do you think the seasons change? How do you know winter is coming? How do you know spring is starting? Have you seen a movie or visited somewhere where winter or summer was different from ours?

Build and Bridge: What experiences will your students need to correct misconceptions and build a more complete mental model? (Reflect on the Misconceptions section.) Use and discuss the data you generate as a class to help students address misconceptions and create understanding. As needed, help students understand through discussion and validation that they can have the concept of their cultural story of the seasons and also have the scientific understanding based on their data.
Ask: Why was it important to the Aztecs, prehistoric English and other cultures to know when the seasons were going to change? What can we do in the summer that we can't do in the winter? Why can we do those things then? What are some things your family does in each season? You may want to keep an anchor chart throughout the year.

Students who demonstrate understanding can:

1-PS4-1. **Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.** [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct investigations collaboratively to produce evidence to answer a question. - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** • Science investigations begin with a question. • Scientists use different ways to study the world.	**PS4.A: Wave Properties** • Sound can make matter vibrate, and vibrating matter can make sound.	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
4.ETS1.A

Common Core State Standards Connections:
ELA/Literacy —
W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS4-1)
W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-1)
SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. *(1-PS4-1)*

Grade	*NGSS Discipline*
1	**Physical Science 4.1**
1.PS4-1	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● Drums make sound when you hit them. ● Bats fly at night using sound from their voices. ● Vocal cords vibrate when we talk or sing.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Inspired by StemScopes: https://app.acceleratelearning.com/scopes/14934/elements/670941 There are many different types of sounds. There are loud and quiet sounds. There are high- and low-pitched sounds. When you hit a drum, it makes a sound. If the drum is close to a cymbal, the cymbal will also make a sound without anything even hitting it.

Thinking like a scientist, how do the drum and the cymbal make sound?

*Give students the following sentence starter: The reason the drum and cymbal make sound is because of___________.

Write how you know! (Leave space to write)

Draw how you know! (Leave space to draw)

Universal Supports	Targeted Supports
● Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) ● Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) ● Explicit introduction and modeling of Tier 2 vocabulary ● Use picture cues and sentence stems to support students in acquiring new vocabulary ● Provide opportunities for students to explain their thinking ● As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment ● Use real objects and photos as much as possible to give students common understandings ● Allow students who are not able to write academically to draw their answers and explain verbally ● Create and hang anchor charts for students to refer back to ● Define and discuss vocabulary with visual examples in context: materials, matter, sound, vibrate. ● Lessons should include many opportunities for students to hear, feel, and see this. Include several things that can be included in their everyday life or have all seen before as well as things that they may not expect to have a vibration.	● These should be small groups or 1:1 depending on the student's needs. ● Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information ● Peer tutoring (teacher-selected partners) to support students in learning ● Provide opportunities for reflection and revision of their work when possible ● Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest ● When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation ● For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. ● For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. ● If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. ● Students may struggle with the fact that they can't actually see the vibrations. They will need to rely on feeling and hearing. Have them put their fingers on their throats and hum. Have students strum the guitar, blow the kazoo, and place their fingertips on the drum skin while it is struck. If you have a tuning fork, strike it on a rubber surface and then hold the ends gently to the palms of students' hands.

Common Misconceptions

- Student's may not understand that sound is made by vibrations and can move through all mediums (their desk, their eardrum, ect.). (*Sound waves vibrate and travel through a medium (liquid, gas, solid). When the vibrations enter our ears, our brain changes the vibrations into sounds.*)
- Student's at this age may not understand that sound can cause other objects to move. (*Sound vibrations cause other objects around it to move, depending on the intensity of the sound*.)

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Do you know someone that plays musical instruments? What is one way that someone might need vibrations in their everyday life? Have you ever been to a concert? Here are some examples of times that I felt sound. Now you share a time you felt sound. Discuss and affirm student's responses about sound and how it feels.

Build and Bridge: What experiences will your students need to correct misconceptions and show evidence of sound vibrating? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life?
Ask: What actually makes the sound? How can sound cause another object to make a sound? Why do drums make sound? Does the sound come from our hands? What's the relationship between sound and vibration? Can a sound from one object cause another object to make a sound? Why can we hear?

Students who demonstrate understanding can:

1-PS4-2. **Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.** [Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	**PS4.B: Electromagnetic Radiation** • Objects can be seen if light is available to illuminate them or if they give off their own light.	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels: N/A

Common Core State Standards Connections:

ELA/Literacy —

W.1.2	Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. *(1-PS4-2)*
W.1.7	Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS4-2)
W.1.8	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-2)
SL.1.1	Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. *(1-PS4-2)*

Grade	*NGSS Discipline*
1	**Physical Science 4.2**
1.PS4-2	**Sample Phenomena** *When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.* ● You cannot see in a dark and deep cave. ● Lighthouses can save ships from crashing. **Classroom Assessment Items** *When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available.* From Wonder of Science: https://docs.google.com/document/d/1mu7JLO8grvXjmC8aIfSc0Pn6jfxk6HuHo-ofhPiqgek/edit#heading=h.mvtakar3preb What Happens in the Refrigerator? Teacher reads...

Mr. Andersen has always wondered what happens in the refrigerator when the door is closed. Whenever the door is open the light is on and everything in the refrigerator is illuminated. However he can't see what happens when the door is closed and so he has designed an experiment to answer the following question:

What happens in the refrigerator when the door is closed?

Video https://www.youtube.com/watch?v=WmACbd3g7SY (video shows what happens when you close the refrigerator door. This can be recorded on your own as well)

Use thumbnails from previous sites or could make your own

Teacher asks each student to individually make observations from the video and thumbnails to construct an evidence-based account for the following question.
What happens in the refrigerator when the door is closed?

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create and hang anchor charts for students to refer back to	• These should be small groups or 1:1 depending on the student's needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Doing activities such as shutting their eyes and having them explain what they see. Then explaining it is black because light cannot reach our eyes so we cannot see anything.

Common Misconceptions

- Students might not realize that light is related to how we see. (*In order for them to see anything, light has to be reflected off the object and back through their eyes for them to see what they are looking at.)*
- Students think that they can see in the dark just because there is not a lot of light.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: When might someone experience total darkness and not be able to see things? Have you ever experienced true darkness? Why can the darkness be scary? Discuss and affirm student's thoughts and beliefs on what they know about light and dark. What is the darkest place you have ever been and can you still see things?

Build and Bridge: What experiences will your students need to correct misconceptions and show evidence of light illuminating objects? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life?

Ask: Why is the darkness in a cave different from the darkness in your room at night? Have you ever experienced true darkness? Why could you still see some things in the darkness? Where does that light come from?

Students who demonstrate understanding can:

1-PS4-3. **Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.** [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] [*Assessment Boundary: Assessment does not include the speed of light.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct investigations collaboratively to produce evidence to answer a question.	**PS4.B: Electromagnetic Radiation** • Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
2.PS1.A

Common Core State Standards Connections:
ELA/Literacy —

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS4-3)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-PS4-3)

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. *(1-PS4-3)*

Grade	NGSS Discipline
1	**Physical Science 4.3**
1.PS4-3	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● Shadows are everywhere. ● The light doesn't go through the cardboard box. ● Pencil bends when you have it on the other side of the glass.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Inspired by StemScopes: https://app.acceleratelearning.com/scopes/14935/elements/670975 Tony's teacher had a clear cup on her desk. When she placed pens inside, Tony could still see the bottom part of the pens inside the cup, but they looked fuzzy. Why do the bottoms of the pens inside the mug look fuzzy? Write a sentence that answers the question.

Draw how you know! Label your drawing.

Draw a picture of what the pencils would look like if a coffee mug.

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create and hang anchor charts for students to refer back to • Using several different materials and allowing students to explore what happens when objects are put in front of light is key. Using different materials, such as wax paper, plexiglass, mirrors, water, wood, and paper then give students lots of opportunities to use these materials and manipulate the light. • Make light stations with activities and questions to deepen the understanding.	• These should be small groups or 1:1 depending on the student's needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Have students look around the room for items that allow light to go through, allow light to partially go through, or block light completely. Lead a discussion with the guiding questions to discuss what they found. • Make sure students understand that light travels in a straight line until it strikes an object or material. Shadows are created when light cannot pass through an object. Light interacts with materials or objects that it strikes in different ways.

Common Misconceptions

- Kids may not understand how to draw something behind an object so you may need to show them how to do this.

- Students often think light must be completely absorbed or must completely pass through; however, some light may be reflected while some light passes through an object. (*Translucent objects, such as a colored plastic water bottle, let some light pass through, and some light is reflected.)*
- Students sometimes believe that light must be either absorbed or reflected, but not both. (*Objects absorb and reflect light to different degrees.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Why do we have windows? Why do we cover the windows? Why are windows sometimes clear and sometimes hard to see through? Discuss and affirm student's thoughts and beliefs about how objects can look different through different mediums.

Build and Bridge: What experiences will your students need to correct misconceptions and show investigations of materials changing the path of light? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life?

Ask: What are some reasons that we put things in our car windows? What are some things that we might use to cover our windows? Can we block all the light? What happens to the light?

Students who demonstrate understanding can:

1-PS4-4. **Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*** [Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [*Assessment Boundary: Assessment does not include technological details for how communication devices work.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Use tools and materials provided to design a device that solves a specific problem.	**PS4.C: Information Technologies and Instrumentation** • People also use a variety of devices to communicate (send and receive information) over long distances.	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science, on Society and the Natural World** • People depend on various technologies in their lives; human life would be very different without technology.

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **2.ETS1.B** ; **4.PS4.B** ; **4.PS4.C**

Common Core State Standards Connections:

ELA/Literacy —

W.1.7	Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-PS4-4)

Mathematics —

MP.5	Use appropriate tools strategically. *(1-PS4-4)*
1.MD.A.1	Order three objects by length; compare the lengths of two objects indirectly by using a third object. *(1-PS4-4)*
1.MD.A.2	Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps. *(1-PS4-4)*

Grade	*NGSS Discipline*
1	**Physical Science 4.4**
1.PS4-4	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● Lighthouses communicate with ships and boats. ● Morse Code was used to communicate many years ago.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. From STEMscopes: https://app.acceleratelearning.com/scopes/14936/elements/671008 TJ and his dad were walking along the shore. TJ saw a ship on the ocean. He also heard a loud horn and saw flashing lights. They were not near a road, so he wondered what it could be. His dad told him it was a lighthouse warning a ship that it was close to land. Prompt: Using scientific reasoning, explain how lighthouses communicate with ships and boats.

Claim: Lighthouses use __________ and ____________ to communicate with ships and boats.

Evidence: Write how you know!

Draw how you know!

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create and hang anchor charts for students to refer back to • Define and discuss vocabulary with visual examples in context: Communication, devices, light, long distance, sound. • Use photos, written and spoken words to show students different photos of communication and noncommunication examples.	• These should be small groups or 1:1 depending on the student's needs. • Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.

Common Misconceptions

- Students can probably identify cell phones and computers as ways to communicate over long distances, but they may be unfamiliar with both the past and current technologies. (*Other ways to communicate over long distances include telegraph, Morse code, heliograph, sonar, etc. Find examples of these online and show students pictures of each of them while explaining how they function.)*
- Students might think that the only way to communicate over long distances is through modern technology (computers and cell phones). (*Other ways to communicate over long distances without using modern technology include smoke signals, drums, bells, whistles, hand signals, etc.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: Is communication only through our voices and devices? What is communication? Why do we communicate? Discuss and affirm with student's their beliefs on what they believe communication is.

Build and Bridge: What experiences will your students need to correct misconceptions and design a device that uses light and sound to communicate? (Reflect on the Misconceptions section.) How can your students use this knowledge in their daily life?

Ask: How do we know it's time for a specific event? Compare older technology to modern technology? Are any of these still being used today? What are some other ways that we might need to communicate using light and sound? Why do we use both light and sound to alert an emergency?

1.Science and Society		
PERFORMANCE EXPECTATIONS Students who demonstrate understanding can: **1-SS-1 NM.** **Obtain information about how men and women of all ethnic and social backgrounds in New Mexico have worked together to advance science and technology.** [Clarification Statement: Introduce the concept that regardless of ethnicity, gender, or social background, any person can contribute to advances in science and technology.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. • Obtain information using various tests, text features (e.g. headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim. • Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	**ETS1.A Defining and Delimiting Engineering Problems** • A situation that people want to change or create can be approached as a problem to be solved through engineering. • Asking questions, making observations, and gathering information are helpful in thinking about problems.	**Patterns** • Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. --- **Connections to Nature of Science** **Science Addresses Questions about the Natural and Material World** • Scientists study the natural and material world **Science is a Human Endeavor** • People have practiced science for a long time. • Men and women of diverse backgrounds are scientists and engineers.
Connections to other DCIs in this grade-band: N/A		
Articulation of DCIs across grade-bands: ***3-5.ETS1.A***		
Common Core State Standards Connections:		
ELA/Literacy – **RI.1.1** Ask and answer questions about key details in the text. **RI.1.2** Identify the main topic and retell key details of a text. **RI.1.10** With prompting and support, read informational texts appropriately complex for grade 1. **W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions.) *Mathematics -*		

Grade	*NGSS Discipline*	
1	**Science and Society**	
1.SS-1	**Sample Phenomena**	
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. • The Atomic Age, including the first atomic bombs, were founded at Los Alamos National Labs (LANL) in New Mexico and included contributions from many diverse groups. • The Navajo Agricultural Products Industry is an agricultural consortium that sells agricultural products produced by Native farmers.	
	Classroom Assessment Items	
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Draw a picture of a scientist or engineer in your life doing science or engineering! Students should explain their work either through writing or verbal explanations. Note this doesn't have to be a professional scientist, but can be a layman that uses science in their day to day work/life.	
	Universal Supports	**Targeted Supports**

- Use multiple modes of media to introduce students to concepts (audio, video, text, photographs)
- Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary
- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Create and hang anchor charts for students to refer back to
- This is a great opportunity to bring in guest speakers from your students' families or local resources like universities or industries to give students first-hand interaction with a variety of scientists or individuals that use science in their daily lives.

- Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information
- Peer tutoring (teacher-selected partners) to support students in learning
- Provide opportunities for reflection and revision of their work when possible
- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest
- When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- Students may need practice identifying how science gets used in jobs that aren't traditionally considered science-based. Brainstorm with students about a specific job and how it uses science. For example, construction workers use measuring techniques to layout, cut and join together different materials to build a house. They also must know how much and when to use additives in concrete. This is information gained not just from reading about it, but from their experiences on the job.
- Another example is a teacher that uses anecdotal records and student assignments to evaluate student progress and gain information about what is the best way to teach a particular concept to students.

Common Misconceptions

- Scientists can only look a certain way. (*There is as much variety to scientists and engineers as there are people in this world.)*
- Scientists are only people that do science for a living. (*We all engage in science every day as we identify and solve problems that come up in our daily lives.)*

- Scientists can only conduct or perform science in a traditional lab. (*Science is done everywhere! From construction workers deciding how much additive to put in concrete, to bakers developing a new recipe, science is done everywhere as a way to make our daily lives better.)*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate and Affirm: What is your students' current mental model of a scientist? What experiences will they need to build a more diverse view of who can be a scientist?

Students will likely have a more limited idea of who can be a scientist based on preconceptions drawn from TV and other resources. Validate their current perceptions, but challenge them to begin thinking of scientists they may know that don't fit that model.

Ask the students: Draw a scientist doing science. Who is the scientist you drew? What are they doing? Who do you know who is a scientist?

Build and Bridge: How do we use science in our daily lives? How have your students used science?

Students will need to see, read about and discuss a wide variety of scientists and people that do science to understand that science is for everyone. Focus on individuals that may not be professional scientists, but who have used science to better the lives of themselves or others.

Ask: How have you used science? How does your family use science? Prompt that this may be non-professional, like growing better tomatoes or improving a recipe. What is something you didn't know was science?

Students who demonstrate understanding can:

K-2-ETS1-1. **Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. • Ask questions based on observations to find more information about the natural and/or designed world(s). • Define a simple problem that can be solved through the development of a new or improved object or tool.	**ETS1.A: Defining and Delimiting Engineering Problems** • A situation that people want to change or create can be approached as a problem to be solved through engineering. • Asking questions, making observations, and gathering information are helpful in thinking about problems. • Before beginning to design a solution, it is important to clearly understand the problem.	

Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:

Kindergarten: K-PS2-2, K-ESS3-2

Articulation of DCIs across grade-levels:

3-5.ETS1.A ; **3-5.ETS1.C**

Common Core State Standards Connections:

ELA/Literacy —

RI.2.1	Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text. (K-2-ETS1-1)
W.2.6	With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1)*
W.2.8	Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1)

Mathematics —

MP.2	Reason abstractly and quantitatively. *(K-2-ETS1-1)*
MP.4	Model with mathematics. *(K-2-ETS1-1)*
MP.5	Use appropriate tools strategically. *(K-2-ETS1-1)*
2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1)

<table>
<tr><th>Grade</th><th colspan="2">NGSS Discipline</th></tr>
<tr><td>1</td><td colspan="2">Engineering Design 1.1</td></tr>
<tr><td rowspan="5">K-2 ETS1-1</td><td colspan="2">Sample Phenomena</td></tr>
<tr><td colspan="2">When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don’t have local instructional materials available.
• Sometimes humans use cotton swabs to hand pollinate plants.</td></tr>
<tr><td colspan="2">Classroom Assessment Items</td></tr>
<tr><td colspan="2">When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don’t have local instructional materials available.
Make an observation about a person using a paint brush to pollinate.
Why is someone using a paintbrush?
What is on the paintbrush?
What do you predict will happen?
What could have happened before?</td></tr>
<tr><td>Universal Supports</td><td>Targeted Supports</td></tr>
</table>

	- Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) - Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) - Explicit introduction and modeling of Tier 2 vocabulary - Use picture cues and sentence stems to support students in acquiring new vocabulary - Provide opportunities for students to explain their thinking - As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment - Use real objects and photos as much as possible to give students common understandings - Allow students who are not able to write academically to draw their answers and explain verbally - Use the graphic organizer to go over terms and processes for the **Engineering Design Cycle and NGSS Dimension 1: Engineering Practices**. Provide the students with a non-example that they can improve and demonstrate that some solutions need to be revised.	- Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information - Peer tutoring (teacher-selected partners) to support students in learning - Provide opportunities for reflection and revision of their work when possible - Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest - When designing solutions, have students work with a partner and/or teacher to develop steps - For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. - For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. - If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. - Explicit instruction in the process of coming up with multiple solutions during The Engineering Design Cycle, provide examples of the step-by-step investigation procedure. This should help students understand that this process skips around and does not follow a sequential process every time. - Help students that struggle with perseverance (when a solution doesn't work).

Common Misconceptions

- A problem only has **one** true solution.
- Some problems cannot be solved.
- A solution can be perfect, with no limitations or drawbacks.
- Everyone will benefit from the best solution
- Solutions do not have to meet criteria.
- A solution doesn't need to be revised.

Specific to Example Phenomenon & Assessment:

- Students may believe that fruit just happens. They are not aware of pollination happening.
- Students may not be aware that there are world issues where humans are now having to do the pollination.

Additional resource used in research: *Minding Design Missteps: A watch list of misconceptions for beginning designers.*

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

Student Questions:

- What tools do you and your family use and for what?
- What is an example of a tool that your family has improved?
- What names do you and your family call certain tools?
- How have you and your family solved a problem with a tool?

Teacher Questions:

- Do I see the necessary connection between tier II words and validation and affirmation?
- Do I recognize that my student's use of slang provides an opportunity for building academic language?

Build & Bridge:

Student Questions:

- You referred to this (image) as, it can also be called ___.
- How and what tools help make jobs more efficient?
- After learning about pollination, what self-connections/world connections can you make? (e.g. gardening)
- How could you and your family help the plants pollinate?
- What types of food do you eat that may be a result of pollination?

Teacher Questions:

- Do I have a plan for tier II words for robust vocabulary instruction?
- Do I know how to teach the word acquisition strategies?
- Do I provide plenty of practice for academic vocabulary?

Students who demonstrate understanding can:

K-2-ETS1-2. **Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Develop a simple model based on evidence to represent a proposed object or tool.	**ETS1.B: Developing Possible Solutions** • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	**Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s).

Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:
Kindergarten: K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; **3-5.ETS1.B** ; **3-5.ETS1.C**

Common Core State Standards Connections:
ELA/Literacy —
SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

Grade	*NGSS Discipline*	
1	**Engineering Design 1.2**	
K-2 ETS1-2	**Sample Phenomena**	
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● Bees' legs have a special pollen basket to help them collect pollen.	
	Classroom Assessment Items	
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. ● Can animals help with the spreading of pollen or seeds? Sketch, draw, or create a model as a visual representation to show what that would look like.	
	Universal Supports	**Targeted Supports**
	● Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) ● Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) ● Explicit introduction and modeling of Tier 2 vocabulary	● Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information ● Peer tutoring (teacher-selected partners) to support students in learning ● Provide opportunities for reflection and revision of their work when possible ● Provide extension opportunities for students or additional readings to go

- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Create a graphic organizer for students to label the process for the **Engineering Design Cycle and NGSS Dimension 1: Engineering Practices**. Provide the students with a non-example that they can improve and demonstrate that some solutions need to be revised.

deeper in learning, for those students with high interest

- When designing models, have students work with a partner and/or teacher
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- Explicit instruction in developing a simple model, provide an example model giving step-by-step directions on how to create a model.

Common Misconceptions

- A problem only has **one** true solution.
- Some problems cannot be solved.
- A solution can be perfect, with no limitations or drawbacks.
- Everyone will benefit from the best solution
- Solutions do not have to meet criteria.
- A solution doesn't need to be revised.

Specific to Example Phenomenon & Assessment:

- Students may believe that fruit just happens. They are not aware of pollination happening.
- Students may not be aware that there are world issues where humans are now having to do the pollination.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

Student Questions:

- What tools do you and your family use and for what? How does the shape help with how you use it?
- What names do you and your family call certain tools?
- How have you and your family solved a problem with a tool? Draw an example.

Teacher Questions:

- Do I see the necessary connection between tier II words and validation and affirmation?
- Do I recognize that my student's use of slang provides an opportunity for building academic language?

	Build & Bridge: Student Question: ● You referred to this (image) as, it can also be called ___. ● You said (this term), sketch the term you were sharing. How does the shape help with its use? ● After learning about pollination, sketch self-connections/world connections can you make? (e.g. gardening) ● How could you and your family help the plants pollinate? Create a physical model of a tool you could use. ● What types of food do you eat that may be a result of pollination? Teacher Questions: ● Do I have a plan for tier II words for robust vocabulary instruction? ● Do I know how to teach the word acquisition strategies? ● Do I provide plenty of practice for academic vocabulary?

Students who demonstrate understanding can:

K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Analyze data from tests of an object or tool to determine if it works as intended.	**ETS1.C: Optimizing the Design Solution** • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	

Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Second Grade: *2-ESS2-1*

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; ***3-5.ETS.1.B*** ; ***3-5.ETS1.C***

Common Core State Standards Connections:
ELA/Literacy —

W.2.6	With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-3)*
W.2.8	Recall information from experiences or gather information from provided sources to answer a question. *(K-2-ETS1-3)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(K-2-ETS1-3)*
MP.4	Model with mathematics. *(K-2-ETS1-3)*
MP.5	Use appropriate tools strategically. *(K-2-ETS1-3)*
2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-3)

Grade	*NGSS Discipline*	
1	**Engineering Design 1.3**	
K-2 ETS1-3	**Sample Phenomena**	
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. ● A paintbrush's fine bristles can collect pollen from flowers but so can the soft cotton mass at the end of a cotton swab.	
	Classroom Assessment Items	
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. ● Make an observation about a person using a paint brush and a cotton swab to pollinate. Record and analyze the data made.	
	Universal Supports	**Targeted Supports**
	● Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) ● Use multiple methods of CFU's to ensure	● Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information

students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Create a graph on data collected to show effectiveness of various tools. Rank the outcomes of the various tools.	• Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Explicit instruction in utilizing various data points such as graphs and charts. Discuss to analyze and interpret the data to ensure that information is usable.

Common Misconceptions

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- Some problems cannot be solved.
- A solution can be perfect, with no limitations or drawbacks.
- Everyone will benefit from the best solution
- Solutions do not have to meet criteria.
- A solution doesn't need to be revised.

Specific to Example Phenomenon & Assessment:

- Students may believe that fruit just happens. They are not aware of pollination happening.
- Students may not be aware that there are world issues where humans are now having to do the pollination.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

Student Questions:

- What tools do you and your family use and for what? How does the shape help with how you use it? Discuss in a small group how different tools are used and how well they work.
- How have you and your family solved a problem with a tool? Discuss in a small group how different tools are used and how well they work.
- What pollination methods do you think work best based on your experience/knowledge?

	Teacher Questions: Do I see the necessary connection between tier II words and validation and affirmation? Do I recognize that my student's use of slang provides an opportunity for building academic language? Build & Bridge: Student Question: ● After learning about pollination, what thoughts come to mind? (e.g. gardening) ● Discuss in a small group how different tools are used to help pollinate and how well they work. ● Discuss other modifications that may work better based on your discussion. Teacher Questions: Do I have a plan for tier II words for robust vocabulary instruction? Do I know how to teach the word acquisition strategies? Do I provide plenty of practice for academic vocabulary?

Section 3: Resources

Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. [8] Our core science instruction must also allow for students to develop their science and engineering practices over time in addition to disciplinary core ideas. We know that children enter kindergarten with a surprisingly complex way of thinking about the world.[9] We know that students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas' interconnections over a period of years rather than weeks or months.[2] We know that in order for students to develop a sustained attraction to science and for them to appreciate the many ways in which it is pertinent to their daily lives, classroom learning experiences in science need to connect with their own interests and experiences.[1] To this end, the National Research Council lays out a three-dimensional framework that is foundational to the development of the *Next Generation Science Standards (NGSS)*.

Dimension 1 describes the scientific and engineering practices (SEP). Dimension 2 describes the crosscutting concepts (CCC). Dimension 3 describes the core ideas (DCI) in the science disciplines and the relationships among science, engineering, and technology. All three of these dimensions must be interwoven in curriculum, instruction, and assessment.[1]

Engaging in the Practices of Science

Students provided sustained opportunities to engage in the practices of science and engineering better understand how knowledge develops and provides them an appreciation of the diverse strategies used to investigate, model, and explain the world.[1] The practices for K-12 science classrooms are:

1. Asking questions (science) and defining problems (engineering)
    a. Science asks:
        i. What exists and what happens?
        ii. Why does it happen?
        iii. How does one know?
    b. Engineering asks:
        i. What can be done to address a particular human need or want?
        ii. How can the need be better specified?
        iii. What tools or technologies are available, or could be developed, for addressing this need?
    c. Both ask:
        i. How does one communicate about phenomena, evidence, explanations, and design solutions?
2. Developing and using models
    a. Mental models: functional, used for thinking, making predictions, and making sense of experiences.
    b. Conceptual models: allow scientists and engineers to better visualize and understand phenomena and problems.

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[8] National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

[9] National Research Council. (2007). *Taking Science to School: Learning and Teaching Science in Grades K-8.* Committee on Science Learning, Kindergarten through Eighth Grade. R.A. Duschl, H.A. Schweingruber, and A.W. Shouse (Eds.). Board of Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

   c. Are used to represent current understanding of a system (or parts of a system) under study, to aid in the development of questions or explanations, and to communicate ideas to others.
3. Planning and carrying out investigations
   a. Used to systematically describe the world and to develop and test theories and explanations of how the world works.
4. Analyzing and interpreting data
   a. Once collected, data are presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others.
5. Using mathematics and computational thinking
   a. Enables the numerical representation of variables, the symbolic representation of relationships between physical entities, and the prediction of outcomes.
6. Constructing explanations (science) and designing solutions (engineering)
   a. Explanations are accounts that link scientific theory with specific observations or phenomena.
   b. Engineering solutions must include specifying constraints, developing a design plan, producing and testing models/prototypes, selecting among alternative design features to optimize achievement, and refining design ideas based on prototype performance.
7. Engaging in argument from evidence
   a. Scientists and engineers use reasoning and argumentation to make their case concerning new theories, proposed explanations, novel solutions, and/or fresh interpretations of old data.
8. Obtaining, evaluating, and communicating information
   a. Being literate in science and engineering requires the ability to read and understand their literature. Science and engineering are ways of knowing that are represented and communicated by words, diagrams, charts, graphs, images, symbols, and mathematics.

STEM teaching tools develop briefs to assist STEM teachers with issues that arise in the teaching of STEM. Here are some briefs that address scientific practices. All of these can be found at www.stemteachingtools.org/tools

Why focus on science and engineering practices – and not "inquiry?" Why is "the scientific method" mistaken? - STEM teaching tool #32

For decades science education has engaged students in a version of science inquiry that reduces the investigation of the natural world to a fixed, linear set of steps—sometimes devoid of a deep focus on learning and applying science concepts. Rigid representations of a single "scientific method" do not accurately reflect the complex thinking or work of scientists. The new vision calls for engaging students in multifaceted science and engineering practices in more complex, relevant, and authentic ways as they conduct investigations.

Practices should not stand alone: how to sequence practices in a cascade to support student investigations – STEM teaching tool #3

Science and engineering practices should strongly shape instruction—and be integrated with disciplinary core ideas and cross-cutting concepts. Some people might treat the practices as "stand alone" activities to engage students, but research shows that it is more effective to think about designing instruction as a cascade of practices. Practices should be sequenced and intertwined in different ways to support students in unfolding investigations.

What is meant by engaging youth in scientific modeling? - STEM teaching tool #8

A model is a representation of an idea or phenomenon that otherwise may be difficult to understand, depict, or directly observe. Models are integral to the practice of science and are used across many disciplines in a variety of ways. Scientists develop, test, refine, and use models in their research and to communicate their findings. Helping students develop and test models supports their learning and helps them understand important aspects of how science and engineering work.

Beyond a written C-E-R: supporting classroom argumentative talk about investigations – STEM teaching tool #17

Argumentation, a central scientific practice, relies on the coordination of claims, evidence, and reasoning (C-E-R). C-E-R scaffolds can help students compose a written argument for an investigation. However, there are additional important dimensions to argumentation beyond individually written claims. Classroom discussions that require students to make evidence-based claims and collectively build understanding also reflect argumentation. Several types of discussions can be used and can help build a supportive classroom culture.

Why should students learn to plan and carry out investigations in science and engineering? - STEM teaching tool #19

The NRC Framework for K-12 Science Education specifies eight science and engineering practices to be incorporated into science education from kindergarten through twelfth grade. One of these is planning and carrying out investigations. Although many existing instructional models and curricula involve engaging students in planned investigations, this tool will help you think about ways you can promote student agency by having them plan and conduct science investigations.

How can assessments be designed to engage students in the range of science and engineering practices? - STEM teaching tool #26

The new vision for K-12 science education calls for engaging students in three-dimensional science learning. This approach requires us to figure out new ways to assess student learning across these multiple dimensions—including the eight science and engineering practices. But there aren't many assessment tasks that require students to apply their understanding of core ideas using practices. In this tool, we describe how to use "task formats" to guide the development of such items. The formats can also spark ideas for designing classroom instruction.

Integrating science practices into assessment tasks – STEM teaching tool #30

This detailed and flexible tool suggests activity formats to help teachers create three-dimensional assessments based on real-world science and engineering practices. In response to this felt need being expressed among educators, researchers at the Research + Practice Collaboratory have developed a series of "task format" tables, which suggest different possible templates for student activities that integrate real-world science and engineering practices with disciplinary core ideas. This tool also combines two of the Research + Practice Collaboratory's major focuses: formative assessment and engaging learners in STEM practices. This tool offers between four and eight possible task formats for each of the science and engineering practices listed in the Next Generation Science Standards. It can be a great way for educators to brainstorm new activities or to adapt their existing lesson plans to this new three-dimensional vision.

Engaging students in computational design during science investigations – STEM teaching tool #56

Inquiry in science has become increasingly computational over the past several decades. The broad availability of computational devices, sensor networks, visualizations, networking infrastructure, and programming have revolutionized the way science and engineering investigations are carried out. Computational thinking practices enable unique modes of scientific inquiry that allow scientists to create models and simulations to generate data, and to understand and predict complex phenomena. K-12 science classrooms are natural contexts in which students can engage in computational thinking practices during their investigations.

Designing productive uncertainty into investigations to support meaningful engagement in science practices – STEM teaching tool #60

We want students to engage from the earliest ages in science and engineering practices with sincere curiosity and purpose. Science investigations can be viewed as "working through uncertainty." However, 3D instructional materials often try to support engagement in science practices by making them very explicit and scaffolding the process to make it easy to accomplish—arguably, too easy. An alternative approach that emphasizes productive uncertainty focuses on how uncertainty might be strategically built into learning environments so that students establish a need for the practices and experience them as meaningful ways of developing understanding.

Crosscutting concepts

A Framework for K-12 Education identifies seven concepts that bridge disciplinary boundaries. These concepts provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world.[1] These crosscutting concepts are:

1. Patterns – guide organization and classification, prompt questions about relationships and the factors that influence them.
2. Cause and effect: mechanisms and explanations – a major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across contexts and used to predict and explain events in new contexts.
3. Scale, proportion, and quantity – in considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. Systems and system models – Defining systems under study provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. Energy and matter: flows, cycles, and conservation – Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. Structure and function – The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
7. Stability and change – conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

STEM teaching tools develop briefs to assist STEM teachers with issues that arise in the teaching of STEM. Here are some briefs that address scientific practices. All of these can be found at www.stemteachingtools.org/tools

Prompts for integrating crosscutting concepts into assessment and instruction – STEM teaching tool #41

This set of prompts is intended to help teachers elicit student understanding of crosscutting concepts in the context of investigating phenomena or solving problems. These prompts should be used as part of a multi-component extended task. These prompts were developed using the Framework for K-12 Science Education and Appendix G of the Next Generation Science Standards, along with relevant learning sciences research.

The planning and implementation of instruction in your classroom should allow your students multiple and sustained opportunities to learn disciplinary core ideas through the science and engineering practices, as well as using appropriate crosscutting concepts as lenses to understand the disciplinary core idea and its relationship to other core ideas.

Planning Guidance for Culturally and Linguistically Responsive Instruction

"Equity in science education requires that all students are provided with equitable opportunities to learn science and become engaged in science and engineering practices; with access to quality space, equipment, and teachers to support and motivate that learning and engagement; and adequate time spent on science. In addition, the issue of connecting to students' interests and experiences is particularly important for broadening participation in science[1]"

In order to ensure our students from marginalized cultures and languages view themselves as confident and competent learners and doers of science within and outside of the classroom, educators must intentionally plan ways to counteract the negative or missing images and representations that exist in our curricular resources. The guiding questions below support the design of lessons that validate, affirm, build, and bridge home and school culture for learners of science:

> **Validate/Affirm:** How can you design your classroom to intentionally and purposefully legitimize the home culture and languages of students and reverse the negative stereotypes regarding the science abilities of students of marginalized cultures and languages?
>
> **Build/Bridge:** How can you create connections between the cultural and linguistic behaviors of your students' home culture and language and the culture and language of school science to support students in creating identities as capable scientists that can use science within school and society?

STEM Teaching tools highlight ways of working on specific issues that arise during STEM teaching. Here are some tools that have been created to guide STEM instruction around the concept of culturally and linguistically responsive instruction. All of these can be found at www.stemteachingtools.org/tools

How can we promote equity in science education? - STEM teaching tool #15

Equity should be prioritized as a central component in all educational improvement efforts. All students can and should learn complex science. However, achieving equity and social justice in science education is an ongoing challenge. Students from non-dominant communities often face "opportunity gaps" in their educational experience. Inclusive approaches to science instruction can reposition youth as meaningful participants in science learning and recognize their science-related assets and those of their communities.

Building an equitable learning community in your science classroom – STEM Teaching Tool #54

Equitable classroom communities foster trusting and caring relationships. They make cultural norms explicit in order to reduce the risk of social injuries associated with learning together. Teachers are responsible for disrupting problematic practices and developing science classroom communities that welcome all students into safe, extended science learning opportunities. However, this is tricky work. This tool describes a range of classroom activities designed to cultivate communities that open up opportunities for all students to learn.

How can you advance equity and justice through science teaching? - STEM teaching tool #71

Inequities are built into the systems of science education such that "students of color, students who speak first languages other than English, and students from low-income communities… have had limited access to high-quality, meaningful opportunities to learn science." Intersecting equity projects can guide the teaching and learning of science towards social justice. Science educators who engage in these projects help advance Indigenous self-determination (details) and racial justice by confronting the consequences of legacies of injustice and promoting liberatory approaches to education.

Focusing science and engineering learning on justice-centered phenomena across PK-12 – STEM Teaching tool #67

In the Framework vision for science education, students engage in active investigations to make sense of natural phenomena and analyze and build solutions to problems. Basing these investigations on justice-centered phenomena can be a powerful and rightful way to support science and engineering learning. Justice-centered investigations can open up important opportunities for students to engage in projects that support equity for communities and to see how the application of science and engineering are fundamentally entwined with political and ethical questions, dimensions, and decisions.

Teaching STEM in ways that respect and build upon indigenous peoples' rights – STEM teaching tool #10

Indigenous ways of knowing are sometimes thought to be in opposition to and detrimental to the learning of Western Science or STEM. Consequently, indigenous ways of knowing are rarely engaged to support learning. If STEM learning is to be meaningful and transformative for Indigenous youth, respecting Indigenous peoples' rights and related critical issues, including Indigenous STEM, settler-colonialism, and decolonization, must be understood and explicitly addressed in Indigenous youths' informal and formal STEM learning experiences.

How can formative assessment support culturally responsive argumentation in a classroom community? - STEM teaching tool #25

Argumentation has long been seen as an important practice in science and thus in science education. Formative assessment can be used to help students value the contributions and perspectives of others as they engage in argumentation to make sense of natural phenomena. Educators can use these strategies to help foster argumentation that is culturally responsive, meaning it draws from and respects students' cultural resources, backgrounds, and personal experiences. Culturally responsive formative assessment happens within a community of learners where the teacher has cultivated explicit norms for increasing student-centered discourse, making decisions for their own purposes through democratic processes, and using clear guidelines for maintaining mutual respect.

Engaging English learners in science and engineering practices – STEM teaching tool #27

Routinely engaging all students in the practices of science and engineering is a crucial fixture of the new vision for K-12 science education. The practices can be seen as a barrier to participation for English Learners (ELs), or they can be viewed as an opportunity to provide rich instruction that builds science-related competencies and identities. Certain elements of the practices and related instructional approaches can be beneficial for students learning science while also learning the language of instruction.

How can I promote equitable sensemaking by setting expectations for multiple perspectives? - STEM teaching tool #47

In a phenomena-focused, 3D approach to science learning, students use science practices to consider each other's ideas based on available interpretations and evidence. To promote deep and equitable learning, plan purposefully to ensure that the various perspectives that students bring to making sense of phenomena are solicited, clarified, and considered. It is important to support students as they develop a shared understanding of the different perspectives in the group.