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New Mexico STEM Ready! Science Standards Implementation Guide

Overview

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

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

The standards

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

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

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

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

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

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

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

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

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

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

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

Sample Phenomena

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

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

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

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

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

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

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

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

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

Classroom Assessment Items

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Common Misconceptions

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

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

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

Multi Layered System of Supports (MLSS)

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

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

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

Culturally and Linguistically Responsive Instruction

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

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

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

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

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

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

STANDARDS BREAKDOWN

Physical Sciences	Life Sciences	Earth and Space Sciences	Engineering, Technology, and Applications of Science
Motion and Stability: Forces and Interaction 3-PS2-1 3-PS2-2 3-PS2-3 3-PS2-4	**From Molecules to Organisms: Structures and Processes** 3-LS1-1 **Ecosystems: Interactions, Energy, and Dynamics** 3-LS2-1 **Heredity: Inheritance and Variation of Traits** 3-LS3-1 3-LS3-2 **Biological Evolution: Unity and Diversity** 3-LS4-1 3-LS4-2 3-LS4-3 3-LS4-4	**Earth's Systems** 3-ESS2-1 3-ESS2-2 **Earth and Human Activity** 3-ESS3-1	**Engineering Design** 3-5-ETS1-1 3-5-ETS1-2 3-5-ETS1-3

Students who demonstrate understanding can:

3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]

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

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.

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of methods, tools, and techniques.

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

PS2.B: Types of Interactions
- Objects in contact exert forces on each other.

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships are routinely identified.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
K.PS2.A ; **K.PS2.B** ; **K.PS3.C** ; **5.PS2.B** ; **MS.PS2.A** ; **MS.ESS1.B** ; **MS.ESS2.C**

Common Core State Standards Connections:

ELA/Literacy -

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-PS2-1)*
W.3.7	Conduct short research projects that build knowledge about a topic. (3-PS2-1)
W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-PS2-1)

Mathematics -

MP.2	Reason abstractly and quantitatively. *(3-PS2-1)*
MP.5	Use appropriate tools strategically. *(3-PS2-1)*
3.MD.A.2	Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-PS2-1)*

Grade	NGSS Discipline
3	Physical Science 2.1

3.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.* ● The walking table can be moved in different directions through a series of balanced and unbalanced forces. **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.* ● Olivia and Max were playing with blocks. Olivia set up a lot of blocks and then Max pushed one of the blocks with his finger. This video shows what happened. ○ Based on the video, describe how the block moved when Max's finger touched the first block. Make sure to: (1) Describe how the first block moved. (2) Describe how the rest of the blocks moved. ● Olivia and Max are learning about forces in science and they wonder how force plays a role in what they saw. They think about the different forces that are involved and how they may be balanced or unbalanced ○ What role did forces play in causing the blocks to move? Make sure to include: (1) What role did balanced or unbalanced forces play in causing the first block to move? (2) What role did balanced or unbalanced forces force play in causing the remaining blocks to move? ● Based on your observations, write a question that you can use to test how the balanced or unbalanced force acting on a block is related to whether or not the block starts moving. *Adapted from Next Generation Science Assessment*

Universal Supports	Targeted Supports
● As a class, review/reteach how to plan and carry out a scientific investigation. ● Use of multiple modes of media to introduce concepts of balanced and unbalanced forces (ex: print, video, audio, etc.) ● Concrete and hands-on model examples of balanced and unbalanced forces on an object. ● Explicit introduction and modeling of Tier 2 vocabulary *(ex: balanced, unbalanced, forces, motion of an object).*	● Graphic organizers with steps listed for planning an investigation. ● Create sentence stems to support students in using the academic vocabulary. ● Use photos or images of objects that have balanced and unbalanced forces and match them to definitions. ● Strategic partners/groups when carrying out the investigations. ● Provide multiple opportunities for student reflections to revise and share thinking.

Common Misconceptions

- If an object is not moving, children may not recognize that there are still forces acting upon it.
- Students may think of force as a property of an object rather than a relationship between objects.
- Students may not readily see the relationship between force and motion.

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 are some examples of things that are balanced that you can think of? Things at home? Maybe things on the playground?*
- *What are some things that you have seen that move with force? Can you give some examples?*
- *What is the fastest force you can think of? How does it work?*

Build & Bridge:

- *Thinking about some of the forces discussed in class, how can we draw a model to represent the forces acting on the object?*
- *When you are playing outside on the playground, what are some types of forces you see interacting?*
- *What are some types of forces we could create a model to represent here in the classroom?*

Students who demonstrate understanding can:

3-PS2-2. **Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.** [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [*Assessment Boundary: Assessment does not include technical terms such as period and frequency.*]

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/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. - - - - - - - - - - ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**PS2.A: Forces and Motion** • The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)	**Patterns** • Patterns of change can be used to make predictions.

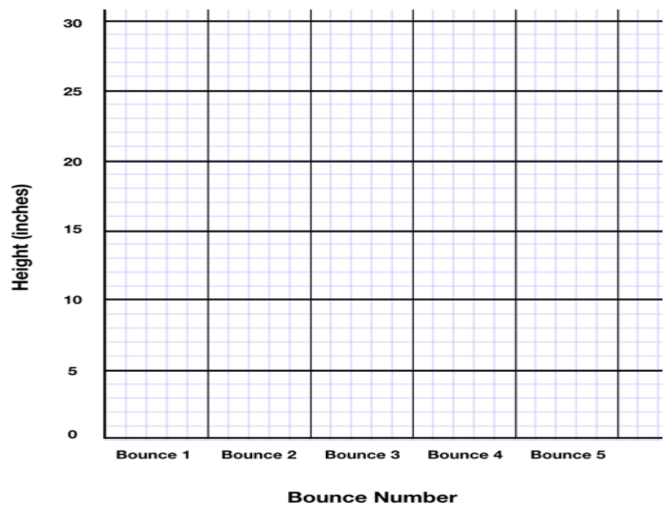
Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
1.ESS1.A ; **4.PS4.A** ; **MS.PS2.A** ; **MS.ESS1.B**

Common Core State Standards Connections:
ELA/Literacy -
W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-2)
W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. *(3-PS2-2)*

Grade	*NGSS Discipline*
3	**Physical Science 2.2**
3.PS2-2	**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.* ● When you are pushed forward on a swing, you will continue to push forward and pull backwards. **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.* ● Watch the following video of a rubber ball bouncing on a table. The video was filmed in slow motion and zoomed in so the readings on a yardstick can be made. ○ After watching the video record the height bounces 1, 2, and 3 in a chart.

- Graph the height of bounces 1, 2 , and 3 on the graph below.



- Based on the patterns of motion in the first three bounces predict the heights of Bounce 4 and Bounce 5. Be sure to use the graph to the right to help make your guesses.

  Bounce 4 = ___________inches

  Bounce 5 = __________ inches

- Watch the following video to see how close your guesses were to the actual Bounce 4 and Bounce 5.How close were your original guesses to the actual bounce heights to explain how you came up with your prediction?

Adapted from The Wonder of Science

Universal Supports	Targeted Supports
• Model how to use measuring tools (ex: yard stick) to measure the distance of movement. • Explicit introduction and modeling of Tier 2 vocabulary *(ex: predict, measure, observation, motion, future, evidence, pattern).* • Use of concrete models and pictures to represent predictable motion of objects and their distance being measured. • Use of graphic organizers, picture cues, and sentence stems to support development of thinking.	• Hands-on small group activities to further demonstrate concepts (ex: have a student swing on a swing, and ask students to predict and explain the pattern and motion they see). • Using peer-teaching, have students partnered up and have the peer-leader assist in explaining and modeling standard concepts. • Provide opportunities for students to share reflections, additional questions, and new thinking.

Common Misconceptions

- Students may think that the pattern of motion cannot be predicted.

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:

- *Have you ever swung on a swing? What do you notice about how the swing moves? Why do you think that may be?*
- *What propels you to swing higher than a classmate?*
- *What makes a classmate stop quicker on the swing than you?*
- *Are there other examples of things you have seen in your home that have repetitive motion? What are they? How do you think they may work?*

Build & Bridge:

- *What do you have to do to ensure the swing keeps moving?*
- *What would happen if you stopped this action?*
- *Do you think there is a different force that can cause the swing to move?*

Students who demonstrate understanding can:

3-PS2-3. **Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.** [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [*Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.*]

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 grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated based on patterns such as cause and effect relationships.	**PS2.B: Types of Interactions** • Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change.

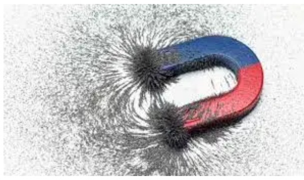
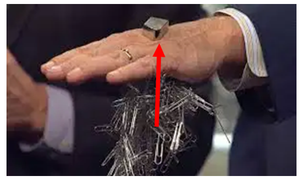
Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.PS2.B

Common Core State Standards Connections:
ELA/Literacy -

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-PS2-3)
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-PS2-3)
RI.3.8	Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence). *(3-PS2-3)*
SL.3.3	Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. *(3-PS2-3)*

Grade	*NGSS Discipline*
3	**Physical Science 2.3**
3.PS2-3	**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.* ● When a magnet is placed above a pile of paper clips, the paper clips will attach themselves to the magnet. **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.* ● Students were investigating how static electricity and magnets can cause objects to move. They decided to take pictures of what they observed.

- Write a scientific explanation about the forces that can affect objects when the objects are not touching.
- What is going to happen when the two north poles are facing each other? Explain the reaction using science vocabulary.
- Why do you think the child's hair is standing up? Have you ever experienced this?

Adapted from STEMscopes

Universal Supports

- Whole class review and reteach of the principle cause and effect. How does this play out in science?
- Hands-on exploration with the North pole and South pole of magnets and how they interact with objects in the classroom.
- Use of graphic organizers, including KWL charts, to organize students' developing thinking and questions.
- Explicit introduction and modeling of Tier 2 vocabulary *(ex: repel, attract, electric magnet, poles)* with visual examples.

Targeted Supports

- Reteach a small group using hands-on activities that further demonstrate principles of magnets (ex: use multiple magnets and steel paper clips, hold the magnets a set distance above the paper clips and see how many paper clips will be attracted with one magnet, 2 magnet, etc.)
- Use of peer tutoring and strategic small groups to reteach concepts amongst students.
- Provide multiple opportunities for students to share reflections and developing thinking and questions.

Common Misconceptions

- Students may think that electric and magnetic forces between objects require that the objects be touching to occur.
- Students have a hard time understanding that magnets can attract objects through media such as glass, wood, plastic, and water
- Some students mistakenly think the larger the magnet, the greater the force.
- Some students believe all electric and magnetic forces are the same strength.
- Students may not understand that magnetic forces between two magnets change depending on their orientation relative to each other.

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: • *Do you know what a magnet is?* • *Do you have any at home? What does your family use magnets for?* • *Where do you find these magnets?* Build & Bridge: • *Do you keep magnets near electronic devices? I wonder what would happen?* • *What happens when we bring magnets near metal objects?* • *How can we tell if like poles are being brought together with magnets? What about opposite poles?*

Students who demonstrate understanding can:

3-PS2-4. **Define a simple design problem that can be solved by applying scientific ideas about magnets.*** [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

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 grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Define a simple problem that can be solved through the development of a new or improved object or tool.	**PS2.B: Types of Interactions** • Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **4.ETS1.A** ; **MS.PS2.B**

Common Core State Standards Connections: N/A

Grade	*NGSS Discipline*	
3	**Physical Science 2.4**	
3.PS2-4	**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. ● Maglev trains hover in mid air using repulsive forces.	
	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. ● Using a weak magnet, place a piece of paper on the board. Allow the paper and magnet to fall down to the bottom of the board. Explain how we can fix this problem by applying what you know and have learned about magnets.	
	Universal Supports	**Targeted Supports**
	● Hands-on exploration activities for students to solve different problems with magnets in the	● Give students alternative examples of things we use to hold things together

	classroom (ex: how can we use magnets to hold up something heavy?) ● Multiple modes of media to share different problems that can be solved with magnets (ex: print, video, audio, etc.) ● Use multiple opportunities to check for understanding throughout activities (ex: turn and talks, small group discussion, white boards, etc.)	(staples in paper, screws and wood, zipper, paper clipped with a paperclip, paper and glue, paper and tape) What do all these examples have in common? How is a magnetic cabinet demonstration also related to these examples? ● Use real objects and photos of different types of magnets and how they are used to solve problems in real-life ● Provide multiple opportunities for students to share reflections and revisions to their original thinking

Common Misconceptions

- Some students believe all electric and magnetic forces are the same strength.
- Students may not understand that magnetic forces between two magnets change depending on their orientation relative to each other.
- Students may not realize that magnets can actually be used to solve problems in real life. They are used to thinking magnets are just used to hold things to a surface.

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:

- *How have you seen magnets used at home? In your classroom?*
- *How may some people use magnets in their careers? How could they help?*
- *Have you ever opened a refrigerator door? What did you notice about opening that door?*

Build & Bridge:

- *What are problems we can brainstorm that could perhaps be solved with magnets?*
- *Why are magnets used as solutions in the real-world? What are some properties that magnets have that make them so beneficial?*

Students who demonstrate understanding can:

3-LS1-1. **Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.** [Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]

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 models to describe phenomena. - - - - - - - - - - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**LS1.B: Growth and Development of Organisms** • Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	**Patterns** • Patterns of change can be used to make predictions.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.LS1.B

Common Core State Standards Connections:
ELA/Literacy —

RI.3.7 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). *(3-LS1-1)*

SL.3.5 Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details. *(3-LS1-1)*

Mathematics —

MP.4 Model with mathematics. *(3-LS1-1)*

3.NBT Number and Operations in Base Ten *(3-LS1-1)*

3.NF Number and Operations—Fractions *(3-LS1-1)*

Grade	*NGSS Discipline*
3	**Life Science 1.1**
3.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.* ● Sunflowers and chickens each have life-cycles, but their stages are different. **Classroom Assessment Items** *When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available.* ● Kayla's science club has been studying different plants and animals. They have used pictures of sunflower plants, frogs, and birds to see what each looks like during their lives. Kayla is starting to think that the life cycles of different organisms may actually be very similar. She decides to use these pictures of different stages of the life cycles of a sunflower plant, a frog, and a bird. ○ Think about what you know about life cycles. Use pictures and labels to create a model to help Kayla show that the sunflowers, frogs, and birds have similar life cycles.

- Explain the life cycle model you created. Why did you draw the pictures and labels the way you did?
- How does your model help you show the similarities in the life cycles of sunflowers, frogs, and birds?

Adapted from Next Generation Science Assessment

Universal Supports	Targeted Supports
• Create graphic organizers, charts, timelines to model and compare and contrast a variety of life cycles. • Use multiple modes of media to introduce students to different life cycles that share the same following components- birth, growth, reproduction, death (ex: print, video, audio, etc.) • Provide multiple opportunities for checks for understanding to assess students' growing understanding of concepts (ex: turn and talks, partner work, group discussions, white boards, etc.) • Explicit introduction and modeling of Tier 2 vocabulary *(ex: birth, growth, reproduction, death, life cycle, pattern)*	• In a small group, clarify with students the sequence of events found in a life cycle using picture cue cards and sentence stems. • Use photos of various life-cycle stages and have students match them to their definition. • Use timelines and graphic organizers to work collaboratively to map out a particular life cycle. • Provide opportunities for students to reflect on learning, revised ideas, and continue to ask questions.

Common Misconceptions

- Students mistakenly think larvae and adult insects are two separate insects.
- It is common for students to believe that the first stage of every animal life cycle is an egg.
- Many students think that all insects have the same stages in their life cycles.

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:

- *As humans we all change and grow. Have students bring in pictures of either themselves or other family members, put the pictures in chronological order.*
- *What are some organisms you can think of? How do they grow? What are their different stages of life called?*
- *Have you ever seen a baby animal? What are those babies called?*

Build & Bridge:

- *Compare the life cycle of a plant or animal with how you have changed over time.*
- *Choose two life cycles- how are they similar? How are they different? Can you think of any life cycles that are very similar?*

Students who demonstrate understanding can:

3-LS2-1. Construct an argument that some animals form groups that help members survive.

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). • Construct an argument with evidence, data, and/or a model.	**LS2.D: Social Interactions and Group Behavior** • Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size *(Note: Moved from K–2).*	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
1.LS1.B ; **MS.LS2.A**

Common Core State Standards Connections:
ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-LS2-1)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS2-1)*
W.3.1	Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-LS2-1)

Mathematics —

MP.4	Model with mathematics. (3-LS2-1)
3.NBT	Number and Operations in Base Ten. (3-LS2-1)

Grade	*NGSS Discipline*
	Life Science 2.1
3.LS2-1	See below

Life Science 2.1

3.LS2-1

Sample Phenomena

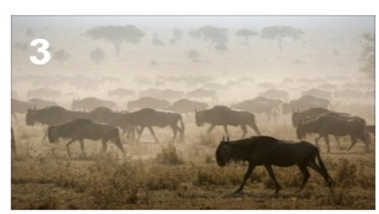
When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.

- Elephants live in family groups and will make a protective circle around their young if there is danger or a predator.

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.

- Some animals, such as bears, tigers, eagles, and spiders, live alone. Other animals, such as small fish, gazelles, penguins, and zebras, live in groups.



- Observe the pictures and decide how living in a group can help or hurt animals' survival.
    - Write a scientific explanation for or against animals living in a group. Write a claim and state your evidence. What could happen to the young when they are separated from their group? Why?

Universal Supports	Targeted Supports
• Use hands-on models and visuals of animal groups helping their members survive. • Use graphic organizers for students to share developing thinking of the different ways animal groups ensure the survival of its members. • Whole class mini-lessons to review and reteach the sequence to an argument writing piece. Provide examples of what solid scientific arguments look and sound like. • Provide multiple modes of media (ex: print, audio, video) to show different examples of animal groups and their functions.	• Peer tutoring and strategic groupings for student shared explanations of science concepts. • Use graphic organizers and sentence stems to scaffold the sequencing of writing an argument piece. • Use multiple methods of assessment (ex: multiple choice, short answer, essay, etc.) to gauge and assess students' developing understanding of concepts.

Common Misconceptions

- Students may think that an animal's fur or skin color is specific to helping it blend in with the environment.
- Some students may think that an individual of a group does all the hunting.
- Students may think that animals that usually live in groups always live in groups.
- Students may not realize that some organisms prefer to live solitary lifestyles.

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 does your community or family do to ensure survival of their members?*
- *Have you ever seen animals living in a group before? What animals were they? Why do you think they may like to live in groups?*
- *Have you ever seen animals that prefer to live alone? Why do you think they may prefer to live alone?*

Build & Bridge:

- *Why do you think it is important for the community and/or families to ensure safety and survival?*
- *If an organism that typically lives in a group somehow loses its group and becomes alone, what do you think may happen to that organism? Why?*

Students who demonstrate understanding can:

3-LS3-1. **Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.] [*Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.*]

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. • Analyze and interpret data to make sense of phenomena using logical reasoning.	**LS3.A: Inheritance of Traits** • Many characteristics of organisms are inherited from their parents. **LS3.B: Variation of Traits** • Different organisms vary in how they look and function because they have different inherited information.	**Patterns** • Similarities and differences in patterns can be used to sort and classify natural phenomena.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
1.LS3.A ; **1.LS3.B** ; **MS.LS3.A** ; **MS.LS3.B**

Common Core State Standards Connections:
ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS3-1)
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS3-1)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS3-1)
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS3-1)*
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS3-1)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS3-1)*
MP.4	Model with mathematics. (3-LS3-1)
3.MD.B.4	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. *(3-LS3-1)*

Grade	*NGSS Discipline*
3	**Life Science 3.1**
3.LS3-1	**Sample Phenomena** *When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.* • A litter of puppies does not always look identical to their parents. **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.* • Cindy is purchasing a hamster pup (young hamster) from a pet store. She picks out the perfect hamster pup and wonders which of the adult hamsters are the parents. She has been learning about inherited traits in school. She collects data about the adult hamsters and your hamster pup.

Trait	Father A	Father B	Mother A	Mother B
Fur Color	Solid tan	Solid black	Black with white spots	Tan and white
Tail Length	Short	Short	Long	Short
Size	Regular size	Dwarf	Dwarf	Dwarf
Fur Length	Long	Long	Short	Long

Help Me Find My Parents	
Traits	Baby
Fur Color	Tan, black, and white
Tail Length	Short
Size	Dwarf
Fur Length	Long

- Write a scientific explanation about which mother and father hamsters are most likely the parents of the hamster pup. Using the data table above, make a claim and state your evidence.
- Choose another Mother and Father from this chart. What do you think their puppy would look like? Why?

Adapted from STEMscopes

Universal Supports

- Create opportunities for students to study different animals- both parents and young- to compare which young were born from which parents.
- Lead student discussions that highlight the differences between inheritance and adaptation.
- Create graphic organizers and charts to track student ideas, questions, and developments.
- Explicit introduction and modeling of Tier 2 vocabulary *(ex: inherited, adaptation, traits, variations, organisms)*.

Targeted Supports

- Provide opportunities for students to create drafts of evidence-based writing, allowing for peer revisions, as well as teacher feedback.
- Consider using scaffolded texts for independent reading, as well as jigsaw reading to support multiple levels of reading.
- Provide multiple opportunities for students to incorporate new academic vocabulary through the use of word banks and sentence stems.

Common Misconceptions

- Students may think that they inherit physical traits from aunts, uncles, cousins, and siblings because family members point out resemblances among relatives.
- Students may think that traits are inherited from only one parent.
- Students may think traits are developed by individuals in response to the needs of the individual.
- Students may think that variation within a species is a result of adaptation to the environment instead of inheritance.

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: • *Do you look like your parents? What are some ways in which you look similar?* • *What about your siblings?* • *Who do you look more like?* • *What about your distant family members?* • Note: Do not talk about students' biological parents unless everyone in the class is comfortable with the topic. Use your own family as an example if needed. Build & Bridge: • *Do you think your inherited traits are affected by your culture?* • *When we look at entire cultures of people, are there similar traits we notice among them? What are some examples? What do you think may be some influences that cause these traits?* • *Create a diagram showing your inherited traits from your parents.*

Students who demonstrate understanding can:

3-LS3-2. **Use evidence to support the explanation that traits can be influenced by the environment.** [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

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. • Use evidence (e.g., observations, patterns) to support an explanation.	**LS3.A: Inheritance of Traits** • Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. **LS3.B: Variation of Traits** • The environment also affects the traits that an organism develops.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.LS1.B

Common Core State Standards Connections:
ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS3-2)
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS3-2)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS3-2)*
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS3-2)
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS3-2)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS3-2)*
MP.4	Model with mathematics. *(3-LS3-2)*
3.MD.B.4	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. *(3-LS3-2)*

Grade	*NGSS Discipline*
3	**Life Science 3.2**
3.LS3-2	**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.* ● Ants can work together to lift things far heavier than them. **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.*

- Plants and animals have unique characteristics that are called traits. Traits can be inherited or they can be caused by the environment. Jeremiah was looking at images of the plants and animals. He was trying to decide if their traits were inherited or caused by the environment.

Color of a tree's bark 	Color of a cat's fur 
Scar on a lion's nose 	Broken stem on a flower 

  - Using the pictures, write a scientific explanation about which of the traits were caused by the environment.
  - What are some examples of plants and animals we see in our community?
  - Choose one and describe some traits this organism may have that are inherited, and describe some that could be caused by their environment?

Adapted from STEMscopes

Universal Supports	Targeted Supports
• Introduce the concepts making a connection with the environment and animals or plants within that environment. • Use multiple examples of media (ex: photos, video, text, audio) to show examples of different organisms in an environment where their traits acclimate to that environment. ○ Consider showing different traits that are useful for different specific environments (ex: desert, tundra, wetlands, etc.) • Use graphic organizers to track different examples of traits caused from the environment, and encourage students to look for trends in their findings.	• Provide additional exposure to content by encouraging students to match real photos of animals and plants to align their traits with various environments. • Provide additional support with Tier 2 vocabulary with word banks and sentence stems to explain student thinking. • Provide students opportunities for peer tutoring and strategic grouping to provide additional support in understanding content.

Common Misconceptions

- Students may not consider that the same species living in different habitats may look or behave differently due to different surroundings.
- Students believe that all organisms in the same habitat will have the same traits.
- Students may believe that all traits are the exact same for an organism.

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:

- *Do you have pets? If so, what type do you have? What are some traits that your pet has? Why do you think those traits are beneficial to your pet?*
- *What changes do your animals go through during different seasons (ex: dogs, cats, and horses shed)?*
- *Does the environment affect your traits? Can you give an example?*

Build & Bridge:

- *In a different environment we have to make adjustments for animals' needs. What adjustments do you make for your pets at home? What if you were to bring your pets to the desert? Or the arctic tundra?*
- *What are some traits that animals who live in the desert may develop in order to survive? Can you think of any organisms that have these traits?*

Students who demonstrate understanding can:

3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [*Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.*]

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. • Analyze and interpret data to make sense of phenomena using logical reasoning.	**LS4.A: Evidence of Common Ancestry and Diversity** • Some kinds of plants and animals that once lived on Earth are no longer found anywhere. *(Note: moved from K-2)* • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**Scale, Proportion, and Quantity** • Observable phenomena exist from very short to very long time periods. - - - - - - - - - - - - - - - - ***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 third grade: N/A

Articulation of DCIs across grade-levels:
4.ESS1.C ; **MS.LS2.A** ; **MS.LS4.A** ; **MS.ESS1.C** ; **MS.ESS2.B**

Common Core State Standards Connections:

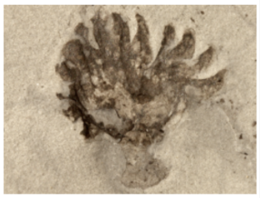
ELA/Literacy —

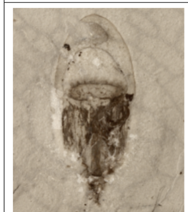
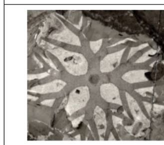
RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-LS4-1)*
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS4-1)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS4-1)*
W.3.1	Write opinion pieces on topics or texts, supporting a point of view with reasons. *(3-LS4-1)*
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS4-1)*
W.3.8	Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-LS4-1)

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS4-1)*
MP.4	Model with mathematics. *(3-LS4-1)*
MP.5	Use appropriate tools strategically. *(3-LS4-1)*
3.MD.B.4	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. *(3-LS4-1)*

Grade	*NGSS Discipline*
3	**Life Science 4.1**
3.LS4-1	**Sample Phenomena**
	When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available. • A fish fossil was found on Wheeler Peak (the highest peak in New Mexico at 13,167 ft.)
	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. • According to an article in Xinhua News scientists in China made a major discovery in 2019. Over 20,000 fossils were discovered in the Hubei Province and over half of the fossils identified have never been seen before. While they were forming the fossils were covered by sediment preserving many of the soft tissue inside the organisms.

Fossil	Organism	Environment	Modern Counterparts
	☐ Plant ☐ Animal ☐ Unsure	☐ Plant ☐ Animal ☐ Unsure	
	☐ Plant ☐ Animal ☐ Unsure	☐ Plant ☐ Animal ☐ Unsure	

Fossil	Organism	Environment	Modern Counterparts
	☐ Plant ☐ Animal ☐ Unsure	☐ Plant ☐ Animal ☐ Unsure	
	☐ Plant ☐ Animal ☐ Unsure	☐ Plant ☐ Animal ☐ Unsure	
	☐ Plant ☐ Animal ☐ Unsure	☐ Plant ☐ Animal ☐ Unsure	

- In the space below draw a picture of what this environment might have looked like 500 million years ago. Your picture must include at least three of the five organisms you described above.
- Describe the characteristics of this environment in the space provided.

Universal Supports

- Explicit introduction and modeling of Tier 2 academic vocabulary *(ex: fossil, extinct, endangered, layers of rock, tropical, tundra, etc.)*
- Provide examples of new vocabulary, and add student-generated examples.
- Provide plenty of exposure to visuals and hands-on fossils students can access. Choose high quality photos that include both plants and animals.
- Multiple modes of media to introduce different types of fossils found in different environments (ex: print, video, audio, etc.)

Targeted Supports

- Provide multiple, targeted opportunities for students to work on independent writing to explain their thoughts and understanding of fossils.
- Encourage students to work with word banks and sentence stems to access Tier 2 vocabulary and use it in context.
- Consider the use of leveled reading passages to support readers of all levels. Use of partner reading or jigsaw to support independent reading.

Common Misconceptions

- Students often try to create situations in which extinct animals can be brought back to life.
- Student populations often think everything that ever was alive (other than dinosaurs) is alive today.
- Many students may say plants can't become extinct.
- It is a popular preconception that losing a species doesn't affect anything.
- Students might think humans don't cause extinctions.
- Students might believe only animals can become fossilized.
- Students regularly think fossils are always bones left from dead animals.

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 are some things you already know about fossils?* ● *Have you ever seen or found an example of a fossil? How would you describe it?* ● *What do fossils typically look like? Where do you think they may be found?* Build & Bridge: ● *Using our phenomena, what do you think the environment was like before on Wheeler Peak?* ● *What do you know about environments that make you say that?*

Students who demonstrate understanding can:

3-LS4-2. **Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.** [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. • Use evidence (e.g., observations, patterns) to construct an explanation.	**LS4.B: Natural Selection** • Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.LS2.A ; **MS.LS3.B** ; **MS.LS4.B**

Common Core State Standards Connections:

ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-LS4-2)*
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS4-2)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS4-2)*
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS4-2)
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS4-2)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS4-2)*
MP.4	Model with mathematics. *(3-LS4-2)*
3.MD.B.3	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *(3-LS4-2)*

Grade	*NGSS Discipline*
3	**Life Science 4.2**
3.LS4-2	**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.* • Cacti are able to store water in their stems by using their thorns to protect themselves. **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 species of moth lives in a forest and is a food source for birds. The bark on the trees is light in color, but the moths themselves can be light or dark in color. A factory has recently been built near the forest. The factory releases a black ash from its smokestack during production. The nearby trees now have a dark coating of black soot on them. An entomologist, or scientist who studies insects, observed and tracked the changes to the moth population for 1 year after the factory was built. Below is the entomologist's data. Use the data table to make your claim.

- Write a scientific explanation that describes how the population of moths changed after the factory was built.

Moth Population Data					
Type of Moth	Population before Factory	Population after 3 Months	Population after Six Months	Population after 9 Months	Population after 12 Months
Light	74	70	59	42	31
Dark	26	32	40	53	68

- What do you think would happen to the population after 2 years?
- What do you think is causing this change?
- How is this change negatively impacting the moths?

Adapted from STEMscopes

Universal Supports

- Explicit introduction and modeling of Tier 2 academic vocabulary *(ex: variations, adaptations, advantages, survival, populate, etc.).*
- Encourage students to create their own examples of vocabulary.
- Use graphic organizers to encourage students to compare examples of different animals and plants of the same species that live in different habitats.
- Review and reteach the writing sequence of an informational piece.

Targeted Supports

- Use additional charts with sentence stems to support students in describing and explaining adaptations that a specific plant or animal has.
- Scaffold informational writing using visuals, sentence stems and graphic organizers.
- Provide multiple opportunities for student feedback on writing, including from both peers and teachers.

Common Misconceptions

- Students may think all adaptations are physical structures.
- Students may believe that adaptations are random traits and behaviors that animals have.
- Many may think that all organisms survive equally well in their environments.

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 are some plants and animals we see in our community? Which organisms seem to survive better than others?*
- *What traits do you think these organisms may have that allow them to survive?*
- *What are some things you notice in the phenomena that may help the animal survive in its environment?*

	Build & Bridge: ● *What questions do we need to answer to determine what animals or plants need to survive, reproduce, and find a mate?* ● *Create or draw an environment and label what the animals and plants will need to survive in that environment.* ● *What do plants and animals need to survive in your community?*

Students who demonstrate understanding can:

3-LS4-3. **Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.** [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]

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). • Construct an argument with evidence.	**LS4.C: Adaptation** • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Connections to other DCIs in third grade:
3.ESS2.D

Articulation of DCIs across grade-levels:
K.ESS3.A ; **2.LS2.A** ; **2.LS4.D** ; **MS.LS2.A** ; **MS.LS4.B** ; **MS.LS4.C** ; **MS.ESS1.C**

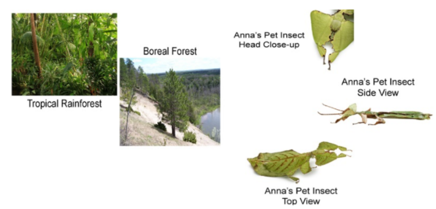
Common Core State Standards Connections:
ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-LS4-3)*
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS4-3)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS4-3)*
W.3.1	Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-LS4-3)
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS4-3)*
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS4-3)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS4-3)*
3.MD.B.3	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *(3-LS4-3)*

Grade	*NGSS Discipline*
3	**Life Science 4.3**
3.LS4-3	**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.* • In a forest habitat, brown moths have higher survival rates than white moths. **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 insect pictured below was Anna's pet. She decided the insect would survive better in an environment that resembled its natural habitat, so she took it to the zoo. The entomologist must now decide which environment would be the best home for the insect. Look at the pictures of the insect and the two different habitats. Think about what you would do if you were the entomologist.



- Write a scientific explanation for which environment would best allow the animal to survive.
    - What is another organism that would survive well in a tropical rainforest?
    - What would be an example of an organism that would not survive well in a tropical rainforest? Why?

Universal Supports

- Use content specific academic vocabulary.
- Use high quality photos that show the adaptation of a specific plant or animal.
- Teach on a specific habitat and create a chart depicting what is in said habitat. On chart also what would a plant or animal need to survive within this habitat. What would happen if one thing is removed?
- Review/reteach the writing sequence for an opinion piece using evidence.

Targeted Supports

- Use models or examples for clarification on what it means to survive well, survive not so well, and not survive at all.
- Scaffold the writing sequence and what it means to use evidence to support students' writing.
- Use visuals, sentence stems, and graphic organizers.

Common Misconceptions

- Students may not be aware that plants have adaptations.Plants have adaptations to help them survive and meet their basic needs. Examples of plant adaptations include color, leaf shape, thorns, root system, etc.
- Students may believe that adaptations are random traits and behaviors that animals have.Adaptations are specific to a species and involve traits and behaviors that help that species survive.
- Many may think that all organisms survive equally well in their environments. There are many factors to be taken into account when it comes to organisms surviving in their environments. Some species survive better than others.

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 are some examples of organisms that live in our community? Which organisms do you see more of? Why do you think that is?*
- *Can you think of any predators in our community? How do they affect the survival of other animals?*

Build & Bridge:

	• *Using your knowledge of a habitat, write, draw, or create a model of a habitat and what the animals or organisms might need within that habitat to survive.* • *What do you think would happen if a desert rabbit and arctic rabbit switched places?*

Students who demonstrate understanding can:

3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [*Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.*]

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

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).

- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

Disciplinary Core Ideas

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. *(secondary)*

LS4.D: Biodiversity and Humans

- Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Engineering, Technology, and Science on Society and the Natural World

- Knowledge of relevant scientific concepts and research findings is important in engineering.

Connections to other DCIs in third grade:
3.ESS3.B

Articulation of DCIs across grade-levels:
K.ESS3.A ; **K.ETS1.A** ; **2.LS2.A** ; **2.LS4.D** ; **4.ESS3.B** ; **4.ETS1.A** ; **MS.LS2.A** ; **MS.LS2.C** ; **MS.LS4.C** ; **MS.ESS1.C** ; **MS.ESS3.C**

Common Core State Standards Connections:
ELA/Literacy —

RI.3.1	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-LS4-4)*
RI.3.2	Determine the main idea of a text; recount the key details and explain how they support the main idea. *(3-LS4-4)*
RI.3.3	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS4-4)*
W.3.1	Write opinion pieces on topics or texts, supporting a point of view with reasons. *(3-LS4-4)*
W.3.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS4-4)*
SL.3.4	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS4-4)*

Mathematics —

MP.2	Reason abstractly and quantitatively. *(3-LS4-4)*
MP.4	Model with mathematics. *(3-LS4-4)*

Grade	*NGSS Discipline*
3	**Life Science 4.4**

3.LS4-4

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.

- A dam was built in a nearby lake to prevent flooding near an apartment complex.

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 Woodson Logging Company is cutting down trees in a snowy forest in order to build new homes in a nearby city. The company wants to be responsible and replace the trees that were cut down, so they are planting new trees.

Type of Tree	Environment	Growth per Year
Chinese Elm	Warm	Three feet
Scotch Pine	Cold	Three feet
Balsam Fir	Cold	Three feetOne foot
Longleaf Pine	Water	Three feet

- Use the data to decide which tree would be the best choice for restoring the forest. Make a claim and explain your evidence.

Adapted from STEMscopes

Universal Supports

- Explicit introduction and modeling of Tier 2 academic vocabulary.
- Use multiple modes of media (ex: print, video, audio, photos, etc.) to share examples of changing environments, both before and after.
- Utilize charts and graphic organizers to share student thinking and ideas about changing environments.
- Review and reteach the writing sequence for an informational writing piece.

Targeted Supports

- Use explicit models or examples for clarification on what it means to survive well, survive not so well, and not survive at all.
- Scaffold the writing sequence. Use visuals, sentence stems, and graphic organizers to support students' development in writing.
- Provide multiple opportunities for students to receive feedback on writing samples, both from peers and teachers.

Common Misconceptions

- Students may not see the relationships between agriculture and industrial practices and the environment around them, especially how these practices may have altered the land or how waste and by-products of these practices may have leached into the air, soil, or water.
- Students may often think that the effects of pollution in one area are limited to that area.
- Students may think that only humans affect habitats.
- Students may think that organisms can adapt after their environment has been changed.

Culturally and Linguistically Responsive Instruction

Guiding Questions	Connections

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

Validate & Affirm:

- *What do you think may happen to organisms when it gets very hot for a long time here in New Mexico?*
- *Have you ever experienced any type of environmental change (earthquake, volcano, forest fire, drought)?*
- *Have you heard of environmental changes that have happened in our community? How have they affected plants and animals?*

	Build & Bridge: ● *When an environment changes, what are some ways that the environment can be re-built?* ● *Are there organisms that are able to withstand environmental changes? How many they be able to do that?*

Students who demonstrate understanding can:

3-ESS2-1. **Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.** [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] *[Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]*

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 tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.	**ESS2.D: Weather and Climate** • Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	**Patterns** • Patterns of change can be used to make predictions.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
K.ESS2.D ; **4.ESS2.A** ; **5.ESS2.A** ; **MS.ESS2.C** ; **MS.ESS2.D**

Common Core State Standards Connections:
Mathematics —

MP.2	Reason abstractly and quantitatively. (3-ESS2-1)
MP.4	Model with mathematics. (3-ESS2-1)
MP.5	Use appropriate tools strategically. *(3-ESS2-1)*
3.MD.A.2	Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. *(3-ESS2-1)*
3.MD.B.3	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in bar graphs. (3-ESS2-1)

Grade	*NGSS Discipline*
3	**Earth and Space Science 2.1**
3.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.* • The city of Miami had an unusually cool day, with a temperature of 65 degrees in the middle of summer. **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 following data shows daily weather conditions for 1 week in Atlanta, Georgia.

Table 1

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
High: 88°F Low: 74°F	High: 92°F Low: 78°F	High: 91°F Low: 77°F	High: 95°F Low: 76°F	High: 94°F Low: 77°F	High: 93°F Low: 74°F	High: 87°F Low: 68°F

The following data shows average weather conditions for Atlanta, Georgia.

Table 2

Average High Temperature	Average Low Temperature	Average Temperature	Average Annual Rainfall	Days per Year with Rainfall
70°F	53°F	61°F	47 inches	117

- Write a scientific explanation describing which data table shows weather and which table shows climate.
  - Compare and contrast the two charts.
  - What do you think this weather/climate feels like? Explain using evidence from the charts.

Adapted from STEMscopes

Universal Supports

- Teacher and students create their own monthly weather calendar to graph. Use visuals while filling in the calendar *(ex:sun, cloud, rain drops, windy, snow…)*
- Show students data of the weather in their city using data from about three or more years to compare the difference between weather and overall climate.
- Using a globe or a digital version, expose students to the Earth's axis and how its tilt affects the seasons and the type of climate experienced during that season.
- Explicit introduction and modeling of Tier 2 vocabulary *(ex: temperature, wind direction, precipitation, climate, weather, etc.)*

Targeted Supports

- In small groups, provide additional examples of weather graphs, maps, and charts to review how to read these types of graphs.
- Provide additional opportunities for students to incorporate Tier 2 vocabulary through the use of sentence stems and word banks.
- Provide multiple opportunities for students to reflect on learning, sharing new ideas, additional questions, and explaining their revised thinking.

Common Misconceptions

- Students have the tendency to believe weather and climate are the same thing.
- Students may think the seasons cause the weather to change.
- Climate is the same for all places on the globe.

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 is the weather like in your community?* • *What are some different events or activities your family participates in during different seasons? How does the weather and climate influence these activities?* • *Draw pictures or have students bring in items that their families use during various weather conditions.* Build & Bridge: • *How do local weather patterns influence your life?* • *How can the weather change on a daily basis?* • *How is the climate we experience in New Mexico different than the climate experienced in Maine? Why might that be?*

Students who demonstrate understanding can:

3-ESS2-2. **Obtain and combine information to describe climates in different regions of the world.**

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 other reliable media to explain phenomena.	**ESS2.D: Weather and Climate** • Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	**Patterns** • Patterns of change can be used to make predictions.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
MS.ESS2.C ; **MS.ESS2.D**

Common Core State Standards Connections:
ELA/Literacy —

RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. *(3-ESS2-2)*
RI.3.9 Compare and contrast the most important points and key details presented in two texts on the same topic. (3-ESS2-2)
W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-ESS2-2)

Mathematics —

MP.2 Reason abstractly and quantitatively. (3-ESS2-2)
MP.4 Model with mathematics. (3-ESS2-2)

Grade	*NGSS Discipline*
3	**Earth and Space Science 2.2**

3.ESS2-2

Sample Phenomena

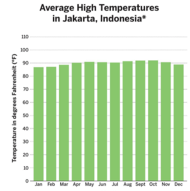
When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.

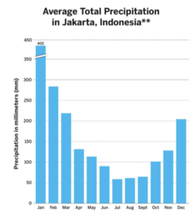
- The Atacama Desert is considered to be the driest place on Earth.

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.

- Amir wants to visit Indonesia to see his grandparents. He looks at a few graphs to determine which time of year would be the best time to visit. Look at the data below and write a scientific claim explaining which month(s) you believe Amir should visit Indonesia, based on the anticipated climate.





Adapted from Amplify Science: Weather & Climate

Universal Supports	Targeted Supports
• As a class, obtain the information of the local climate. • Using graphic organizers, explore and compare climates in other regions of the world. • Provide multiple opportunities for students to read graphs, charts, and maps of climates around the world. • Explicit introduction and modeling of Tier 2 vocabulary *(ex: regions, climate, weather, patterns, tundra, desert, etc.)*	• Supply students with examples or information of the climates in different regions. Quality photos of different climates: tropical, temperate, arctic, desert, tundra, and others. • Provide individualized, scaffolded reading material for students of all reading levels. • Provide multiple opportunities for students to acquire and work with Tier 2 vocabulary (ex: match photos with vocabulary and utilizing sentence stems and word banks).

Common Misconceptions

- Many students believe that the weather they experience is the same weather that all people around the world are experiencing.
- Students may believe that climate never changes over time.

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:

- *How could we describe the climate in New Mexico?*
- *Have you traveled to another country or state before? What was the climate like there?*

Build & Bridge:

- *What did you notice that might be different in the various places you have traveled?*
- *Create a diagram comparing local weather/climate with the weather or climate of the place you have visited.*

Students who demonstrate understanding can:

3-ESS3-1. **Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*** [Clarification Statement: Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods.]

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). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**ESS3.B: Natural Hazards** • A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)*	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). ***Connections to Nature of Science*** **Science is a Human Endeavor** • Science affects everyday life.

Connections to other DCIs in third grade: N/A

Articulation of DCIs across grade-levels:
K.ESS3.B ; **K.ETS1.A** ; **4.ESS3.B** ; **4.ETS1.A** ; **MS.ESS3.B**

Common Core State Standards Connections:
ELA/Literacy —
W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons. *(3-ESS3-1)*
W.3.7 Conduct short research projects that build knowledge about a topic. *(3-ESS3-1)*
Mathematics —
MP.2 Reason abstractly and quantitatively. *(3-ESS3-1)*
MP.4 Model with mathematics. *(3-ESS3-1)*

Grade	*NGSS Discipline*
3	**Earth and Space Science 3.1**
3.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.* • Hurricane Katrina caused devastating damage to the city of New Orleans in 2005 due to a failed levee structure. **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.* • One way lightning can damage buildings and other structures is by causing them to catch fire. Lightning can also damage expensive electronics. Lightning tends to strike tall structures. Lightning rods are installed on top of the tallest buildings in a given area to keep the lightning from striking other structures nearby. When lightning strikes the rod, the electricity is conducted through wires to the ground, where it cannot

cause any damage. A city is planning to add two new towers to their skyline and needs to determine if lightning rods are a good way to protect the towers from lightning damage.

Average Yearly Cost of Damage from Lightning Strikes			
Building	Is a Lightning Rod Installed?	Height	Average Cost of Damage from Lightning (per year)
Tower A	Yes	360 m	$50
Tower B	Yes	442 m	$300
Tower C	No	344 m	$47,000
New Tower D		449 m	
New Tower E		382 m	

- Write a scientific explanation to help the city officials decide if lightning rods can help prevent the new towers from being damaged by lightning. State your claim and cite your evidence.

Adapted from STEMscopes

Universal Supports

- Explicit introduction and modeling of Tier 2 academic vocabulary *(ex: solution, hazards, extreme weather, designs, etc.)*
- Review and teach various examples of extreme weather and natural disasters and the impacts those disasters have on the community.
- Choose a disaster and discuss the hazards and one solution that could protect the community. (ex- floods- the use of sandbags to keep some of the water at bay).

Targeted Supports

- Provide multiple opportunities for students to engage with and acquire Tier 2 academic vocabulary (ex: visual supports, sentence stems, word banks, etc.)
- Provide graphic organizers for students to record developing thinking and additional questions.
- When designing solutions, have students work with a partner and/or teacher to develop steps of the solution

Common Misconceptions

- Students might believe it is possible to eliminate natural hazards.
- Students may think there is nothing that can be done to avoid the impact of natural hazards.
- Students may think that there is no way to know when a natural hazard is going to occur.
- Students commonly think that meteorologists are always right or always wrong when making predictions.

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:

- *Have you ever experienced a weather related disaster? How did you feel and what did you think?*
- *What are some types of extreme weather we experience in New Mexico?*

	When you looked at the image of Hurricane Katrina, what were your thoughts and feelings? *Have you ever helped a family or community member during a storm?* Build & Bridge: *Allow students to express their feelings and possible trauma around the natural disasters (or harsh weather) they may have experienced.* *Looking at some examples of weather-related hazards, what are possible solutions we could create to prevent their impact?*

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**
3-5-ETS1-1	**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.* ● Hurricane Katrina caused devastating damage to the city of New Orleans in 2005 due to a failed levee structure. **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.* ● One way lightning can damage buildings and other structures is by causing them to catch fire. Lightning can also damage expensive electronics. Lightning tends to strike tall structures. Lightning rods are installed on top of the tallest buildings in a given area to keep the lightning from striking other structures nearby. When lightning strikes the rod, the electricity is conducted through wires to the ground, where it cannot cause any damage. A city is planning to add two new towers to their skyline and needs to determine if lightning rods are a good way to protect the towers from lightning damage.

Average Yearly Cost of Damage from Lightning Strikes			
Building	Is a Lightning Rod Installed?	Height	Average Cost of Damage from Lightning (per year)
Tower A	Yes	360 m	$50
Tower B	Yes	442 m	$300
Tower C	No	344 m	$47,000
New Tower D		449 m	
New Tower E		382 m	

- Write a scientific explanation to help the city officials decide if lightning rods can help prevent the new towers from being damaged by lightning. State your claim and cite your evidence.

Adapted from STEMscopes

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:

- *Have you ever experienced a weather related disaster? How did you feel and what did you think?*

	What are some types of extreme weather we experience in New Mexico? *When you looked at the image of Hurricane Katrina, what were your thoughts and feelings?* *Have you ever helped a family or community member during a storm?* Build & Bridge: *Allow students to express their feelings and possible trauma around the natural disasters (or harsh weather) they may have experienced.* *Looking at some examples of weather-related hazards, what are possible solutions we could create to prevent their impact?*

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

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.

Disciplinary Core Ideas

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.

Crosscutting Concepts

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.

- Hurricane Katrina caused devastating damage to the city of New Orleans in 2005 due to a failed levee structure.

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.

- One way lightning can damage buildings and other structures is by causing them to catch fire. Lightning can also damage expensive electronics. Lightning tends to strike tall structures. Lightning rods are installed on top of the tallest buildings in a given area to keep the lightning from striking other structures nearby. When lightning strikes the rod, the electricity is conducted through wires to the ground, where it cannot

Average Yearly Cost of Damage from Lightning Strikes

Building	Is a Lightning Rod Installed?	Height	Average Cost of Damage from Lightning (per year)
Tower A	Yes	360 m	$50
Tower B	Yes	442 m	$300
Tower C	No	344 m	$47,000
New Tower D		449 m	

cause any damage. A city is planning to add two new towers to their skyline and needs to determine if lightning rods are a good way to protect the towers from lightning damage.

Average Yearly Cost of Damage from Lightning Strikes			
Building	Is a Lightning Rod Installed?	Height	Average Cost of Damage from Lightning (per year)
Tower A	Yes	360 m	$50
Tower B	Yes	442 m	$300
Tower C	No	344 m	$47,000
New Tower D		449 m	
New Tower E		382 m	

- Write a scientific explanation to help the city officials decide if lightning rods can help prevent the new towers from being damaged by lightning. State your claim and cite your evidence.

Adapted from STEMscopes

Universal 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 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.

Targeted Supports

- 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.

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: • *Have you ever experienced a weather related disaster? How did you feel and what did you think?* • *What are some types of extreme weather we experience in New Mexico?* • *When you looked at the image of Hurricane Katrina, what were your thoughts and feelings?* • *Have you ever helped a family or community member during a storm?* Build & Bridge: • *Allow students to express their feelings and possible trauma around the natural disasters (or harsh weather) they may have experienced.* • *Looking at some examples of weather-related hazards, what are possible solutions we could create to prevent their impact?*

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.	

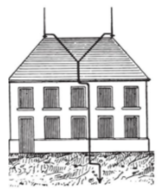
Connections to 3-5-ETS1.B: Developing Possible Solutions Problems include:
Fourth Grade: 4-ESS3-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

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.* • Hurricane Katrina caused devastating damage to the city of New Orleans in 2005 due to a failed levee structure. **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.* • One way lightning can damage buildings and other structures is by causing them to catch fire. Lightning can also damage expensive electronics. Lightning tends to strike tall structures. Lightning rods are installed on top of the tallest buildings in a given area to keep the lightning from striking other structures nearby.

When lightning strikes the rod, the electricity is conducted through wires to the ground, where it cannot cause any damage. A city is planning to add two new towers to their skyline and needs to determine if lightning rods are a good way to protect the towers from lightning damage.



Average Yearly Cost of Damage from Lightning Strikes			
Building	Is a Lightning Rod Installed?	Height	Average Cost of Damage from Lightning (per year)
Tower A	Yes	360 m	$50
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Tower C	No	344 m	$47,000
New Tower D		449 m	
New Tower E		382 m	

- Write a scientific explanation to help the city officials decide if lightning rods can help prevent the new towers from being damaged by lightning. State your claim and cite your evidence.

Adapted from STEMscopes

Universal 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.)
- Provide multiple opportunities for students to reflect and share their revisions for how solutions could be made even stronger.

Targeted Supports

- 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 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: ● *Have you ever experienced a weather related disaster? How did you feel and what did you think?* ● *What are some types of extreme weather we experience in New Mexico?* ● *When you looked at the image of Hurricane Katrina, what were your thoughts and feelings?* ● *Have you ever helped a family or community member during a storm?* Build & Bridge: ● *Allow students to express their feelings and possible trauma around the natural disasters (or harsh weather) they may have experienced.* ● *Looking at some examples of weather-related hazards, what are possible solutions we could create to prevent their impact?*

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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This detailed and flexible tool suggests activity formats to help teachers create three-dimensional assessments based on real-world science and engineering practices. In response to this felt need being expressed among educators, researchers at the Research + Practice Collaboratory 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.

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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.