NEW MEXICO
Public Education Department

New Mexico Instructional Scope
Fifth Grade Science Guide

Table of Contents

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.

---

[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.

<u>How:</u> 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

---

[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

Physical Sciences	Life Sciences	Earth and Space Sciences	Engineering, Technology, and Applications of Science	New Mexico Science and Society
Matter and its Interactions 5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4 Motion and Stability: Forces and Interactions 5-PS2-1 Energy 5-PS3-1	From Molecules to Organisms: Structures and Processes 5-LS1-1 Ecosystems: Interactions, Energy, and Dynamics 5-LS2-1	Earth's Place in the Universe 5-ESS1-1 5-ESS1-2 Earth's Systems 5-ESS2-1 5-ESS2-2 Earth and Human Activity 5-ESS3-1	Engineering Design 3-5-ETS1-1 3-5-ETS1-2 3-5-ETS1-3	Science and Society 5-SS-1

Students who demonstrate understanding can:

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

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 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.

Connections to other DCIs in fifth grade: N/A

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

Common Core State Standards Connections:

ELA/Literacy -

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-PS1-1)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(5-PS1-1)*

MP.4 Model with mathematics. *(5-PS1-1)*

5.NBT.A.1 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *(5-PS1-1)*

5.NF.B.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. *(5-PS1-1)*

5.MD.C.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement. *(5-PS1-1)*

5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. *(5-PS1-1)*

Grade	NGSS Discipline
5	Physical Science 1.1

5.PS1-1

Sample Phenomena

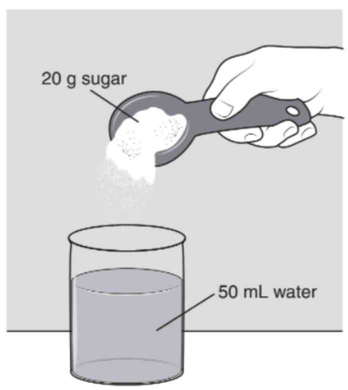
When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.

- We can create visible clouds inside of our mouths!

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.

- Minh adds 20 grams of sugar to 50 milliliters of water, as shown. She stirs the mixture until she can no longer see the sugar particles.



- Describe what a model would show that explains why Minh can no longer see the sugar particles.

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Define and discuss unit vocabulary (Tier 2) with definitions and illustrations, using explicit modeling. • Conduct investigations and hand-on activities to demonstrate that not all matter can be seen. • Use multiple modes of media (print, video, audio, etc.) to discuss particles and how they are too small to be seen.	• These should be a small group or 1:1 depending on students' needs. • Use concrete models to support students. • Use hands-on activities to demonstrate concrete examples. • Further discuss how we know the matter exists even if it cannot be seen, using sentence stems and peer tutoring, where possible

● Give concrete examples of models of matter, *ex. phenomena from the lesson, basketball inflated with air, air in a syringe, sugar in water.* ● Discuss the examples and the matter found in the models. ● Support students in explaining the models and how they relate to unseen particles.	● Create graphic organizers that allow students to organize their thinking as they create models.

Common Misconceptions

- Students sometimes believe gases are not matter because they cannot always be seen and their mass cannot be easily measured.
- Students may not understand that matter is made of small particles.
- Students may think that small solids (sugar, salt, etc.) are liquids because they can be poured.
- Students may think that molecules in a solid do not move.
- Students often assume that solids are always heavier than liquids and that liquids are always heavier than gases, which is not always the case.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Science is about making sense of the world around us. Activate experienced knowledge by discussing: *How do we know something is there if we cannot see it?* (For example, we know wind is present even though we cannot see it because we can feel it.)
  - *Can you think of some things you have at home that you know are made of matter, but you may not be able to see them?*
  - *Have you ever cooked at home with your family? Can you think of a time when matter seemed to "disappear"?*
- Validate students' lack of knowledge about matter and particles, and make them feel comfortable in taking risk of making sense of complex ideas. Help them feel safe in knowing they will not be ridiculed or mocked by their peers when sharing these ideas.

Build & Bridge:

- Help students make sense of what wind is. Make a connection between air and wind, discuss that like the wind air cannot be seen but it can be felt, it takes up space, and it has mass.
  - *What are some ways that we can make the air we breathe appear visible?*
- Emphasize that even when a substance is clear it may still have other substances mixed in. It may have particles that can not be seen but can be identified by tasting and smelling.
  - *What are some examples of mixtures we can create that may have matter that is not visible?*

Students who demonstrate understanding can:

5-PS1-2. **Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.** [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [*Assessment Boundary: Assessment does not include distinguishing mass and weight.*]

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
Using Mathematics and Computational Thinking Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. • Measure and graph quantities such as weight to address scientific and engineering questions and problems.	**PS1.A: Structure and Properties of Matter** • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. **PS1.B: Chemical Reactions** • No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
2.PS1.A ; **2.PS1.B** ; **MS.PS1.A** ; **MS.PS1.B**

Common Core State Standards Connections:
ELA/Literacy -
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. *(5-PS1-2)*
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(5-PS1-2)*
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *(5-PS1-2)*
Mathematics -
MP.2 Reason abstractly and quantitatively. (5-PS1-2)
MP.4 Model with mathematics. (5-PS1-2)
MP.5 Use appropriate tools strategically. (5-PS1-2)
5.MD.A.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real-world problems. *(5-PS1-2)*

Grade	*NGSS Discipline*
5	**Physical Science 1.2**
5.PS1-2	**Sample Phenomena**

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.

- When you take a popsicle outside to eat, and it melts into a liquid, it will still have the same mass.

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.

- Jacob does an investigation using a sugar-water mixture. He follows the steps and makes the observations shown in the table.
    - Predict the weights of the mixture at steps 3, 5, and 7.
    - Make a labeled bar graph that shows the three weights you predicted in Part A.

Step	Observation
1. Fill a plastic cup with water until the cup and the water weigh a total of 40 grams.	
2. Add 2 grams of sugar to the water and stir.	The sugar dissolves in the water.
3. Weigh the cup.	
4. Place the cup in a freezer overnight.	The liquid mixture becomes ice.
5. Remove the cup from the freezer and weigh the cup.	
6. Place the cup on a counter overnight.	The ice melts.
7. Weigh the cup.	

- Explain how your predictions and bar graph provide evidence of what happens to the total weight of matter when substances are mixed, frozen, and thawed.

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Define and discuss unit vocabulary (*ex: mass, matter, conserved, solid, liquid, gas, physical changes, chemical changes*) with definitions and illustrations, using explicit modeling. • Use multiple modes of media (print, video, audio, etc.) to introduce concepts of conservation of mass. • Conduct investigations and hands-on activities or experiments to demonstrate conservation of mass using measurement tools. • Students should have opportunities to explain, in words and in writing, observations made during the investigations.	• These should be in small groups or 1:1 depending on students' needs. • Support students in explaining the scientific phenomena with claim/evidence statements, using sentence stems and sample academic vocabulary. • Students should be able to explain, using evidence, that mass is not lost when a solution is created. Peer tutoring, partner work, and small group discussions would be beneficial to support this work. • Students should be able to explain, using evidence, that when matter changes states, the weight does not change. Peer tutoring, partner work, and small group discussions would be beneficial to support this work.

Common Misconceptions

- Students may need clarification around mass versus weight.
- Students sometimes believe gases are not matter because they cannot always be seen and their mass cannot be easily measured.
- When substances are mixed and a chemical reaction occurs, the gas may escape into the air making it seem that matter is not conserved.
- Students may think that when something dissolves, it melts or disappears.
- Students may think that some mass of the substances will be lost when separating a solution.
- Students may think matter has more weight in the solid form than as a liquid or gas.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Science understanding grows out of lived experiences. Discuss:
  - *Have you witnessed matter changing its state when cooking?* (ex. melting butter, boiling water).
  - *Does it matter in a recipe if the ingredient is solid or melted? Or are solid amounts and melted amounts the same?*
  - *How might we find evidence that the total weight of matter remains the same?* (We can weigh it.)
  - *Where do you think heat comes from?*

	Build & Bridge: ● Discuss the importance of conservation of matter when heat is applied. *What happens if we boil water for a long time?* ● *What would be some ways we could try to measure the mass of a gas to prove that mass is conserved?*

Students who demonstrate understanding can:

5-PS1-3. **Make observations and measurements to identify materials based on their properties.** [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [*Assessment Boundary: Assessment does not include density or distinguishing mass and weight.*]

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 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**PS1.A: Structure and Properties of Matter** • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Connections to other DCIs in fifth grade: N/A

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

Common Core State Standards Connections:

ELA/Literacy -

W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. *(5-PS1-3)*
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(5-PS1-3)*
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(5-PS1-3)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (5-PS1-3)
MP.4	Model with mathematics. (5-PS1-3)
MP.5	Use appropriate tools strategically. (5-PS1-3)

Grade	*NGSS Discipline*
5	**Physical Science 1.3**
5.PS1-3	**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.* ● Not all metal objects can be picked up with a magnet grabber. **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.* ● After a rainfall, Katie and Bryan found a piece of metal on the playground at school. The Sun was shining brightly now, and the light reflected off the silver metal. Bryan picked it up. It felt warm and wet. They discussed the possible metals it could be. They narrowed it down to three kinds: iron, copper, or aluminum. They carried it into the classroom and found it was not attracted to a magnet and did conduct electricity. Use your knowledge of physical properties to help them figure out what kind of metal they found.

Metal	Iron	Copper	Aluminum
Color	Gray	Yellow orange	Shiny silver
Electrical Conductivity	Yes	Yes	Yes
Thermal Conductivity	Yes	Yes	Yes
Magnetism	Magnetic	Nonmagnetic	Nonmagnetic
Reflectivity	Reflective	Reflective	Reflective
Solubility	No	No	No

- Use the data chart to analyze the properties of each metal. Draw a conclusion and make a claim as to what type of metal was found.
- Write a scientific explanation for which metal Katie and Brian found. State your evidence and reasoning to support your claim.

Adapted from STEMScopes

Universal Supports

- Define and discuss unit vocabulary (Tier 2) with definitions and illustrations, using explicit modeling.
- Conduct a variety of investigations and hands-on activities to identify properties of different materials.
- Use multiple types of checks for understanding (turn and talks, show call, group discussions, etc.) to assess students' developing understanding of concepts.
- Use visual examples and anchor charts to sort types of materials, based on their properties.
- Provide information about properties of different materials in data tables (see assessment example).

Targeted Supports

- These should be a small group or 1:1 depending on students' needs. Students may need more time to experiment with different materials to test for response to magnetic forces, electrical or thermal conductivity.
- Use as many concrete models and examples to demonstrate different types of properties.
- Students could sort picture cards to sort items by their physical property categories.
- Encourage students to explain their thinking and reasoning behind the sorts, using sentence stems and graphic organizers to compile thoughts.

Common Misconceptions

- Mass and volume are the same property.
- Solids are always heavier than liquids and liquids are always heavier than gases.
- Students are usually very good at measuring the volume of liquids and of square and rectangular prisms, but they often think that irregularly shaped objects do not have a volume or that they cannot be measured.
- Students often think all metals are attracted to magnets. Iron, nickel, and cobalt are attracted to magnets.

- Students often think physical properties are only things you can see.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Students lend valuable ideas to discussions.
- *What are some everyday uses for magnets?*
- *How have you or your family used magnets as tools to help you, both at home or in the classroom?*
- *Are magnets attracted to everything, or just certain things?*
- *Do colors have a specific meaning to you?* (In some countries the color red often means something is hot or indicates to stop).

Build & Bridge:

- Students have great ideas to guide future investigations and inquiries.
- *Does your family bake or cook often?*
- *While working in the kitchen, have you ever mixed up flour and powdered sugar? Why do you think this is something that could easily happen?*
- *What are some things you do to tell the difference between the two substances?*
- *Are there any other types of matter that people often confuse because they look the same? (Example: cucumbers and zucchinis.)*

Students who demonstrate understanding can:

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

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 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**PS1.B: Chemical Reactions** • When two or more different substances are mixed, a new substance with different properties may be formed.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

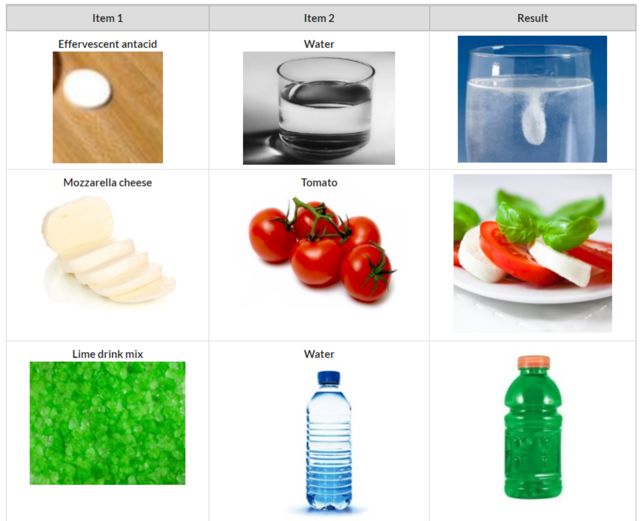
Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
2.PS1.B ; **MS.PS1.A** ; **MS.PS1.B**

Common Core State Standards Connections:
ELA/Literacy -

W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-4)
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-PS1-4)
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(5-PS1-4)*

Grade	*NGSS Discipline*
5	**Physical Science 1.4**
5.PS1-4	**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.* • When iron filings are added to slime, the slime becomes magnetic. **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.* • Luke noticed how everyone in his family was mixing things and causing changes. His dad was taking an antacid by mixing it with water. His mom was making a snack with cheese and tomatoes. Luke was making himself a cold drink with some water and lime drink mix. He wondered if his family was actually creating anything new. Luke remembered from science class that when a new substance is created it means that a chemical reaction has occurred.



- Look at the diagram above to help you describe which type of mixture each family member is making.
- Make a claim about which mixture caused a chemical reaction. Write a scientific explanation using evidence and reasoning to support your claim.

Adapted from STEMscopes

Universal Supports

- Define and discuss unit vocabulary *(ex: chemical reactions, physical reactions, solid, liquid, gas, states of matter, etc.)* with visual examples and explicit modeling.
- Conduct investigations with a variety of mixtures that cause physical change or a chemical reaction.
- Support students in differentiating between the two types of mixtures, based on their observations.
- Use multiple modes of media (print, audio, vido, etc.) to provide context and examples of mixtures and reactions.

Targeted Supports

- Use of hands-on activities that allow students to investigate scenarios where different substances are mixed such as lemon with water.
- Further discuss whether the mixture forms a new substance as in a chemical reaction, using sentence stems.
- Students can conduct hands-on experiments to test if the mixture of the substances results in chemical reactions.

Common Misconceptions

- Students may have a hard time distinguishing between chemical reactions and physical changes.
- Students may think that freezing and boiling are examples of new substances forming.
- Students may think that a reaction means a change in appearance with no change in substance.
- Students may think that when any substance produces bubbles, a chemical reaction has occurred.

Culturally and Linguistically Responsive Instruction

	Guiding Questions and Connections
	The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture. Validate & Affirm: ● All students bring valuable life experiences that are relevant to classroom learning. ● *What kinds of things have you mixed together at home? (Examples may include: drink packets and water, iced tea and sugar, milk and chocolate syrup).* ● *What are some things your family makes at home? What are some of the ingredients they use?* ○ *When you use those ingredients, are you able to create a new substance? How do you know? What type of change occurs?* Build & Bridge: ● *What did the solution look like when you mixed the two things?* ● *When you mixed those things, did you see bubbles?* ● *Did the solution have a different color from either of the ingredients?* ● *Do you think the mixture was a physical change* (both substances were there, but just mixed) *or a chemical reaction* (a new substance was formed)*? How do you know?*

Students who demonstrate understanding can:

5-PS2-1. **Support an argument that the gravitational force exerted by Earth on objects is directed down.** [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*]

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
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**PS2.B: Types of Interactions** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
3.PS2.A ; **3.PS2.B** ; **MS.PS2.B** ; **MS.ESS1.B** ; **MS.ESS2.C**

Common Core State Standards Connections:
ELA/Literacy -
RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(5-PS2-1)*
RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-PS2-1)
W.5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-PS2-1)

Grade	*NGSS Discipline*
5	**Physical Science 2.1**
5.PS2-1	**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.* ● When we carry a lot of objects in our backpack, it feels heavy. ● The pull of gravity is the force that makes roller coasters fun. **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.* ● A man standing on the South Pole of the Earth drops a ball. Mike thinks that the ball will move away from the Earth and Maria thinks that the ball will move toward the Earth.

- Which student do you agree with? Why?
- Which student do you disagree with? What could you say to that person to convince them that their idea is not correct? Be sure to use evidence to support your idea.

Adapted from the Stanford NGSS Assessment Project

Universal Supports

- Define and discuss unit vocabulary with definitions and illustrations, using explicit modeling.
- Reflect on prior knowledge of how objects fall on Earth (see Phenomena "Gravity pulls objects down") using turn and talks, checks for understanding, etc.
- Use multiple modes of media to give students context on concepts of gravity (ex: print, video, audio, etc.)
- Engage students in hands-on labs modeling how a force has an area of effect and pulls in a consistent direction (see Phenomena "Why do people and objects stay on the Earth?").
- Students should apply their knowledge to a real-world example that asks them to predict what will happen.

Targeted Supports

- These should be in small groups or 1:1 depending on the student's needs.
- Students struggling with gravity concepts could benefit from hands-on experiences with throwing balls, noticing how the force of gravity pulls objects down to the ground.
  - Discuss: *When you throw a ball, why does it not keep going?*
- Peer tutoring, reflection discussions, and intentional groupings can be beneficial to give students additional context and ideas on gravity concepts.

Common Misconceptions

- Students may think that size determines how quickly gravity pulls an object down.
- Gravitational force is not present when an object is sitting still.
- Students may believe that objects that are not close to the ground are not affected by gravity.
- Gravity does not exist on Earth, only in space.
- Students may relate the term gravity to astronauts and therefore believe that gravity means to float.

Culturally and Linguistically Responsive Instruction

Guiding Questions and **Connections**

	The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture. Validate & Affirm: ● Science understanding grows out of personal interest and lived experiences. ● Have students think about their favorite sport. *What is one of your favorite sport activities to play? Describe how that sport is played.* ● *When you throw things, such as a baseball or a toy, what will happen to that item after you throw it?* ○ *Why do you think that may be?* Build & Bridge: ● Connect student responses to the concept that gravity pulls objects down by asking students to explain: *How does the force of gravity affect your favorite sport activity?* ● *How would the sport activity change if gravity was not present or was less, like if you were playing on the moon?* ● *What would happen if you were playing on another planet where the force of gravity was stronger?* ● *Is there a way to throw something, and to keep it in the air? Or to prevent it from falling toward the ground?*

Students who demonstrate understanding can:

5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. [Clarification Statement: Examples of models could include diagrams, and flow charts.]

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 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS3.D: Energy in Chemical Processes and Everyday Life** • The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). **LS1.C: Organization for Matter and Energy Flow in Organisms** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary)*	**Energy and Matter** • Energy can be transferred in various ways and between objects.

Connections to other DCIs in fifth grade: N/A

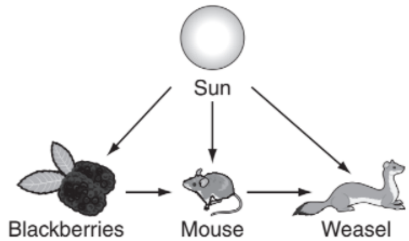
Articulation of DCIs across grade-levels:
K.LS1.C ; 2.LS2.A ; 4.PS3.A ; 4.PS3.B ; 4.PS3.D ; MS.PS3.D ; MS.PS4.B ; MS.LS1.C ; MS.LS2.B

Common Core State Standards Connections:
ELA/Literacy -

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-PS3-1)*

SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-PS3-1)*

Grade	*NGSS Discipline*
5	**Physical Science 3.1**
5.PS3-1	**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.* ● As sunflowers grow, they grow and follow the direction of the Sun.
	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.* ● Justin drew this model to explain how energy flows among blackberries, mice, and weasels. The model is not supported by what happens in nature.



- Describe how the model is not supported by what happens in nature.
- How could we adjust the model to more accurately reflect what happens in nature?
- Explain why the Sun is an important part of the model.

Adapted from STEM Gauge

Universal Supports

- Use multiple modes of media (ex: print, video, audio, etc.) to drive the concept that animals need the sun in order to get energy.
- Define and discuss vocabulary with visual examples in context and explicit modeling *(ex: body repair, energy, growth, motion)*.
- Have students think about energy transfer. *What does it mean to them and why?*
- Use multiple checks for understanding to give students opportunities to share energy transfer and defend their thought process.

Targeted Supports

- These should be in small groups or 1:1 depending on the student's needs.
- Use concrete models and pictures to describe different types of organisms and how energy is transferred.
- Use graphic organizers to create food chains, and create opportunities for student discussions on how their food chains are similar and different.
- Discuss what other organisms are part of the ecosystem. Could they be a part of this food chain? Choose one student's food chain as an example. One at a time, ask students to add an organism to the whiteboard, with an arrow showing where it connects. This will create a food web.

Common Misconceptions

- Students think of the Sun mainly in terms of heat, not as a source of chemical energy in aiding food production
- Students may immediately think of batteries and electricity when they think of energy used to power something.
- Students may not see the connection between food and energy.
- Students may think only plants need energy to live, having learned that plants require sunlight.
- Students may only see food as a need for growing.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

	The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture. Validate & Affirm: ● Science is more meaningful to students when it is linked to their everyday lives. Explain that the ingredients in the food we eat were once living organisms. Think about your favorite thing to eat. ● *What ingredients are found in your favorite food item?* ● *Where did these ingredients come from?* ● *Does anyone you know have a garden? What are some things grown in that garden? How does the Sun support the growth of these things?* Build & Bridge: ● Make connections to the science ideas by asking: *What ingredients received energy directly from the sun to grow?* ● *Which ingredients needed to eat other organisms in order to live and grow?* ● *Why do we need to eat? Where does all of our energy originate?*

Students who demonstrate understanding can:

5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

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
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Plants acquire their material for growth chiefly from air and water.	**Energy and Matter** • Matter is transported into, out of, and within systems.

Connections to other DCIs in fifth grade:
5.PS1.A

Articulation of DCIs across grade-levels:
K.LS1.C ; **2.LS2.A** ; **MS.LS1.C**

Common Core State Standards Connections:
ELA/Literacy -

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(5-LS1-1)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-LS1-1)
W.5.1	Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-LS1-1)

Mathematics -

MP.2	Reason abstractly and quantitatively. *(5-LS1-1)*
MP.4	Model with mathematics. *(5-LS1-1)*
MP.5	Use appropriate tools strategically. *(5-LS1-1)*
5.MD.A.1	Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. *(5-LS1-1)*

Grade	*NGSS Discipline*
5	**Life Science 1.1**

5.LS1-1

Sample Phenomena

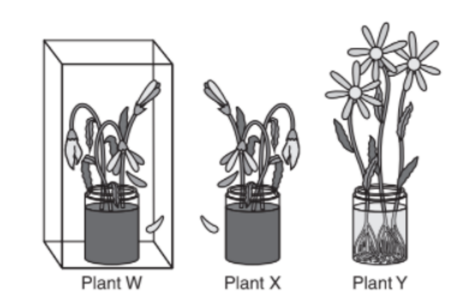
When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.

- Bean plants can grow without soil.
- Ivy, carrots, celery, and sweet potatoes can be grown in water.

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.

- Grace and Linda investigate the effects of three growing conditions on plants. They place each of three plants that are the same size and type into its own container. The containers are the same size and shape.
  - Plant W is given soil and water and is put in a clear plastic box where all of the air is removed.
  - Plant X is given soil and left out in the open, but it does not receive water.



- Plant Y is placed in water and left out in the open, but it does not receive soil.
- The diagram shows how the plants look after a few days.

- Grace and Linda notice that Plant Y is taller than when they began their investigation. Grace claims that the results of the investigation show that plants need both air and water to grow. Linda claims that the results of the investigation show that soil is less important for plant growth than water and air.
    - Explain whether the evidence in the diagram supports or does not support Grace's claim.
    - Explain whether the evidence in the diagram supports or does not support Linda's claim.
    - Create a chart that shows the different variables used for each experiment. Analyze each specific variable.

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Define and discuss lesson vocabulary (Tier 2) with definitions and illustrations, using explicit modeling. • Display a picture or diagram of a plant and identify the plant parts. Discuss each structure and its purpose. • Create multiple opportunities for student discussions focusing on how plants obtain the energy needed from the Sun to survive. • Investigate and conduct hands-on experiments to demonstrate what happens to plants if they do not receive water or air	• Use multiple checks for understanding to assess students' understanding of the concept that plants need other material, apart from sunlight, in order to grow. • Use graphic organizers for students to create a list of elements plants may need to survive. • Use of picture cues and sentence stems to further develop students' Tier 2 vocabulary.

Common Misconceptions

- Students often think plants get their food from the soil.
- Students often think water is plants' only source of matter needed for growth.
- Students often relate the term food with something that has to be eaten that can make understanding plants manufacturing their own food difficult.
- Students may believe that all substances that enter a plant must enter through the roots.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- All students bring valuable life experiences that are relevant to classroom learning. Ask: *Do you have plants in your home?*
- *Do you have a garden at your home, your school, or community?*
- *What do you have to do to keep the plants healthy and growing?*
- *What kinds of plants do you have?*

	● *In your community, have you heard of or seen plants that can grow without soil?* Build & Bridge: ● *Have you ever conducted experiments with plants?* ● *What kinds of experiments?* ● *What were your observations about what plants need to live and grow?* ● *What do you think would happen if we took a plant, such as a sunflower, and removed it from its soil? Would it still be able to grow?* ● *What do you think would happen if we took a celery plant that was growing without soil, and placed it into a pot of soil? Would it continue to grow? Why?*

Students who demonstrate understanding can:

5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

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 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model to describe phenomena. ***Connections to the Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Science explanations describe the mechanisms for natural events.	**LS2.A: Interdependent Relationships in Ecosystems** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	**Systems and System Models** • A system can be described in terms of its components and their interactions.

Connections to other DCIs in fifth grade:
5.ESS2.A ; 5.PS1.A

Articulation of DCIs across grade-levels:
2.PS1.A ; 2.LS4.D ; 4.ESS2.E ; MS.PS3.D ; MS.LS1.C ; MS.LS2.A ; MS.LS2.B

Common Core State Standards Connections:
ELA/Literacy -

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-LS2-1)*

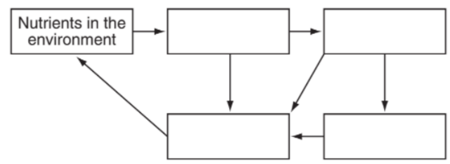
SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-LS2-1)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(5-LS2-1)*

MP.4 Model with mathematics. *(5-LS2-1)*

Grade	*NGSS Discipline*
5	**Life Science 2.1**
5.LS2-1	**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. ● Fall leaves seem to "disappear" over time as the seasons change.
	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. ● Complete the model to show how matter moves back to the environment, using the following living things: *Deer, Fungi, Grass, Wolves*



- Explain why each living thing belongs in the position that you selected in the model.
- What would happen if one of the living things was removed from the model? What would happen to the matter then?

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Define Tier 2 unit vocabulary (*ex: ecosystem, matter etc.*) with explicit modeling. • Use of hands-on models and images to display how matter moves within an environment *(ex: display a picture of a fish tank and discuss the ecosystem inside. Create a matter movement model using the fish tank to describe how matter is cycling within that environment. Talk about the visible and invisible elements such as bacteria present contributing to the successful ecosystem)* • Use multiple opportunities for student discussion to analyze the role of decomposers in nature	• Use anchor charts and graphic organizers to list the necessary conditions for an ecosystem to thrive. • Use peer tutoring to analyze and discuss the roles of each organism (plants, animals, and decomposers) in the matter cycle. ○ Create scenarios where one or more of the necessary conditions is/are missing, causing the ecosystem to become unstable. • Use graphic organizers to curate and list thoughts and develop models.

Common Misconceptions

- A stable ecosystem is one that has similar population sizes of predators and prey.
- Ecosystems never change.
- Students may believe that environments and the relationships within them are stable and unchanging.
- Students may not think of space as a basic need.
- Only humans are responsible for the destruction of habitats and ecosystems.
- Students may think that once an ecosystem is unbalanced, it cannot recover.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Learning is meaningful when home and school worlds connect.
- *Do you have a fish or other type of pet that lives in an aquarium or cage?*

	• *What needs does the pet have?* • *Have you ever seen an organism in nature that was dead? What begins to happen to their body when they die?* Build & Bridge: • Students can tell you how what they're doing today is helping them explain a phenomenon or solve a problem. • *Can a pet get all its needs met from its environment, or does the pet need human assistance to live? (air, water, food, cage/tank cleaning?)* • *Why is human intervention necessary?* • Water cycles in every environment. *How have you witnessed water cycling in your area*?

Students who demonstrate understanding can:

5-ESS1-1. **Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.** [*Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).*]

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
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**ESS1.A: The Universe and its Stars** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
MS.ESS1.A ; **MS.ESS1.B**

Common Core State Standards Connections:
ELA/Literacy -

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(5-ESS1-1)*
RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-ESS1-1)*
RI.5.8	Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). *(5-ESS1-1)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS1-1)
W.5.1	Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-ESS1-1)

Mathematics -

MP.2	Reason abstractly and quantitatively. *(5-ESS1-1)*
MP.4	Model with mathematics. *(5-ESS1-1)*
5.NBT.A.2	Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *(5-ESS1-1)*

Grade	*NGSS Discipline*
5	**Earth and Space Science 1.1**
5.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.* • The Sun appears like it is the largest star in the sky. **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.* • The diagram represents the Sun, five spacecrafts (V, W, X, Y, and Z), and the distance each spacecraft is from the Sun.

- Each spacecraft measures how bright the Sun appears. This brightness is reported using a scale of 1 to 5, where 1 is the least bright and 5 is the brightest. The data is shown in the table.
    - Make a claim about the effect that the distance from the Sun has on how bright the Sun appears.
    - Support your claim with evidence from both the diagram and the table.

Spacecraft	How Bright the Sun Appears
V	5
W	4
X	3
Y	2
Z	1

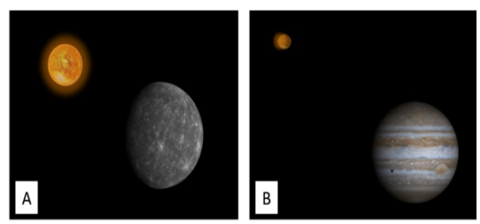
Adapted from STEM Gauge

Universal Supports

- Define and discuss lesson vocabulary with definitions and illustrations *(ex: stars, planets, brightness, celestial bodies)* and using explicit modeling.
- Use hands-on models to demonstrate the effect of distance on brightness using a flashlight. Students will observe the beam of a flashlight from various distances and discuss the differences.
- Through discussion in teams and in whole-groups support students in constructing an argument about distance and brightness of a star based on their observations with the flashlight.
- Use multiple checks for understanding to assess students' on-going development.

Targeted Supports

- To show that brightness and distance are related to one another, display pictures of the sun in relationship to other planets. Have students construct an argument describing distance and brightness of a star in relation to the planet's proximity.
- Use sentence stems and modeling to support student explanations of arguments.
- Use graphic organizers to record new learnings, questions, and developing understanding.



Common Misconceptions

- Students may not be aware of how small the Sun is when compared to other stars.
- Students may believe all stars are the same size and that stars in a constellation are close to each other.
- Students may have prior knowledge about the sun not being the brightest star (due to size and temperature- luminosity).

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

	Validate & Affirm: • Validate students prior knowledge about the sun and its appearance by asking questions like: *Why is the Sun important to Earth?* • *What do you already know about the Sun?* • *When you go outside to look at the sky, what do you like to observe? What do you notice about our night sky?* • *Have you ever looked at the stars in another country?* • *Do you think all stars look the same, no matter where on the globe you are?* Build & Bridge: • Children naturally explore their surroundings and talk about the causes of the phenomena they observe. • Connect student's thinking to the science concept by asking: *How big is the sun?* • *Why does it seem bigger than all of the other stars?* • *How can we compare the size of stars or their distance from Earth with one other by looking into the sky?*

Students who demonstrate understanding can:

5-ESS1-2. **Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.** [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.] *[Assessment Boundary: Assessment does not include causes of seasons.]*

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 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.	**ESS1.B: Earth and the Solar System** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.	**Patterns** • Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
1.ESS1.A ; **1.ESS1.B** ; **3.PS2.A** ; **MS.ESS1.A** ; **MS.ESS1.B**

Common Core State Standards Connections:
ELA/Literacy -
SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-ESS1-2)*
Mathematics -
MP.2 Reason abstractly and quantitatively. (5-ESS1-2)
MP.4 Model with mathematics. (5-ESS1-2)
5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS1-2)

Grade	*NGSS Discipline*
5	**Earth and Space Science 1.2**
5.ESS1-2	**Sample Phenomena**

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.

- Summer days are "longer" than winter days in New Mexico.

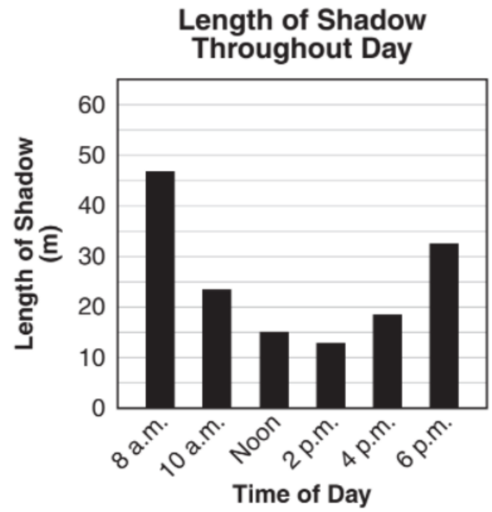
Classroom Assessment Items

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.

- Tia measured the length of the shadow cast by a flagpole six times during one sunny day. The data she collected are shown in the table.

Time of Day	Length of Shadow (m)
8 a.m.	46.9
10 a.m.	24.0
Noon	14.8
2 p.m.	12.9
4 p.m.	18.2
6 p.m.	32.1

- The bar graph shown, represents the data in the table.



  - Describe the data pattern shown in your bar graph. Use the data to support your description.
  - Explain why the data pattern you described in part (b) happens.

Adapted from STEM Gauge

Universal Supports

- Define and discuss lesson vocabulary *(ex: rotation, revolution, shadows, seasons, solstice, etc.)* with definitions and illustrations and explicit modeling.
- Hands-on group work activities (*ex: conduct shadow-tracking investigations, graphing the data collected from the investigation, discuss patterns observed due to the rotation of Earth that cause shadows to appear to move throughout the day*)
- Use visual examples and models to prompt student responses.
- Graphic organizers to support tracking specific, well-known constellations during certain times of the year.

Targeted Supports

- To clarify Earth's rotation vs Earth's revolution, show videos and pictures that illustrate how Earth *rotates* on its axis and Earth *revolves* around the sun.
- Use additional modeling to demonstrate how Earth revolves around the sun rotating on its axis.
- Use of peer tutoring and strategic partners to reflect on on-going learning

Common Misconceptions

- Students may believe that the Sun is the moving object, because it appears to be in different places throughout the day.
- Students may believe the Moon makes its own light.
- Students may confuse the meaning of Earth's rotation with Earth's revolution around the sun
- Students may believe that shadows are stationary.
- Students often believe that stars and constellations appear in the same place in the sky every night.
- Students may think the Sun disappears at night and that the Moon disappears during the day.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Students lend valuable ideas to discussions. Affirm students' prior knowledge of the Earth in relation to the sun. Ask: *What patterns have you noticed caused by the Earth's rotation and revolution around the Sun (ex: day and night)?*
- *What is causing these patterns?*
- *What are seasons in New Mexico as compared to seasons in northern parts of the country? Why do you think this happens? How do the different seasons affect your everyday life?*
- *Have you traveled to other places? What do you notice about the seasons there? Why do you think this may be?*
- Many cultures have stories centered around constellations in the night sky. Ask: *What stories or myths about constellations have you heard?*

Build & Bridge:

- Science is about making sense of the world around us.
- Engage students in developing and/or use models to describe and/or predict patterns observed in the length and direction of shadows.
- *Why does our shadow change positions and size throughout the day? Is there a way we can test this?*
- *What are some places on the globe that may have opposite seasons as us? Why would this be?*

Students who demonstrate understanding can:

5-ESS2-1. **Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [*Assessment Boundary: Assessment is limited to the interactions of two systems at a time.*]

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 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an example to describe a scientific principle.	**ESS2.A: Earth Materials and Systems** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	**Systems and System Models** • A system can be described in terms of its components and their interactions.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
2.ESS2.A ; **3.ESS2.D** ; **4.ESS2.A** ; **MS.ESS2.A** ; **MS.ESS2.C** ; **MS.ESS2.D**

Common Core State Standards Connections:

ELA/Literacy -

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-ESS2-1)*

SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-ESS2-1)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(5-ESS2-1)*

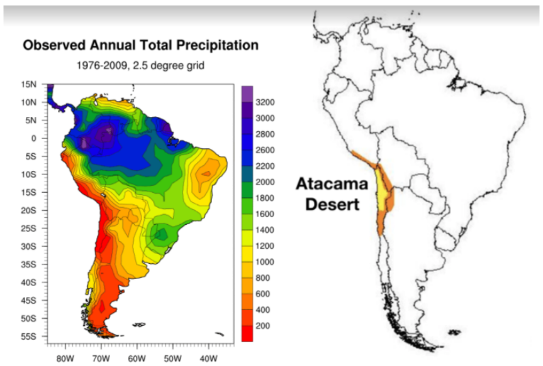
MP.4 Model with mathematics. *(5-ESS2-1)*

5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *(5-ESS2-1)*

Grade	*NGSS Discipline*
5	**Earth and Space Science 2.1**
5.ESS2-1	**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. • Some parts of New Mexico are more desert-like, such as the Chihuahuan Desert, and others are more forest-like, such as Coronado National Park.
	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. • The Atacama desert is the driest place on Earth. The average rainfall is .06 inches per year and some weather stations in the Atacama have never received rain. The Atacama is so dry that many mountains higher than 20,000 ft. are completely free of glaciers. The Atacama desert sits in the shadow of the Andes

Mountains which block the rainfall from the east. To the west of the Atacama desert is the Pacific Ocean. Cold ocean water prevents the evaporation of water and the formation of clouds.

- You will be creating an interacting systems model that will explain the dry weather of the Atacama Desert. Additional information will be provided related to landforms, bodies of water, and weather data. Use this information to create your model.



- Develop an interacting system model in the space below to explain why the Atacama Desert is the driest place on earth.

Adapted from the Stanford NGSS Assessment Project

Universal Supports

- Create a living vocabulary chart throughout the unit/lesson where students and teachers define the meaning of topic related words using written definitions and illustrations. The chart should include a picture that illustrates the meaning of the word (GLAD CCD Chart).
- Use multiple modes of media to introduce the 4 spheres (ex: video, print, audio, etc.)
- Construct an anchor chart of each of the 4 spheres and its description/examples. Have students generate several examples of how the spheres interact with each other.

Targeted Supports

- Display pictures and concrete models that illustrate the 4 spheres interacting with each other and have students describe what they see and discuss how the spheres are interacting in the picture.
- Use peer tutoring and strategic small groups to lead student discussions on developing understanding of how the spheres interact.
- Use sentence stems and graphic organizers to support students' developing thinking.

Common Misconceptions

- Some students may think the atmosphere, hydrosphere, biosphere, and geosphere all operate independently, and therefore a change in one will not affect any of the others.
- Students may not think that oceans are important factors for influencing the weather; however, they play a very important role in the weather.
- Students may not realize that land continues under the ocean, especially if they have never been to a beach, and therefore may have a difficult time understanding how oceans can cause changes to landforms.
- Students may argue that clouds are part of the hydrosphere, not the atmosphere, since they consist of water vapor.

- Students may not realize that precipitation in the atmosphere is part of the hydrosphere.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Learning is meaningful when home and school worlds connect. When discussing sphere interactions, choose examples that are meaningful to the student population. (For example, many students do not have prior knowledge or experience about ocean systems.)
- *What do you think the world is made of? What is your family's perception about Earth and outer space?*
- *How would you describe the climate here in New Mexico? How is it?*

Build & Bridge:

- Science is about making sense of the world around us. Have students model interactions in ecosystems in the community and environment where they live.
- *Draw/create a model of Earth including the 4 spheres and explain how they interact. Connect prior beliefs to scientific content.*

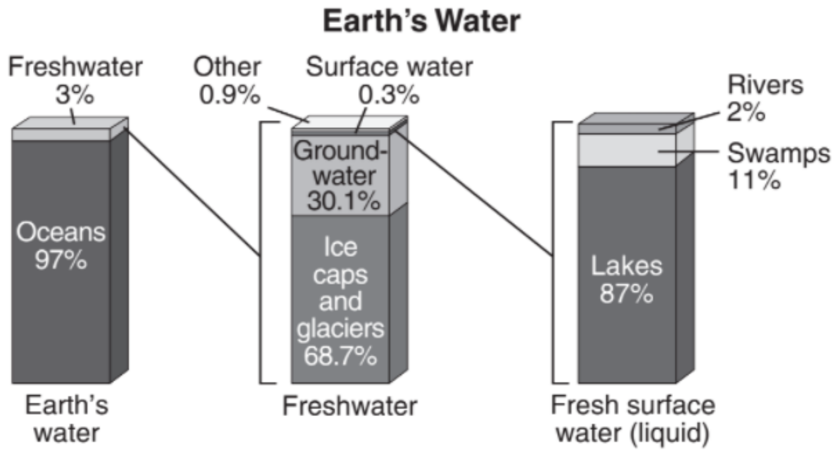
Students who demonstrate understanding can:

5-ESS2-2. **Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** *[Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]*

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
Using Mathematics and Computational Thinking Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams,	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight and volume.

Grade	NGSS Discipline
5	Earth and Space Science 2.2
5.ESS2-2	**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. ● Glaciers, which often store freshwater, are melting away in Glacier National Park. The park used to have 150 glaciers, and that number has been reduced to 25.
	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. ● This diagram shows the percentages and sources of Earth's water.



- Make a pie chart that shows the percentages of saltwater and freshwater on Earth.
- Make a pie chart that shows the percentages of fresh surface water sources on Earth.
- Compare the amount of fresh surface water to the total amount of water on Earth.

Adapted from STEM Gauge

Universal Supports

- Define and discuss lesson vocabulary with definitions and illustrations *(ex: freshwater, saltwater, glaciers, ground water, lakes, oceans)* using explicit modeling.
- Expose students to a variety of graphic displays (bar graphs, pie charts, sticker charts, etc.) to show the distribution of water on the Earth.
- Use maps and globes to show the evidence of a greater amount of salt water versus fresh water on the planet.
- Create an anchor chart with pictures to emphasize the variety of fresh water sources (ponds, lakes, rivers, swamps, etc.)

Targeted Supports

- Hands-on activities, such as using containers to represent the different amounts of water on the Earth. Have students decide and discuss which bottle matches each source of water (oceans, polar ice caps and glaciers, groundwater, and lakes/rivers.)
- Additional opportunities for students to practice graphing using pie charts, bar graphs, etc.

Common Misconceptions

- Some students may not have background knowledge in identifying fresh/salt water sources.
- Once water has been used, it is gone forever.
- Students may think most of the water on Earth is freshwater.
- Students may have a preconceived notion that groundwater means lakes, rivers, and swamps.
- Students may find common water distribution charts confusing.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections:

	The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture. Validate & Affirm: • Learning is meaningful when home and school worlds connect. • *Does water have any special significance in your family/culture?* • *Where is water found on Earth?* • *What different sources can you think of that provide fresh water/salt water in New Mexico?* Build & Bridge: • *How is water important to your community?* • *How many gallons of water do you think your family uses in a day?* • *Since water is in short-supply, what are some ways your family can conserve water in your home?* • *Why might conserving water be important to your community?* • *What kind of plants do we find in New Mexico?* • *Being that New Mexico is covered by desert and forested areas, how do plants survive in New Mexico's extreme climate?*

Students who demonstrate understanding can:

5-ESS3-1. **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.**

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 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	**ESS3.C: Human Impacts on Earth Systems** • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.	**Systems and System Models** • A system can be described in terms of its components and their interactions. ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World.** • Science findings are limited to questions that can be answered with empirical evidence.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
MS.ESS3.A ; **MS.ESS3.C** ; **MS.ESS3.D**

Common Core State Standards Connections:
ELA/Literacy -

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(5-ESS3-1)*
RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS3-1)
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1)
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS3-1)
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(5-ESS3-1)*

Mathematics -

MP.2	Reason abstractly and quantitatively. *(5-ESS3-1)*
MP.4	Model with mathematics. *(5-ESS3-1)*

Grade	*NGSS Discipline*
5	**Earth and Space Science 3.1**
5.ESS3-1	**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.* ● Schools use recycled paper to help reduce the amount of trees cut down per year. **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.* ● The United States Environmental Protection Agency posted a guide that describes volunteer projects related to protecting Earth's resources and environment. These are descriptions of two of the projects:

> Volunteers for a project in Columbia, Missouri, help collect dangerous household waste for safe disposal. They also teach people how to compost vegetable scraps and grass clippings in their backyards so that the people might not take this waste to a landfill.
>
> —adapted from "Volunteers Instill an Environmental Ethic,"
> Columbia Public Works, Columbia, Missouri,
> United States Environmental Protection Agency website

> "Rock the Earth" is a group that works with music tours to protect the environment from human activities related to large concerts. The group encourages music tours to use biofuel (fuel made from once-living plants and animals) instead of fossil fuel for tour buses, sell T-shirts made from organic cotton, and use wind power as a source of energy for lights and equipment.
>
> —adapted from "Defending the Planet One Beat at a Time,"
> Rock the Earth, Denver, Colorado,
> United States Environmental Protection Agency website

- These two projects use different science ideas to protect Earth's environment and resources.
  - Identify the science idea that each project uses to protect Earth's environment and/or resources.
  - Explain how each project uses the science idea identified in part (a) to protect Earth's environment and/or resources.

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Define and discuss lesson vocabulary with definitions and illustrations using explicit modeling • As a class, generate a list of natural resources. Create a T chart about renewable and nonrenewable resources. • Lead turn and talks or class discussions about what the community is doing or could do to conserve natural resources. • Class brainstorming to discuss what humans can do to reduce waste and become more reliant on renewable resources.	• Have students look at picture cards of waste (landfills, litter, etc.) and pollution (car exhaust, smog, industrial, etc.) and discuss how humans are affecting the environment. • Determine how people can use science ideas to help protect Earth's resources and environment, using sentence stems to frame a discussion. • Multiple opportunities for students to grapple and incorporate lesson vocabulary.

Common Misconceptions

- Students may be unaware of how their actions impact Earth.
- Students may think they have to make drastic changes in their lifestyle to reduce their footprint.
- Students may feel that the actions of one person do not really make a difference in the big picture.
- Students may not see the relationships between agriculture and industrial practices and the environment around them.
- Students may often think that the effects of pollution in one area are limited to that area.

- Students may believe that only humans are responsible for the destruction of habitats and ecosystems.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- What counts as important science knowledge is closely tied to a community's values and what is useful in that community.
- *What are some natural resources in your area and how are they used?*
- *Why do you believe using renewable resources versus non-renewable resources is important?*
- *How is your community/family contributing to the conservation of Earth's resources?*

Build & Bridge:

- *How does human activity in your community impact the environment positively?*
- *How does human activity in your community impact the environment negatively? (For example, do people water their lawns? Are there limits to how much or when this activity can occur? Why might we need limits or rules?)*

Students who demonstrate understanding can:

3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

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 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	**ETS1.A: Defining and Delimiting Engineering Problems** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies.

Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:
Fourth Grade: 4-PS3-4

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

Common Core State Standards Connections:
ELA/Literacy -

W.5.7	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1)
W.5.8	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1)*
W.5.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1)*

Mathematics -

MP.2	Reason abstractly and quantitatively. *(3-5-ETS1-1)*
MP.4	Model with mathematics. *(3-5-ETS1-1)*
MP.5	Use appropriate tools strategically. *(3-5-ETS1-1)*
3-5.OA	Operations and Algebraic Thinking *(3-ETS1-1)*

Grade	*NGSS Discipline*
3-5	**Engineering, Technology, and Applications of Science 1.1**

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.

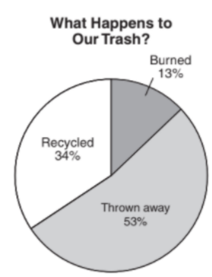
- Humans can design solutions to reduce the effects of human actions on the environment.

Classroom Assessment Items

3-5-ETS1-1

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.

- Edward learns that the landfill (dump) for his town is almost full. He wonders if students in his school can do something to help solve this problem.
- First, he studies this pie chart about trash in many towns across the United States.



- Edward learns that many schools have recycling programs. He thinks a recycling program at his school could help solve the landfill problem. Edward finds this information about how to start a recycling program in his school.

How to Start a Recycling Program at a School

- Organize a team of teachers, students, staff, and parents who will help get the program started.
- Find out how much trash and what kind of trash comes from every part of the school: classrooms, cafeteria, kitchen, and school grounds.
- Think of ways some of the trash can be reused and ways to reduce trash.
- Set up ways to collect trash that can be recycled and sent to a recycling center.

—adapted from "Greening at the Grass Roots: School Recycling,"
American Federation of Teachers website

  - Explain why starting a recycling program at Edward's school could help solve the landfill problem, based on information in the pie chart.
  - Using the information provided and knowledge you already have about recycling, think about ways to reduce trash from your school. Develop a recycling program that would involve teachers and students at your school. What plan could you help put in place to reduce waste in your school?
  - What problems do you foresee with your plan?
  - What are some things you can do if you face some resistance from teachers and students in participating in your plan? How can you get them to help?

Adapted from STEM Gauge

Universal Supports

- Activate prior knowledge by asking students to brainstorm and discuss environmental problems we are facing as a society.
- As a class, create graphic organizers to capture student thinking and ideas.
- Discuss how those problems may be solved. Define and discuss the meaning of *criteria* and *constraints* and how they apply to problem solving.
- Choose a problem example. In small groups have students discuss and define the problem, while identifying possible criteria and constraints for solving the problem.

Targeted Supports

- Using pictures or videos, pose scenarios that illustrate different environmental problems (ex- litter on the beach).
- Ask the students to define the problem and discuss why solving the problem may be difficult, using provided sentence stems and target vocabulary.
- Provide opportunities for students to reflect and refine their developing thinking.

Common Misconceptions

- Some problems are too big to be solved, or cannot be solved.
- A problem has one *true* solution.

- *Designing* is the same thing as *inventing* so unique solutions must be found.
- A solution can be perfect, with no limitations or drawbacks.
- Solutions do not have to meet criteria or constraints.
- The design steps (define, develop, improve) must be followed once and in a specific order.
- A solution does not need to be revised.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- What counts as important science knowledge is closely tied to a community's values.
- Discuss: *How do the people in your community feel about protecting the environment and natural resources?*
- *What important resources in your community need protecting?*

Build & Bridge:

- Highlight known environmental problems in the community.
- Discuss: *What environmental problems does your community have?*
- *How do you decide if a situation is a problem or not?*

Students who demonstrate understanding can:

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the 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
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.	**ETS1.B: Developing Possible Solutions** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.

Connections to 3-5-ETS1.B: Developing Possible Solutions Problems include:
Fourth Grade: 4-ESS3-2

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

Common Core State Standards Connections:
ELA/Literacy -

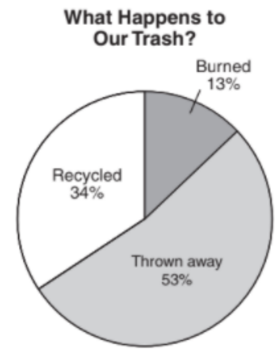
RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*
RI.5.1	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)

Mathematics -

MP.2	Reason abstractly and quantitatively. *(3-5-ETS1-2)*
MP.4	Model with mathematics. *(3-5-ETS1-2)*
MP.5	Use appropriate tools strategically. *(3-5-ETS1-2)*
3-5.OA	Operations and Algebraic Thinking *(3-ETS1-2)*

Grade	NGSS Discipline
3-5	**Engineering, Technology, and Applications of Science 1.2**
3-5-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.* • Humans are conflicted about the best methods in reducing the amount of trash on Earth. Some believe that recycling is most effective, others believe incinerators can burn large amounts of trash, and others believe that landfills are most beneficial. **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.* • Edward learns that the landfill (dump) for his town is almost full. He wonders if students in his school can do something to help solve this problem.

- First, he studies this pie chart about trash in many towns across the United States.



- Edward learns that many schools have recycling programs. He thinks a recycling program at his school could help solve the landfill problem. Edward finds this information about how to start a recycling program in his school.

How to Start a Recycling Program at a School

- Organize a team of teachers, students, staff, and parents who will help get the program started.
- Find out how much trash and what kind of trash comes from every part of the school: classrooms, cafeteria, kitchen, and school grounds.
- Think of ways some of the trash can be reused and ways to reduce trash.
- Set up ways to collect trash that can be recycled and sent to a recycling center.

—adapted from "Greening at the Grass Roots: School Recycling," American Federation of Teachers website

  - Explain why starting a recycling program at Edward's school could help solve the landfill problem, based on information in the pie chart.
  - Using the information provided and knowledge you already have about recycling, think about ways to reduce trash from your school. Develop a recycling program that would involve teachers and students at your school. What plan could you help put in place to reduce waste in your school?
  - What problems do you foresee with your plan?
  - What are some things you can do if you face some resistance from teachers and students in participating in your plan? How can you get them to help?

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Provide support for helping students understand there is more than one way to solve a problem. • Pose a specific example of a relevant problem *(ex- disposable water bottles used in school are thrown in the trash)* and define the constraints. • Ask students to jot down some possible solutions to the problem. Students share their solutions in small groups. Review a few of the solutions	• Strategic student groupings to evaluate possible student solutions to ensure they meet the criteria and constraints of the problem. • Create rubrics for students to evaluate one another's solutions and provide feedback. • Provide opportunities for students to reflect on developing thinking and to ask questions.

whole-group and evaluate them in reference to the criteria and constraints. ● Assist students in reflecting on the process and in coming to the conclusion that a problem may have many viable solutions.	

Common Misconceptions

- Some problems are too big to be solved, or cannot be solved.
- A problem has one *true* solution.
- *Designing* is the same thing as *inventing* so unique solutions must be found.
- A solution can be perfect, with no limitations or drawbacks.
- Solutions do not have to meet criteria or constraints.
- The design steps (define, develop, improve) must be followed once and in a specific order.
- A solution does not need to be revised.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- Students lend valuable ideas to the discussion of problems and suggestions.
- *What are some possible solutions to problems in your community that you identified?*
- *How is your community trying to solve environmental problems?*

Build & Bridge:

- *How can community members come together to solve problems?*

Students who demonstrate understanding can:

3-5-ETS1-3. **Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

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 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**ETS1.B: Developing Possible Solutions** • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **ETS1.C: Optimizing the Design Solution** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	

Connections to 3-5-ETS1.B: Developing Possible Solutions Problems include:
Fourth Grade: 4-ESS3-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

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

Common Core State Standards Connections:
ELA/Literacy -

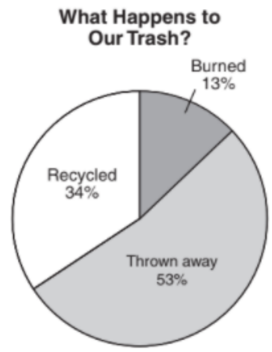
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-3)
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-3)*
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-3)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(3-5-ETS1-3)*
MP.4 Model with mathematics. *(3-5-ETS1-3)*
MP.5 Use appropriate tools strategically. *(3-5-ETS1-3)*

Grade	*NGSS Discipline*
3-5	**Engineering, Technology, and Applications of Science 1.3**
3-5-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.* ● Students at Wayside Elementary decide to test which methods are best for reducing the amount of trash in their community. Some believe that recycling is most effective, others believe incinerators can burn large amounts of trash, and others believe that landfills are most beneficial. **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.* ● Edward learns that the landfill (dump) for his town is almost full. He wonders if students in his school can do something to help solve this problem.

- First, he studies this pie chart about trash in many towns across the United States.



- Edward learns that many schools have recycling programs. He thinks a recycling program at his school could help solve the landfill problem. Edward finds this information about how to start a recycling program in his school.

> **How to Start a Recycling Program at a School**
>
> - Organize a team of teachers, students, staff, and parents who will help get the program started.
> - Find out how much trash and what kind of trash comes from every part of the school: classrooms, cafeteria, kitchen, and school grounds.
> - Think of ways some of the trash can be reused and ways to reduce trash.
> - Set up ways to collect trash that can be recycled and sent to a recycling center.
>
> —adapted from "Greening at the Grass Roots: School Recycling," American Federation of Teachers website

  - Explain why starting a recycling program at Edward's school could help solve the landfill problem, based on information in the pie chart.
  - Using the information provided and knowledge you already have about recycling, think about ways to reduce trash from your school. Develop a recycling program that would involve teachers and students at your school. What plan could you help put in place to reduce waste in your school?
  - What problems do you foresee with your plan?
  - What are some things you can do if you face some resistance from teachers and students in participating in your plan? How can you get them to help?

Adapted from STEM Gauge

Universal Supports	Targeted Supports
• Facilitation of student discussions surrounding how they know if a solution is successful or not. • Use multiple modes of media to share examples of solutions to science problems (ex: print, video, audio, etc.)	• Support students in evaluating solutions to a problem. Discuss strategies for finding the best solution to a problem. *How do we decide if a solution is the best solution? How do we know if a better solution could*

• Provide multiple opportunities for students to reflect and share their revisions for how solutions could be made even stronger.	*be found? What do we do if our solution fails?* • Create rubrics for students to evaluate one another's solutions and provide feedback. • Provide opportunities for students to reflect on developing thinking and to ask questions.

Common Misconceptions

- Some problems are too big to be solved, or cannot be solved.
- A problem has one *true* solution.
- *Designing* is the same thing as *inventing* so unique solutions must be found.
- A solution can be perfect, with no limitations or drawbacks.
- Solutions do not have to meet criteria or constraints.
- The design steps (define, develop, improve) must be followed once and in a specific order.
- A solution does not need to be revised.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- In evaluating solutions to our community's environmental problems, discuss: *Are the solutions immediate solutions that may cause greater problems later?*

Build & Bridge:

- *Why are solving environmental problems important to our community and to the Earth as a whole?*

5.Science and Society

PERFORMANCE EXPECTATIONS

Students who demonstrate understanding can:

5-SS-1 NM. **Communicate information gathered from books, reliable media, or outside sources, that describes how a variety of scientists and engineers across New Mexico have improved existing technologies, developed new ones, or improved society through applications of science.**

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 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. ▪ Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.	**ETS2.A: Interdependence of Science, Engineering, and Technology** ▪ Advances in science offer new capabilities, new materials, or new understanding of processes that can be applied through engineering to produce advances in technology. ▪ Advances in technology, in turn, provide scientists with new capabilities to probe the natural world at larger or smaller scales; to record, manage, and analyze data; and to model ever more complex systems with greater precision. ▪ In addition, engineers' efforts to develop or improve technologies often raise new questions for scientists' investigation.	**Science is a Human Endeavor** ▪ Men and women from all cultures and backgrounds choose careers as scientists and engineers. ▪ Most scientists and engineers work in teams. ▪ Science affects everyday life. ▪ Creativity and imagination are important to science. **Science is a Way of Knowing** ▪ Science is both a body of knowledge and processes that add new knowledge. ▪ Science is a way of knowing that is used by many people

Connections to other DCIs in this grade-band: N/A

Articulation of DCIs across grade-bands: N/A

Common Core State Standards Connections:

ELA/Literacy –

RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.

SL.5.5 Include multimedia components (e.g., graphics, sounds) and visual displays in presentations when appropriate to enhance the development of main ideas or themes

Mathematics –

Grade	*NGSS Discipline*	
5	**New Mexico: Science and Society 1**	
5-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. ● New Mexico teams of scientists are working to find out if there was, or is, life on Mars.	
	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. ● Compare Earth's four spheres to Mars' four spheres. ○ Are there similarities? ○ What are the differences? ○ How will the technologies developed by New Mexico scientists and engineers help us learn more about Mars?	
	Universal Supports	**Targeted Supports**

- Define and discuss unit vocabulary with definitions and illustrations using explicit modeling.
- Activate prior knowledge by brainstorming and discussing what scientists and engineers are and do.
- Provide articles about diverse New Mexico scientists and engineers who have improved or created technologies to overall improve society through applications of science.
- Chunk and jigsaw articles to support readers of all levels.

- Provide pictures or videos of people in the workforce (doctors, nurses, teachers, etc.) and discuss how the people in the pictures are doing science. Discuss how we are all involved in doing science.
- Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information

Common Misconceptions

- Students have not thought about the role of New Mexico's scientists and engineers and how they are impacting science and technology in our global society.
- Scientists and engineers work independently.
- Scientists are only people that do science for a living.
- Scientists can only conduct or perform science in a traditional lab.
- Students may not be aware that there is gender, ethnic and racial diversity among scientists and engineers.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

The teacher could use these questions in science classroom discussions to bring out the student's thoughts, ideas and culture.

Validate & Affirm:

- What counts as important science knowledge is closely tied to what is useful in a community.
- Explain that many of today's common jobs require an understanding of science ideas and concepts.
- Think about some of the people that work in your community. *Which jobs do you think require some science understanding?* (doctors, nurses, veterinarians, miners, farmers, teachers, etc.)

Build & Bridge:

- Students may be surprised by the number of science-related occupations.
- Emphasize that people who do science for a living could be any gender and belong to any ethinic/cultural background.
- Discuss: *How are each of these people helping our community? What role does science play in making our community a better place to live?*

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.[8] 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.[9] 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.[9]

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.[9] 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.

---

[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 has 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.