NEW MEXICO
Public Education Department

New Mexico Instructional Scope
Kindergarten Science Guide

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New Mexico STEM Ready! Science Standards Implementation Guide

Overview

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

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

The standards

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

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

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

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

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

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

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

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

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

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

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

Sample Phenomena

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

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

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

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

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

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

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

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

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

Classroom Assessment Items

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

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

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

- Measuring the three-dimensional science learning called for in the framework and the NGSS requires assessment tasks that examine students' performance of scientific and engineering practices in the context of crosscutting concepts and disciplinary core ideas. To adequately cover the three dimensions, assessment tasks will generally need to contain multiple components. It may be useful to focus on individual practices, core ideas, or crosscutting concepts in the various components of an assessment task, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given performance expectation.
- The Next Generation Science Standards require that assessment tasks be designed so they can accurately locate students along a sequence of progressively more complex understandings of a core idea and successively more sophisticated applications of practices and crosscutting concepts.
- The NGSS places significant demands on science learning at every grade level. It will not be feasible to assess all the performance expectations for a given grade level with any one assessment. Students will

[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 Science	Life Science	Earth and Space Science	Engineering Design
Motion and Stability: Forces and Interactions K-PS2-1 K-PS2-2 Energy K-PS3-1 K-PS3-2	From Molecules to Organisms: Structures and Processes K-LS1-1	Earth's Systems K-ESS2-1 K-ESS2-2 Earth and Human Activity K-ESS3-1 K-ESS3-2 K-ESS3-3	K-2 ETS1-1 K-2 ETS1-2 K-2 ETS1-3

Students who demonstrate understanding can:

K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [*Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.*]

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 K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
- With guidance, plan and conduct an investigation in collaboration with peers.

Connections to the Nature of Science

Scientific Investigations Use a Variety of Methods
- Scientists use different ways to study the world.

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Pushes and pulls can have different strengths and directions.
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.

PS2.B: Types of Interactions
- When objects touch or collide, they push on one another and can change motion.

PS3.C: Relationship Between Energy and Forces
- A bigger push or pull makes things speed up or slow down more quickly. *(secondary)*

Crosscutting Concepts

Cause and Effect
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Connections to other DCIs in kindergarten:
N/A

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

Common Core State Standards Connections:
ELA/Literacy -
W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS2-1)
Mathematics -
MP.2 Reason abstractly and quantitatively. *(K-PS2-1)*
K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. *(K-PS2-1)*
K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS2-1)

Grade	*NGSS Discipline*
K	**Physical Science 2.1**
K.PS2-1	**Sample Phenomena** *When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.*

- When you go down the slide on your own it is at a different speed than when a friend pushes you down the slide.
- When you push a heavy ball it moves differently from when you push a light ball.
- Skateboarding ollie in slow motion: https://thewonderofscience.com/phenomenon/2018/7/9/the-ollie-skateboarding-slow-motion

Classroom Assessment Items

When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available.
Inspired by: https://www.washboroschools.org/wp-content/uploads/2016/07/Kindergarten_Unit-1.pdf:

- With guidance, collaboratively plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include noncontact pushes or pulls such as those produced by magnets.) Some examples of pushes and pulls on the motion of an object could include: A string attached to an object being pulled. A person pushing an object. A person stopping a rolling ball. Two objects colliding and pushing on each other.

- Students are challenged to design a simple way to change the speed or direction of an object using a push or pull from another object.
  - As a class, students determine what the design should be able to do (criteria). For example: An object should move a second object a certain distance; An object should move a second object so that the second object follows a particular path; An object should change the direction of the motion of a second object; and/or An object should knock down other specified objects.
  - Students determine the objects that will move/be moved (balls, ramps, blocks, poker chips) and the types of structures (ramps or barriers) and materials (rubber bands, paper tubes, cardboard, foam, wooden blocks) that can be used to meet this challenge.
  - Groups of students then develop a simple drawing or diagram and use given materials to build their design. Groups should be given a predetermined amount of time to draw and build their designs.
  - Groups share their designs with the class, using their drawings or diagrams, and then test their designs.
  - Students make and use observations to determine which of the designs worked as intended, based on the criteria determined by the class. While engaging in this process, students should use evidence from their observations to describe how forces (pushes and pulls) cause changes in the speed or direction of an object.

Universal Supports

- Use multiple modes of media to introduce students to concepts (audio, video, text, photographs)
- Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary

Targeted Supports

- Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information
- Peer tutoring (teacher-selected partners) to support students in learning
- Provide opportunities for reflection and revision of their work when possible

- Use picture cues and sentence stems to support students in acquiring new vocabulary - Provide opportunities for students to explain their thinking - As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment - Give students opportunities to observe, record their findings using notes or drawing pictures. Record student questions and observations and discuss. - Allow students who are not able to write academically to draw their answers and explain verbally	- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest - When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation - Some students may need help with written or drawn observations. Another option is recording their observation using an ipad or chromebook, or dictating to the teacher or aide. - For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. - Work with individuals or smaller groups who are struggling with cause/effect, with describing what they are observing, or other misconceptions that arise. - For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.

Common Misconceptions

- If an object is not moving, students may not recognize there are forces acting upon it. Forces such as gravity continue to act on objects, even if they are not moving.
- Students may think of force as a property of an object rather than as a relation between objects.Forces are applied to objects.
- Students may not understand the difference between push and pull (Note - using a skateboard is a better object to use to model than a ball. Use a string to pull it, for example)
- Students are only beginning to understand cause and effect.
- All things fall down, but heavy things fall faster. (we are not assessing gravity, but this could be a common misconception.)
- Students may not know what force and direction are.
- Not understanding how different properties affect how an object moves (size, material, shape, etc)
- May have misconceptions that something new, bigger, prettier moves faster.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is it important to know how to move things?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?

	Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore. Validate and Affirm the different backgrounds regarding investigations.: Have you ever done an investigation? What steps did you follow? Build and bridge on students' previous experiences to build and bridge to new investigations. Validate and Affirm prior knowledge and experiences: What are ways that you move things?What are objects in your house that you can pull? What are objects in your house that you can push? Build and bridge: Use their prior knowledge to make connections to objects and ways of moving them that they may not be familiar with.

Students who demonstrate understanding can:

K-PS2-2. **Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*** [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [*Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.*]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Analyze data from tests of an object or tool to determine if it works as intended.	**PS2.A: Forces and Motion** • Pushes and pulls can have different strengths and directions. • Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. **ETS1.A: Defining Engineering Problems** • A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. *(secondary)*	**Cause and Effect** • Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Connections to other DCIs in kindergarten:
K.ETS1.A ; **K.ETS1.B**

Articulation of DCIs across grade-levels:
2.ETS1.B; **3.PS2.A** ; **4.PS3.A** ; **4.EST1.A**

Common Core State Standards Connections:
ELA/Literacy -
RI.K.1 With prompting and support, ask and answer questions about key details in a text. *(K-PS2-2)*
SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. *(K-PS2-2)*

Grade	NGSS Discipline
K	**Physical Science 2.2**
K.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. ● A slinky can go down stairs. https://thewonderofscience.com/kps22#phenomena ● Amazing slinky tricks: https://thewonderofscience.com/phenomenon/2018/7/5/amazing-slinky-tricks ● The harder you push a swing, the higher the swing goes.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Inspired by: https://docs.google.com/document/d/1V0--hwv-Nr59nYv_g6LhmAYsndv318L9VESoWa44PTk/template/preview ● Read the following to the students: Engineers create solutions to design problems. We are going to watch a video that details the adventures of a red ball. An engineer at Sprice Machines has created a design that will hopefully deliver the ball to a goal at the end. Observe carefully how pushes and pulls allow the red ball to have an adventure.

- Show the students the following video from Sprice Machines. We will be investigating a scene from this video.

Questions for students:

- The goal of the engineer was to move the red ball to the goal at the end. Did the engineer succeed?
- If they did succeed, how did they make it work?

(The teacher can create a page with yes or no at the top - students can circle whether they think the engineer succeeded or not. Then students can draw their explanation of how it worked. Each student can then explain their thinking to the teacher one-on-one.)

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Allow students who are not able to write academically to draw their answers and explain verbally	• Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • Pre Teach vocabulary to students who need the scaffolding (ex: ELLs): pull, push, speed, direction • For students who struggle with fine motor skills, provide larger materials for their investigations. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Provide extra opportunities to analyze data

Common Misconceptions

- If an object is not moving, students may not recognize there are forces acting upon it. Forces such as gravity continue to act on objects, even if they are not moving.
- Students may think of force as a property of an object rather than as a relation between objects.Forces are applied to objects.
- What is data? How do we collect it?
- If an adult made it (or maybe an older student), then it will work (Associating success with age and experience)
- Relying heavily on teacher guidance and not on their own thinking and designing

- An experiment not working is a failure (Students need to learn that making mistakes is part of science and that it's okay)
- Misconception for teachers - Kinder students can't design an experiment

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is data important?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?
Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

Validate and affirm: How can we make sure that everyone gets to participate in the investigation?
Build and bridge: work together to set norms.

Validate and affirm the variety of student responses: What is something you have needed to find a solution to?
Build and bridge their personal solutions to a broader solution.

Students who demonstrate understanding can: **K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.** [Clarification Statement: Examples of Earth's surface could include sand, soil, rocks, and water.] [*Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.*]
The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Make observations (firsthand or from media) to collect data that can be used to make comparisons. - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Scientific Investigations Use a Variety of Methods** • Scientists use different ways to study the world.	**PS3.B: Conservation of Energy and Energy Transfer** • Sunlight warms Earth's surface.	**Cause and Effect** • Events have causes that generate observable patterns.

Connections to other DCIs in kindergarten: N/A
Articulation of DCIs across grade-levels: **1.PS4.B** ; **3.ESS2.D**
Common Core State Standards Connections: *ELA/Literacy -* **W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS3-1) *Mathematics -* **K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K- PS3-1)

Grade	*NGSS Discipline*
K	**Physical Science 3.1**
K.PS3-1	**Sample Phenomena** *When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don't have local instructional materials available.* ● Snowman melts in the sun: https://thewonderofscience.com/phenomenon/2018/6/15/snowman-melt-timelapse ● Car seats get hot in the summer. ● Sometimes the playground slide gets too hot to play on but the swings don't seem to get so hot. ● We feel hot when playing on the blacktop but feel cool under the trees. **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.* ● Observe the temperature of a variety of surfaces after being in the sun for 30 minutes. Ask: What makes the slide warmer than the bench under the tree? Where is it cooler, out on the baseball field or in the picnic shelter? ● Inspired by: Wonder of Science: https://thewonderofscience.com/kps31#assessments :

- If there are shaded areas around your school, the teacher can use shaded and unshaded spaces. If it is a struggle to find shaded/ unshaded areas, the teacher can use an umbrella. Go outside and have the students collect evidence in the four locations: grass in the sun, grass in the shade, sidewalk in the sun, sidewalk in the shade. Students should identify each location as cool, warm or hot. Ask students: which was the hottest surface? Which was the coolest?
- Other ideas: The teacher could have a bowl of water, a piece of metal, and other materials in the shade and in the sun, and add them to their records.

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally	• Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • If students are struggling to determine the warmth of objects with their hands, use thermometers - showing students that the higher the temperature, the hotter it is.

Common Misconceptions

- If an object is not moving, students may not recognize there are forces acting upon it.Forces such as gravity continue to act on objects, even if they are not moving.
- Students may think of force as a property of an object rather than as a relation between objects.Forces are applied to objects.
- Students may not have the concept of the sun in space and that sunlight comes from very far away
- There's no sunlight in the shade or that clouds completely block sunlight

- The sun goes away at night
- Students may think that all areas of the playground are the same temperature or that sunny and shady areas will have the same temperature.
- Lack of knowledge about the different surfaces of the Earth
- Students may think that color does not influence how heat from sunlight affects surfaces or that rocks and soil will heat at the same rate in the sun.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, ask: Why is the sun important?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?
Build and Bridge: Use students’ responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students’ preferred ways to explore.

Validate and affirm student responses about the sun: What do you know about the sun?

Build and bridge students' responses to get into more complex topics.

Students who demonstrate understanding can:

K-PS3-2. **Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth's surface.*** [Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. • Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem.	**PS3.B: Conservation of Energy and Energy Transfer** • Sunlight warms Earth's surface.	**Cause and Effect** • Events have causes that generate observable patterns.

Connections to other DCIs in kindergarten:
K.ETS1.A ; **K.ETS1.B**

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

Common Core State Standards Connections:
ELA/Literacy -
W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). *(K-PS3-2)*
Mathematics -
K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS3-2)

Grade	*NGSS Discipline*
K	**Physical Science 3.2**
K.PS3-2	**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.* ● Some people carry umbrellas when it is sunny. ● Picnic areas are often covered. **Classroom Assessment Items** *When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available.* Inspired by Wonder of Science: https://thewonderofscience.com/kps32#assessments ● Read the following to the students: One of the greatest treats on a hot day is a popsicle (source). A popsicle can keep us cool while the Sun is heating us up. Unfortunately the Sun is also warming up the popsicle so you have to eat it fast before it melts. Today you will be individually designing and building a Popsicle Protector to solve the problem of melting popsicles on a hot day. Your popsicle protector should provide shade for your popsicle. It should also allow you to eat the popsicle.

- Students should sketch ideas and build one design with the materials provided. After they have created their design they should take it outside and evaluate how well it works. Students should use their design to answer the following questions individually.

1. Describe the problem we are trying to solve.
2. How does your original design solve the problem?
3. How do the structures of your design provide shade for the popsicle?
4. How well did your design solve the problem of the melting ice cube?

Materials: popsicles, paper, scissors, popsicle sticks, paper cups, string, paper clips, brads, any other materials that make sense

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Students follow the engineering design process - the teacher can scaffold this one step at a time, doing steps in small groups or individually as determined by the teacher.	• Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • When designing investigations, have students work with a partner and/or teacher to develop steps of the investigation • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Provide extra opportunities to conduct investigations, and/or model more examples before asking students to conduct their investigation independently.

Common Misconceptions

- The Sun warms Earth's surface evenly.

- Some of Earth's materials are heated more easily than others.
- Objects in the shade are completely protected from the Sun's light and heat. (The air is heated by the Sun, so objects are still heated even when they are in the shade. The rate at which the objects are heated is just reduced by being in the shade, not eliminated.)
- Students may think that if it is sunny outside, it will feel warm. Depending on the time of year, it may be cold outside even though it is clear and sunny.
- All surfaces, colors, materials heat at the same rate.
- Beauty vs function - may think that "prettier" things are better when designing
- Students may struggle with testing and then making changes to their design without being frustrated
- Lack of independence
- Sun light doesn't pass into the shade
- Darker areas are cooler

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, ask: Why is it important to protect yourself from the sun?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?

Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

Validate and affirm: Students may have different understandings of the effect of the sun and different structures. Ask: What objects do you know of that can protect you from the sun? What structures do you know of that can protect you from the sun?

Build and Bridge: Use students' background knowledge about the sun and structures to help them in their design.

Students who demonstrate understanding can:

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	**Patterns** • Patterns in the natural and human designed world can be observed and used as evidence.

Connections to other DCIs in kindergarten: N/A

Articulation of DCIs across grade-levels:
1.LS1.A ; **2.LS2.A** ; **3.LS2.C** ; **3.LS4.B** ; **5.LS1.C** ; **5.LS2.A**

Common Core State Standards Connections:
ELA/Literacy -
W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-LS1-1)
Mathematics -
K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *(K-LS1-1)*

Grade	*NGSS Discipline*
K	**Life Science 1.1**
K.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. • Desert Beetle Harvesting Water: https://thewonderofscience.com/phenomenon/2018/7/11/desert-beetle-harvests-water • A tortoise can survive in the desert, while a sea turtle cannot. • A house plant that is put into a dark closet will not survive. • If you feed a dog, a rabbit and a fish the same foods, they will not all survive.
	Classroom Assessment Items
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Inspired by Wonder of Science: https://docs.google.com/document/d/1tB-Lqjjwt_MimYhZiUVWykiGb5OJ3U7DBwEY7EVuhb0/template/preview:

- Option 1: Give each student a copy of plant and animal cards.Students should sort the cards into different piles. Then ask, What pattern did you use to sort the cards? After cutouts are organized ask:

1. What do all plants need?
2. What do all animals need?
3. Where do animals get their food from?

- Option 2: Present this challenge to the students: A mystery animal is arriving at the zoo! The zookeeper needs to figure out what to feed this mystery animal. Help the zookeeper figure out which meal package he should choose for the new animal! The animal is a plant eater. Give students three options: two edible animals, one grass and one water, or one edible animal and one water.

- Explain which meal package would best suit this new animal.
  Claim: The zookeeper should choose a package for the mystery animal.
  Evidence: Draw a picture explaining why the package you picked would be best for a plant eater. Describe your picture to your teacher.

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

examples perhaps focusing on animals and plants that they are most familiar with when you ask them to sort.
- If students are struggling to identify needs, then give them one of the needs, such as food - and ask them to sort animals, plants and objects into "need food" and "don't need food" groups. Then ask them to think of another set of categories that they could use to sort.

Common Misconceptions

- Students at this age may not be aware of the purpose of food. They often don't realize that stored energy in food can be used by an animal.Food provides the human body with nutrients, which help the body grow and give it energy.
- Students may not understand that humans are animals.Humans need food in order to live and grow, just like other animals, such as dogs or cats.
- Students who have pets may believe that animals must be given what they need to survive versus having adaptations to obtain their needs. A dog that is a natural hunting dog might be given regular dog food, but if left out on an open farm, the dog has adaptations to be able to hunt for its own food.
- Students may not understand that animals obtain their food from plants and other animals.Animals obtain food in order to live and grow. The type of food they eat depends on what kind of animal it is.
- Students may not know that plants can look different from each other but can still be plants.Plants can look different, but they all take energy from the Sun to make their own food.
- Students may not understand that plants make their own food.Plants are living things. They do not go out and search for food, like animals do. They use sunlight and water to help them make their own food.
- Students may believe soil is needed in order for any plant to grow and that people add fertilizer as plant "food" to make them grow larger. Not all plants need soil. Some plants live on water or underwater. Fertilizer doesn't make plants grow larger; it simply provides the plant with extra nutrients that the soil might be lacking.
- Students are just beginning to learn about patterns in Kinder and need lots of practice and clarification
- Students may associate patterns with math and not science.
- Students may struggle to differentiate between needs and wants
- Students may not understand that plants are living and have needs to survive
- Students may not know that there is water in soil.
- Students may not know that plants have roots.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is it important for plants and animals to survive?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?
Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

	Validate and affirm prior knowledge and experiences: What plants do you know? Do you have any plants at home? How do you take care of them? What animals do you know? Do you have any animals at home? How do you take care of them? Build and bridge: Use their prior knowledge to make connections to other plants and animals that they may not be familiar with. Validate and affirm prior knowledge and experiences: What do you and your family need to survive? What are some things that you and your family want? What does your family value as a need and a want? Build and bridge: Classify student generated responses into categories: community, family, food, water, shelter, mental health, exercise, etc.

Students who demonstrate understanding can:

K-ESS2-1. **Use and share observations of local weather conditions to describe patterns over time.** [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [*Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.*]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Science Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world.	**ESS2.D: Weather and Climate** • Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	**Patterns** • Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Connections to other DCIs in kindergarten: N/A

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

Common Core State Standards Connections:

ELA/Literacy -

W.K.7	Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-ESS2-1)

Mathematics -

MP.2	Reason abstractly and quantitatively. (K-ESS2-1)
MP.4	Model with mathematics. (K-ESS2-1)
K.CC.A	Know number names and the count sequence. (K-ESS2-1)
K.MD.A.1	Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)
K.MD.B.3	Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

K — Earth and Space Science 2.1

K.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.

- Snowmen melt faster during the day than they do at night. Link to video: https://www.youtube.com/watch?v=aBYGKUkfViE&t=1s Description of video: It is a timelapse video of a snowman melting over a period of time. It shows the different rates of the snowman melting during the day and at night.
- The wind is very calm in the morning but is strong in the afternoon.

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.

- For this assessment teachers can either use a whole group calendar to track the weather or individual student calendars.

- Material Preparation

1. Complete the Blank Monthly Calendar Template and the Blank Daily Weather Calendar Template. Historical weather data can be found on various weather websites. (example - https://www.timeanddate.com/weather/)
2. Print out 2 copies of the Monthly Calendar and 1 copy of the Daily Calendar. Cut one of the Monthly Calendars into individual day squares.

- Prompts for Students

1. Have students look at 2 of the different monthly weather calendars (shown below). “Today we will be looking at observations of weather patterns that we collected. What weather patterns do you observe when you compare the two months?”
2. Give the students the cut-up month day squares. Provide time to the students to look at the days and ask students, “What patterns do you observe in one month?” “Can you describe weather patterns?” “Can you organize the weather into patterns?” “Can you describe the patterns you have made?” “Which of your groups have more?”
3. Have students look at 2 days on the daily weather calendars. Ask students, “What patterns do you observe between two days?
4. Have students look at 1 daily weather calendar. Ask students, “Can you describe what weather patterns you observe on (specific day)?”

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU’s to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Teach weather related vocabulary using photographs and the real-time weather: sunny, cloudy, partly cloudy, rainy, snowy, windy,	• Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher’s aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • The teacher can also provide weather icons that can be cut and pasted onto a weather log.

temperature. On a daily basis practice describing the weather and recording it on a calendar using pictures and words. ● Provide multiple opportunities for students to observe the weather, and provide alternate ways to record their observations.	● If students are struggling to see the patterns in weather using real data, work in a small group looking at teacher created data that has a more obvious pattern in order to practice finding patterns. ● Some students may need more practice with patterns in general - this can be practiced with colored blocks, with objects, with more concrete manipulatives first, and then they can move on to the weather patterns.

Common Misconceptions

- Students may believe the weather they are experiencing is the same weather everyone in the world is experiencing. Weather changes from place to place depending on many factors, such as air temperature and moisture in the air.
- Wind speed is sometimes believed to be related to the temperature of the air (e.g., high speed means cold air, and gentle or slow winds mean warm air). There can be high winds on a summer day. There can be high winds in the desert, yet it is very hot there.
- Students in more southern areas may not be familiar with snow. Pictures depicting snowmen may not have any relevance unless they are explained.Snow is similar to very fine, crushed ice. You might want to gather some fine, crushed ice so these students can have an opportunity to build a snowman in class if they have never seen or felt snow before!
- Students may believe that heat and temperature are the same thing. Heat is the total energy of the motion of molecules inside an object. Temperature is the measure of the average heat of molecules in a substance.
- Patterns are usually in math- colors, numbers, shapes vs. phenomena in nature
- Anything can be a pattern
- Weather varies throughout the world
- Students have experienced weather throughout their lives and have preconceived weather rules (ex. There will always be lightning/thunder when it rains.
- Non-scientific beliefs regarding weather
- Clouds are cotton/wool.
- Clouds move when we do.
- Clouds are sponges.
- Rain is shaped like tears.
- Lightening only occurs with thunder.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is it important to be aware of the weather around you?

Validate and affirm: What is the weather like where we live? Is the weather the same everywhere? Have you ever lived somewhere with different weather?
Build and bridge: Use students' background knowledge to build upon more complex weather patterns.

Validate and affirm: What patterns do you see/use in your life? How are patterns in the world helpful?

	Build and bridge: Use student's knowledge about patterns in their own life to connect it to patterns in the natural world.

Students who demonstrate understanding can:

K-ESS2-2. **Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.** [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

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 K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). • Construct an argument with evidence to support a claim.	**ESS2.E: Biogeology** • Plants and animals can change their environment. **ESS3.C: Human Impacts on Earth Systems** • Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. *(secondary)*	**Systems and System Models** • Systems in the natural and designed world have parts that work together.

Connections to other DCIs in kindergarten: N/A

Articulation of DCIs across grade-levels:
4.ESS2.E ; **5.ESS2.A**

Common Core State Standards Connections:
ELA/Literacy -

R.K.1	With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)
W.K.1	Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)
W.K.2	Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. *(K-ESS2-2)*

Grade	*NGSS Discipline*
K	**Earth and Space Science 2.2**
K.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.

- Sunflowers will turn to follow the sun and get more sunlight. Video link: https://www.youtube.com/watch?v=1gaWrMCiZR8 Description of video: Sunflowers will turn to follow the sun. As they mature they will face East. Bees are more attracted to warmer flowers and the flowers facing east are the warmest.
- Fire ants rebuilt their home to adapt to the environment.

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 will make a simple t-chart to identify the needs and how the animal/plant changes their environment to fit their needs. This will vary based on what plants and animals you taught in class.

Needs	How the animal/ plant changes the environment

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Use real objects and photos as much as possible to give students common understandings • Allow students who are not able to write academically to draw their answers and explain verbally • Use a real life example of how humans change their environment - start with something basic and tangible like moving furniture in the classroom for different activities. Gradually move on to more complex examples for humans, like building a house or farming. From there, move on to animals and plants. Focus on students making observations about how humans, animals, and plants are changing their environment. • Use pictures and videos to allow students to make the observations themselves. • Use graphic organizers and sentence stems to teach students how to construct an argument and how to back it up with evidence. • Provide multiple examples and opportunities for students to practice constructing an argument with evidence as a class and in small	• Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information • Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • Provide extra opportunities to model more examples before asking students to conduct their investigation independently.

groups before asking students to do it independently.

Common Misconceptions

- Students may think that only humans, not plants and animals, are capable of changing the world around them. Plants and animals can have impacts on their environments in the same way humans can.
- Some students may only have the knowledge of taking care of pets and therefore believe that animals must be given what they need to survive versus having adaptations to have their needs met. A dog that is a natural hunting dog might be given regular dog food, but if left out on an open farm, the dog has adaptations to be able to hunt for its own food.
- Students may think only one type of animal can live in a specific habitat. In a forest habitat, for example, many animals coexist (deer, birds, insects, small rodents, etc.) and share the same habitat.
- Humans are changing the environment vs humans have no impact.
- Plants only adapt to their environment and they don't actually change it.
- We can control our environment- change how we feel in different temperatures (how we dress)

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why do plants, animals and humans change their environment?

Validate and affirm: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking? Validate and affirm students' responses and use them to build and bridge to appropriate school science norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.
Build and Bridge: Use student responses to create a set of norms for science exploration. Use these norms to enhance their exploration.

Validate and affirm: How do you and your family change the world around you?
Bridge and Build: Use student responses to guide student discussion and thinking. Use their personal response to bridge to broader questioning.

Validate and affirm: Have you ever seen a plant change the environment around it? Have you ever seen an animal change the environment around it?
Build and bridge: Use students' background knowledge to build upon new information.

Students who demonstrate understanding can:

K-ESS3-1. **Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.** [Clarification Statement: Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas; and, grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions. • Use a model to represent relationships in the natural world.	**ESS3.A: Natural Resources** • Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	**Systems and System Models** • Systems in the natural and designed world have parts that work together.

Connections to other DCIs in kindergarten: N/A

Articulation of DCIs across grade-levels:
1.LS1.A ; **5.LS2.A** ; **5.ESS2.A**

Common Core State Standards Connections:

ELA/Literacy -

SL.K.5 Add drawings or other visual displays to descriptions as desired to provide additional detail. *(K-ESS3-1)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(K-ESS3-1)*
MP.4 Model with mathematics. *(K-ESS3-1)*
K.CC Counting and Cardinality *(K-ESS3-1)*

<table>
<tr><th>Grade</th><th colspan="2">NGSS Discipline</th></tr>
<tr><td>K</td><td colspan="2"><u>Earth and Space Science 3.1</u></td></tr>
<tr><td rowspan="5">K.ESS3-1</td><td colspan="2">Sample Phenomena</td></tr>
<tr><td colspan="2">When available, you should use your locally selected or created high quality instructional materials. However, the following is an example phenomenon you can use if you don’t have local instructional materials available.
● Water lilies grow in ponds and cacti grow in the desert. Link to video: https://www.youtube.com/watch?v=kpk02LOW7bw&t=68s Description of video: The teacher walks around a forest with just a sock. As she is walking the sock picks up different seeds. She then plants the sock in a different location. She looks at which seeds are able to grow in the new area.</td></tr>
<tr><td colspan="2">Classroom Assessment Items</td></tr>
<tr><td colspan="2">When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don’t have local instructional materials available.
● Students will pick an animal. This can be an animal that we have discussed or one that they have picked. They will then make a model of the relationship between the animal and the place they live. Students will be able to discuss the relationship with a peer or teacher.</td></tr>
<tr><td>Universal Supports</td><td>Targeted Supports</td></tr>
</table>

- Use multiple modes of media to introduce students to concepts (audio, video, text, photographs)
- Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary
- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Create a whole class anchor chart that shows the model of a relationship between the different needs of plants and animals and where they live. In using this example, students will have a visual that they can use when creating their own model.
- Provide real animal and plant photos for the students to pick from when creating their model.
- Explain the vocabulary words: model and relationship.

- Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information
- Peer tutoring (teacher-selected partners) to support students in learning
- Provide opportunities for reflection and revision of their work when possible
- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest
- When designing a model, have students work with a partner and/or teacher to develop steps to create their model
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- If students are struggling to create their own model, students can either work in pairs or with the teacher in a small group.
- Instead of picking their own relationship, the teacher can provide options for students to choose from.

Common Misconceptions

- Students may not have a working knowledge of what natural resources are, because so many products used by humans no longer resemble the resources from which they came.Natural resources are commonly used to make new materials. For example, trees are a natural resource that are used to make paper.
- Students may believe that Earth's resources are unlimited and always replenished.Examples of resources that cannot be replaced include oil, natural gas, and coal. Once these are used, there is no way to replace them. Humans must protect our resources by conserving them.
- Students may view rocks and minerals as unimportant when, in actuality, almost every product used in daily life contains or depends upon minerals that have to be mined.Examples of everyday objects that are made from minerals include pencils, toilets, dental floss, watches, computers, vacuums, matches, and batteries.
- Difference between plant and human needs
- How does our environment influence wants vs needs
- Models are representations:It is not just artwork, but an actual representation.

- Plants/animals/humans do not need each other for survival. Not only do plants/animals/humans change the environment, but the environment changes them.
- Artificial habitats (zoo) may confuse students about animals/plants' natural habitats.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why do plants and animals live where they do?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?

Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

Validate and Affirm prior knowledge and experience: What plants do you know? Where do they live? What do they need to survive?

What animals do you know? Where do they live? What do they need to survive?

Where do you live? What do you need to survive?

What plants and animals are most important to your survival?

Build and Bridge: Use students' background knowledge and experiences to connect to other plants, animals, and human relationships that they may not be familiar with.

Students who demonstrate understanding can:

K-ESS3-2. **Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.*** [Clarification Statement: Emphasis is on local forms of severe weather.]

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

Asking Questions and Defining Problems
Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.
- Ask questions based on observations to find more information about the designed world.

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.
- Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world.

Disciplinary Core Ideas

ESS3.B: Natural Hazards
- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.

ETS1.A: Defining and Delimiting an Engineering Problem
- Asking questions, making observations, and gathering information are helpful in thinking about problems. *(secondary)*

Crosscutting Concepts

Cause and Effect
- Events have causes that generate observable patterns.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
- People encounter questions about the natural world every day.

Influence of Engineering, Technology, and Science on Society and the Natural World
- People depend on various technologies in their lives; human life would be very different without technology.

Connections to other DCIs in kindergarten:
K.ETS1.A

Articulation of DCIs across grade-levels:
2.ESS1.C ; **3.ESS3.B** ; **4.ESS3.B**

Common Core State Standards Connections:
ELA/Literacy -
RI.K.1 With prompting and support, ask and answer questions about key details in a text. (K-ESS3-2)
SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-ESS3-2)
Mathematics -
MP.4 Model with mathematics. *(K-ESS3-2)*
K.CC Counting and Cardinality *(K-ESS3-2)*

Grade	*NGSS Discipline*
K	**Earth and Space Science 3.2**
K.ESS3-2	**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. ● Flash floods may occur in an arroyo following a thunderstorm. (This can be various examples depending on location: blizzard or tornado)
	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 video - Statewide Tornado Drill in North Carolina ● After watching the video students will answer the following two questions invididually. 1. What are some types of severe weather? 2. How can warning systems help reduce the effect of severe weather on humans?

- Students will then participate in a discussion in which they are creating their own questions. They will use these questions to guide their thinking. This will be a peer discussion and the teacher will be assessing.

Universal Supports	Targeted Supports
• Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) • Use multiple methods of CFU's to ensure students are grasping content (ex: turn and talks, partner work, group work, show call) • Explicit introduction and modeling of Tier 2 vocabulary • Use picture cues and sentence stems to support students in acquiring new vocabulary • Provide opportunities for students to explain their thinking • As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment • Allow students who are not able to write academically to draw their answers and explain verbally • Provide students with actual photos of dangerous weather.. • Explain the vocabulary words: severe, dangerous, forecasting.	• Peer tutoring (teacher-selected partners) to support students in learning • Provide opportunities for reflection and revision of their work when possible • Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest • For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations. • For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions. • If students struggle to write or draw their questions, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher. • In a small group, discuss the different dangerous weather situations. Provide them with a specific dangerous weather and have them draw a picture of how to prepare for it. • Provide sentence stems to help students state their questions.

Common Misconceptions

- Depending on the students' geographical location, they may not have had experience with severe weather conditions such as droughts, hurricanes, tornados, flooding, blizzards, and avalanches.Not all weather hazards are experienced in every geographical location. You can show students videos showing examples of types of weather hazards that are not frequent in their areas.
- Some students may believe that severe weather only causes local effects, and they may not see the bigger picture of how it impacts other communities or locations.An example could be when an area has a major flood. Major businesses might have to shut down for a period of time, and this could affect sales and production of goods that are shipped to other geographical areas.
- Students might think a tsunami is a weather event.Tsunamis are not weather events. They can be caused by earthquakes, landslides, or meteorite impacts. None of these are considered hazardous weather. Tsunamis are better grouped with geological natural disasters, though some people confuse them as a weather event because the damage done by a tsunami may resemble the damage that results from hurricanes, tornados, or other natural weather events.
- Illogical fear of natural disasters- probability of them occurring is low.
- Weather forecasting is not always correct.
- Difference between a question and statement.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is it important to forecast severe weather?

Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?
Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

Validate and affirm: What is the worst kind of weather that you have experienced?
What's your favorite type of weather? What's your least favorite? What's the scariest?
How does your family prepare for different types of weather?
How do you know what the weather is going to be? Do you watch the news with your family?
Build and bridge: Expand on student's knowledge on weather by presenting new information and connecting it to their prior knowledge and experiences.

Students who demonstrate understanding can:

K-ESS3-3. **Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.*** [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. • Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.	**ESS3.C: Human Impacts on Earth Systems** • Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. **ETS1.B: Developing Possible Solutions** • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary)*	**Cause and Effect** • Events have causes that generate observable patterns.

Connections to other DCIs in kindergarten:
K.ETS1.A

Articulation of DCIs across grade-levels:
2.ETS1.B ; **4.ESS3.A** ; **5.ESS3.C**

Common Core State Standards Connections:
ELA/Literacy -
W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. *(K-ESS3-3)*

Grade	*NGSS Discipline*	
K	**Earth and Space Science 3.3**	
K.ESS3-3	**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 humans waste too much paper, water and plastic it harms the Earth. https://www.youtube.com/watch?v=cVZxg5cSgqQ Description of video: It is a time lapse video on Google Earth that shows the negative impacts that humans have made. It allows students to analyze their impact on the 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. ● Students will draw a human impact (cause), effect on the environment, and a solution to the problem.	
	Universal Supports	**Targeted Supports**
	● Use multiple modes of media to introduce students to concepts (audio, video, text, photographs) ● Use multiple methods of CFU's to ensure	● Provide structured graphic organizers and notecatchers to support students in retaining and organizing new information

- students are grasping content (ex: turn and talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary
- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Provide students with picture cards of different scenarios/waste.
- Differentiate between a positive and negative impact that humans have on the Earth.

- Peer tutoring (teacher-selected partners) to support students in learning
- Provide opportunities for reflection and revision of their work when possible
- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- In a small group, use the individual picture cards to talk about solutions. Create an anchor chart with the problem and the solution. Use the anchor chart to form a discussion.
- Use sentence stems to help students communicate effectively. Provide a list of examples that students can pick from.

Common Misconceptions

- Humans do not have an impact on the environment.
- Trash disappears- garbage man comes and it is gone.
- Paper comes from trees.
- There is a limited supply of items (metal, gas, water) and one day they will run out.
- Students may not have a great concept of time- we have created solutions already. Such as recycling, this is relatively new.

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Start with the why, asking: Why is it important to take care of the Earth?
Validate and Affirm: Students come from different households where they may have experienced exploration in different ways. Ask: How do scientists work? How do you learn about the world around you? How do you like to explore - by touching, by listening, by seeing, by talking?
Build and Bridge: Use students' responses to create science investigation norms, as well as structure lessons and investigations in order to capitalize on students' preferred ways to explore.

Validate and affirm your students' background knowledge and experiences: What are some ways that you and your family take care of your home? What are some ways that you take care of your school? What are some ways that you and your family take care of the world around you?

	What's a problem that you have? How can you fix it? Do you think that people are hurting or helping the world? Build and bridge: Build from a personal connection to a broader perspective.

Students who demonstrate understanding can:

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

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

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

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

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

Articulation of DCIs across grade-levels:

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

Common Core State Standards Connections:

ELA/Literacy —

RI.2.1 Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text. (K-2-ETS1-1)

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1)*

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1)

Mathematics —

MP.2 Reason abstractly and quantitatively. *(K-2-ETS1-1)*

MP.4 Model with mathematics. *(K-2-ETS1-1)*

MP.5 Use appropriate tools strategically. *(K-2-ETS1-1)*

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1)

Grade	*NGSS Discipline*	
K	**Engineering Design 1.1**	
K-2 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. ● Sometimes humans use cotton swabs to hand pollinate plants.	
	Classroom Assessment Items	
	When available, you should use your locally selected or created high quality instructional materials. However, the following are example assessment items you can use if you don't have local instructional materials available. Make an observation about a person using a paint brush to pollinate. Why is someone using a paintbrush? What is on the paintbrush? What do you predict will happen? What could have happened before?	
	Universal Supports	**Targeted Supports**

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

Common Misconceptions

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

Specific to Example Phenomenon & Assessment:

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

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

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

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

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

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

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

Students who demonstrate understanding can:

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

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

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

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

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

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

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

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

deeper in learning, for those students with high interest

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

Common Misconceptions

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

Specific to Example Phenomenon & Assessment:

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

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

Student Questions:

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

Teacher Questions:

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

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

Students who demonstrate understanding can:

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

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

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

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

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

Common Core State Standards Connections:
ELA/Literacy —

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

Mathematics —

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

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

talks, partner work, group work, show call)
- Explicit introduction and modeling of Tier 2 vocabulary
- Use picture cues and sentence stems to support students in acquiring new vocabulary
- Provide opportunities for students to explain their thinking
- As much as possible, provide hands-on materials when introducing new concepts/topics and give students time to explore and experiment
- Use real objects and photos as much as possible to give students common understandings
- Allow students who are not able to write academically to draw their answers and explain verbally
- Create a graph on data collected to show effectiveness of various tools. Rank the outcomes of the various tools.

- Provide opportunities for reflection and revision of their work when possible
- Provide extension opportunities for students or additional readings to go deeper in learning, for those students with high interest
- For students who struggle with fine motor skills, provide larger objects to manipulate during their investigations.
- For students who struggle with following directions or following the steps of an investigation, partner them with a teacher's aide or keep them close to the teacher - giving single step directions.
- If students struggle to write or draw their observations, provide alternate ways to answer, such as using an ipad or chromebook to record their answer, or dictate to a teacher.
- Explicit instruction in utilizing various data points such as graphs and charts. Discuss to analyze and interpret the data to ensure that information is usable.

Common Misconceptions

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

Specific to Example Phenomenon & Assessment:

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

Culturally and Linguistically Responsive Instruction

Guiding Questions and Connections

Validate & Affirm:

Student Questions:

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

Teacher Questions:

Do I see the necessary connection between tier II words and validation and affirmation?

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

Section 3: Resources

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

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

Engaging in the Practices of Science

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Crosscutting concepts

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

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

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

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

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

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

Planning Guidance for Culturally and Linguistically Responsive Instruction

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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