## Kindergarten Instructional Segment 3: Weather Patterns

Weather is something that every child experiences and can observe. Students are naturally motivated to ask, "Is it too rainy to play outside today?" or "Do I need my hat today?" With this relevance in mind, students can record the weather each day and begin to see **patterns [CCC-1]** over time.

### KINDERGARTEN INSTRUCTIONAL SEGMENT 3: WEATHER PATTERNS

**Guiding Questions**

- What is the weather like today and how it is different from yesterday?
- Can I predict tomorrow's weather?
- What happens when the Sun shines on different objects?
- How can I protect myself from the sunlight?
- How do we prepare for severe weather?

**Performance Expectations**

Students who demonstrate understanding can do the following:

**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.*]

**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.]

**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.*]

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

**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.

**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.

**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 expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

## KINDERGARTEN INSTRUCTIONAL SEGMENT 3: WEATHER PATTERNS

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

| Highlighted Science and Engineering Practices | Highlighted Disciplinary Core Ideas | Highlighted Crosscutting Concepts |
|---|---|---|
| [SEP-1] Asking Questions and Defining Problems<br>[SEP-2] Developing and Using Models<br>[SEP-3] Planning and Carrying Out Investigations<br>[SEP-4] Analyzing and Interpreting Data<br>[SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)<br>[SEP-8] Obtaining, Evaluating, and Communicating Information | PS3.B: Conservation of Energy and Energy Transfer<br>ESS2.D: Weather and Climate<br>ESS3.B: Natural Hazards<br>ETS1.A: Defining and Delimiting Engineering Problems<br>ETS1.B: Developing Possible Solutions<br>ETS1.C: Optimizing the Design Solution | [CCC-1] Patterns<br>[CCC-2] Cause and Effect: Mechanism and Explanation<br>[CCC-6] Structure and Function |

**Highlighted California Environmental Principles and Concepts:**

**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

**Principle III** Natural systems proceed through cycles that humans depend upon, benefit from and can alter.

**Principle IV** The exchange of matter between natural systems and human societies affects the long-term functioning of both.

**CA CCSS Math Connections:** K.CC.5–6; K.MD.2-3, 10; K.G.1

**CA CCSS for ELA/Literacy Connections:** L.K.5c, 5d, 6; W.K.2, 3, 8; SL.K.1, 4, 5, 6

**CA ELD Standards Connections:** PI.K.A.1, PI.K.A3, PI.K.C.9

In the CA NGSS, DCIs are revisited many times at an increasing level of complexity. By the end of high school, students will have developed a model of Earth's energy balance and how it relates to the flow of water and air that drives atmospheric and ocean circulation. But at the beginning of the journey, students are solely expected to notice. They notice that weather varies from day to day and wonder about what causes it. They also recognize that these variations are not random; the consistent rhythms of the day and the seasons show **patterns [CCC-1]** that students can explicitly identify.

Because weather varies, patterns are sometimes hard to recognize in small data sets. Students are much more likely to be able to recognize patterns when they collect data consistently over a long period of time. Teachers must select a weather variable that is locally relevant and have students record observations about it. The data recorded each day should probably be qualitative, such as keeping track of the clothing that is most appropriate for recess each day (e.g., short sleeves, long sleeves, a warm coat, or a rain jacket) or choosing the appropriate weather icon after lunch (e.g., sunny, partly cloudy, foggy, windy, rainy, etc.). Students could also keep track of the number of days that meet a certain locally relevant criteria such as number of foggy mornings (for coastal communities), rainy days (for Northern California), or afternoons above 95°F (for desert communities). These observations need to begin long before the actual instructional segment on weather so that students have accumulated enough data to recognize and describe patterns (K-ESS2-1). Animals have grown to depend on these patterns to survive, so teachers can draw connections to life science concepts from earlier in the course. Humans, too, have built cities depending on these patterns and face challenges when these regular cycles are interrupted (EP&C III).

## Opportunities for Mathematics Connections

Students can **count [SEP-5]** and **compare [SEP-4]** (CA CCSSM K.CC.5, K.MD.3) the number of days meeting the criteria within a certain month to recognize seasonal patterns. The California Common Core State Standards for mathematics (CA CCSSM) do not require students to be able to represent data using picture or bar graphs until grade two (CA CCSSM 2.MD.10), but students in kindergarten should be able to look at a picture graph and decide which categories have the most days and the least days that meet the criteria (CA CCSSM K.CC.6).

**CA CCSSM:** K.CC.5–6

Students can record the temperature at the same time of day, several times a day for a week to spot another important weather **pattern [CCC-1]**. On most days, the temperature at the end of the school day is warmer than the temperature at the beginning of the school day. Students should be able to describe this pattern (K-ESS2-1) and **ask questions [SEP-1]** about what causes it. Students can claim based on past experience that the Sun **causes [CCC-2]** this daily warming, and in kindergarten they now **collect observations [SEP-4]** that support that **argument [SEP-7]** (K-PS3-1). They also undergo a design challenge to reduce the effect of sunlight (K-PS3-2).

## KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

**Performance Expectations**

Students who demonstrate understanding can do the following:

**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.*]

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

**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.

**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.

**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 expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

| Highlighted Science and Engineering Practices | Highlighted Disciplinary Core Ideas | Highlighted Crosscutting Concepts |
|---|---|---|
| [SEP-2] Developing and Using Models<br>[SEP-3] Planning and Carrying Out Investigations<br>[SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering) | PS3.B: Conservation of Energy and Energy Transfer<br>ETS1.A: Defining and Delimiting Engineering Problems<br>ETS1.B: Developing Possible Solutions<br>ETS1.C: Optimizing the Design Solution | [CCC-2] Cause and Effect: Mechanism and Explanation<br>[CCC-6] Structure and Function |

**Highlighted California Environmental Principles and Concepts:**

**Principle I** The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

**CA CCSS Math Connections:** K.MD.2, K.G.1

**CA CCSS for ELA/Literacy Connections:** W.K.2, W.K.8, SL.K.1, SL.K.5, SL.K.6

**CA ELD Standards Connections:** ELD.PI.K.A.1, PI.K.A.3, PI.K.C.9

## KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

### Introduction

What effects does the Sun have on us? How can we minimize the negative effects? Energy from the Sun is at the heart of all components of the Earth system and is revisited throughout the entire K–12 sequence. This kindergarten activity merges scientific understanding of cause and effect with an engineering design challenge. Students design and build a shelter to protect rabbits made out of ultraviolet (UV) sensitive beads.

**Day 1: Observe Sun and Shade**

Students go outdoors to observe which areas of the schoolyard are in sun and in shade, and how sunny and shady areas change throughout the day. They record their observations at each time of day.

**Day 2: Reading in the Sun**

Students plan a trip out to the schoolyard to read a book about how different animals stay cool. When they return, they draw and write about how they stay protected from the Sun.

**Day 3: Defining the Problem**

Students read about the ways that jackrabbits stay cool and then explore with a rabbit made out of UV-sensitive beads. They learn about the design challenge to protect their rabbit from the Sun.

**Day 4: Imagine**

Students investigate the possible materials for their shelter. They test the performance of ten basic shelters.

**Day 5: Plan**

Students choose materials and draw a diagram with their shelter plan.

**Day 6–8: Create, Improve, Communicate**

Students build their shelters, test them in the Sun, make improvements, and share their results.

### Day 1: Observe Sun and Shade

**Anchoring phenomenon:** Some areas of the schoolyard are sunny and some are shady at different times throughout the day.

Mrs. K chose a particularly sunny day to begin this sequence and told students that the next day they were going to read a book outside in the schoolyard. Before that, they needed to gather information so that they could decide the best place to sit and read. To make an informed decision, students went outside to observe which parts of the schoolyard were in the sun and which were in the shade at different times of day. They visited four different locations three times during the day and recorded on a simple chart whether each spot was sunny or shady on each

## KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

visit. They discovered that some places were sunny in the morning and shady in the afternoon, other places just the opposite. Were there places that were always sunny or always shady?

Before their third visit outside, Mrs. K taught students how to read thermometers. Inside the classroom, all the thermometers read about the same temperature. Mrs. K asked the students if they thought the thermometer would read a higher number or a lower number when they were outside (a bit more advanced than CA CCSSM K.CC.7; 1.NBT.3). Would the temperature in the Sun be different than the temperature in the shade? Why did they think that? Students then went outside and made note of whether each spot was sunny or shady and then recorded the temperature at each spot. They **analyzed their data [SEP-4]** by comparing the different measurements and completed the sentence frame, Where it is sunny, the temperature is _____. Mrs. K wanted to know what does the Sun give off? What do we receive from the Sun? What does it mean when we say a spot is sunny or shady? How are sunny places different from shady places? It took a while for Mrs. K to find the questions that inspired students to discuss their wide-ranging ideas about the Sun. After a few minutes, their discussion focused on the light that comes from the Sun. Mrs. K introduced the idea of **cause and effect relationships [CCC-2],** providing a few examples from everyday life. She then asked students to write down as many cause and effect relationships about the Sun (_____ causes _____) that they observed in the activity.

### Day 2: Reading Outdoors

On the day for reading outside, Mrs. K told students that she wanted them to be comfortable and able to enjoy the book, so where should they sit? She asked pairs of students to discuss proposals, including a reason why their spot would be the most comfortable place to be. She reminded students to use their observations from yesterday to help them decide. The class eventually reached consensus on a location beneath a tree and they went there to read *Beneath the Sun* by Melissa Stewart (2014). The book shows different ways that animals and people try to stay cool. Mrs. K related what they were reading to the student's own situation, asking if any of them thought it was too bright or too shady, or if they were too warm or cold. She asked them about how trees on the schoolyard could keep them cool (EP&C I). Students returned to the classroom to finish the sentence, I stay protected from the Sun by _____. (CA CCSS for ELA/Literacy: W.K.8)

### Day 3: Defining the Problem

**Everyday phenomenon:** Rabbits spend time in the shade on hot sunny days

In the neighborhood around the school, students sometimes saw rabbits hopping around with their little white tails and big ears. Mrs. K read a text that described a day in the life of a California native, the black-tailed jackrabbit (*Lepus californicus*). It spends most of the hot sunny daytime resting in the shade of bushes. Even in the shade, the rabbit still has its very long ears that help it stay cool.

Mrs. K asked the children to imagine that the class was going to get a jackrabbit for a pet

## KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

and they wanted it to have a place to live outside. There were not any bushes outside the classroom, so students would have to design a shelter to keep their rabbit cool during the hot sunny days. Some light colored rabbits in captivity get sunburned if they sit in the direct sun for too long. While the class would not be getting a real rabbit, she gave each child a tiny rabbit made out of white beads (figure 3.1). She had the students cup them in their hands to protect them as they took them outside for the first time. She had them uncover their rabbits all at once, and the white beads immediately turned vibrant colors. She gave the students time to explore the effects of the Sun on their rabbits, placing them in their shadows, in the shade of a tree, or under their clothing.

**Investigative problem:** How do we keep a pet rabbit out of the Sun?

She then described the challenge: they would design and build a shelter for their rabbit (K-PS3-2). She invited students to ask questions about the project (K–2-ETS1-1). They decided on a few rules (**defining the problem [SEP-1]**), including that the house must have a front entrance, must protect the rabbit from the Sun, and must be built using the materials that Mrs. K provides.

**Figure 3.1. Rabbit Made from UV-Sensitive Beads**

*Source:* Margo's Beadie Critter Collection n.d.

### Day 4: Imagine

**Investigative phenomenon:** Different materials block sunlight better than others.

Mrs. K wanted students to explore the different materials so that they could plan which ones to use for their shelter. She built ten basic shelters using different roof materials (black and white construction paper, wax paper, cardboard, aluminum foil, felt, and clear plastic sheets with and without three different strengths of sunscreen spread over the top). She asked students which roof materials they thought would protect their rabbits the most and least. Several students thought that the cardboard, felt, or foil would work best. Others thought that the clear plastic, regardless of sunscreens, would work the least. When they tested the shelters outside, they also noticed how well, or not, the shelters protected their rabbits. Some rabbits stayed mostly white, while others became multicolored. Mrs. K encouraged students to **explore [SEP-3]** the effects of different roof materials by switching shelters with each other. She had her students discuss how well each material worked

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(**analyzing and interpreting data [SEP-4]**, CA CCSS for ELA/Literacy SL.K.1). The consensus was that the cardboard worked the best because it was thick and prevented sunlight from getting through. The plastic sheet with no sunscreen worked the least because it provided no protection at all. To the students' surprise, the plastic sheet with sun-protection factor (SPF) 50 sunscreen worked very well to keep the rabbits mostly white. One student exclaimed, "Wow, this is why it's so important to wear sunscreen outside!"

**Day 5: Plan**

Students brainstormed possible shelter designs. They **debated [SEP-7]** the pros and cons of each roof material and explained their reasoning. They then drew their individual design idea and labeled the parts (K–2-ETS1-2, CA CCSS for ELA/Literacy W.K.2, SL.K.5). Mrs. K asked students to describe some of the shapes that were present in their structure (CA CCSSM K.G.1). Each pair shared their designs with another pair of students. They described the parts of each design that they thought would work the best, and the parts that they thought might not work as well, or might cause problems. Each pair decided on the design they wanted to build the next day.

**Days 6–8: Create, Improve, Communicate**

Finally, the day came to build their rabbit shelters. They could not wait to get started! They built shelters with roofs, walls, and windows so that the rabbit could look out for predators and doors so that the rabbit could quickly escape if it needed to. Some houses even had a soft clump of grass that mimicked the spot where a rabbit in the wild would rest. They shared ideas freely and gave suggestions to each other along the way. During this process, they struggled with making structures that supported the roof while still having room for their rabbit to fit inside and move around (**structure and function [CCC-6]**). They tested their shelters outside in the sunshine and students compared their designs to others (K–2-ETS1-3). Most students made a series of **improvements [SEP-6]**. For example, several students had houses with windows. But when they noticed that the Sun shone through and turned their rabbit multicolored, they decided to add SPF 50 sunscreen to the windows. One student noticed a gap between his roof and walls that allowed the Sun to get in, so he taped the edges together. Another student added a second layer to the roof to make it thicker and block more of the Sun's rays. Mrs. K took lots of pictures to document students' progress through the steps of the engineering design process (figure 3.2). Once they had completed the work, students presented their houses to the class and **communicated [SEP-8]** (CA CCSS for ELA/Literacy SL.K.6) what special features kept their rabbits protected from the Sun's heat and harmful rays.

**Figure 3.2. Students Testing Their Shade Structures**

*Source:* Kitagawa 2016

## KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

### Vignette Debrief

The engineering design challenge in this vignette frames a three-dimensional learning process.

**SEPs**. Students perform the engineering design process from beginning to end. The exploration outdoors on day 1 and the background reading and discussion of prior experience on days 2–3 ensures that students understand the context of the **problem [SEP-1]**. They **obtain information [SEP-8]** from a variety of texts, including fiction and informative texts (see the Resources section for additional story suggestions). While they never plan an investigation, they engage in several of the components of **conducting investigations [SEP-3]** appropriate for K–2: they collaboratively collect data on day 1 and then compare their qualitative observations with measurements from a thermometer. They make a prediction about where it will be shady enough to read their book. On day 4, they compare different materials. In days 3 and 5–8, students work on **designing solutions [SEP-6]**.

The emphasis of the last two days is on the iterative improvement process. To provide students quick and easy-to-interpret feedback, the UV-sensitive beads allow students to literally see the effectiveness of their shelter. In middle and high school, they will return to solar houses and solar cookers and will collect detailed temperature data, but a quantitative focus is not age-appropriate for kindergarten.

**DCIs**. This activity lays the groundwork for more detailed understanding of the DCIs about energy transfer, electromagnetic radiation, heat flow, forces, and the properties of materials in later grades. Despite the fact that the primary DCI for this vignette (PS3.B) is called Conservation of Energy and Energy Transfer, the word *energy* never appears because the abstract concept of energy is not age appropriate. At this age, students just need to master the idea that sunlight warms Earth's surface.

**CCCs**. On days 4–5, the map itself was a form of **analysis [SEP-4]** as students noticed **patterns [CCC-1]** and created categories while they were still in the field. Once students describe the pattern, they then interpreted their observations in terms of **cause and effect [CCC-2]** (day 6).

**EP&Cs**. On day 1, students focus on how they depend on the natural environment for shade and comfort (EP&C I). They then extend that idea to other living things as they focus on how rabbits need a certain physical environment to survive and thrive. The rabbit's body and behavior are well suited to this physical environment. In the engineering challenge, students actually modify the physical environment on a small scale. The vignette never explicitly introduces this idea, but teachers could emphasize it to introduce EP&C II.

**CCSS Connections to English Language Arts and Mathematics**. Throughout the activity, students engage in discourse about their observations and solutions. They supplement their direct observations with information from written texts. Mathematically, students work with shapes and comparisons.

*Text and images for this vignette come from Kitagawa (2016), which includes more detailed directions and a list of materials. The original lesson uses a lizard instead of a jackrabbit.*

### KINDERGARTEN VIGNETTE 3.1: MADE FOR THE SHADE

**Resources:**

Butterfield, Moira. 1999. *In Hot Places*. London: Belitha Press Ltd.

Kitagawa, Laura. 2016. "Made for the Shade." *Science and Children* 53 (5): 34–40.

Margo's Beadie Critter Collection. n.d. Bunny 2. http://www.cde.ca.gov/ci/sc/cf/ch3.asp#link5

Stewart, Melissa. 2014. *Beneath the Sun*. Atlanta: Peachtree Publishers.

Students are full of questions about extreme weather and the CA NGSS places emphasis on local forms of severe weather. Students might **wonder [SEP-1]**, Do we have hurricanes in California? How many days in a row has it rained in our city? or When was the last flood on our local stream, and did it cause any damage? Students can use local library books or age-appropriate media to **obtain information [SEP-8]** about one such weather hazard. They can then pretend to be a weather forecaster **communicating [SEP-8]** a warning about an upcoming weather hazard (ELD K.PI.C.9). They can inform their classmates about how to prepare for the event (K-ESS3-2). Given the complexity of K-ESS3-2, this task may benefit from parent involvement during a home project.

## Opportunities for ELA/ELD Connections

As part of the introduction to the weather unit to support students building their knowledge of weather terms, the tools used to collect the data, and weather patterns, students can take turns acting as the meteorologist to lead the class in a discussion, with appropriate language support, about weather conditions for that day. In addition to the individual weather journals, a class data collection poster can be used to clarify the recorded weather, adding visual pictures or symbols.

**CA CCSS for ELA/Literacy:** SL.K.4, 5, 6; W.K.3, 8; L.K.5c, 5d, 6

**CA ELD Standards:** ELD.PI.K.9, 11

### Sample Integration of Science and ELD Standards in the Classroom

Students have been collecting local weather data on a daily calendar. They work as a whole group near a large chart that shows labeled images of various types of severe weather (different from those on the daily calendar) and view a video of severe weather (such as heavy rain and wind, blizzard, or heavy snowstorm). Students explore the phenomena, asking questions about the purpose of weather forecasting and how to respond to severe weather in their locality (K-ESS3-2). For example, students may ask, "What if the forecast were this type of weather for our community? What would be the problems for our community if we had this type of weather? What things could we do to prepare for this type of weather? How can forecasting the weather help us prepare and be ready for severe weather?" The teacher supports English learners at the Emerging and Expanding levels of English language proficiency in asking and answering these questions by providing sentence frames (e.g., If ____, then we could ___. We should ___ if ___). The teacher encourages students to refer to the labeled images of weather when they ask and answer questions. When necessary, the teacher asks probing questions and recasts students' responses, affirming their ideas and helping them use vocabulary and structure their statements in ways appropriate for a science discussion.
**CA ELD Standards**: ELD.PI.K.1
*Source*: Lagunoff et al. 2015, 206–207)

## IS4 Kindergarten Instructional Segment 4: Pushes and Pulls

Even very young children have an intuitive sense—a mental model—of the way objects move. They express surprise if they see a ball change its direction of motion or suddenly speed up or slow down with no visible reason for the change. They know how to push or pull toys to get them moving, and they are overjoyed by their own body's ability to move large objects. IS4 builds on this intuitive sense of how the world works and develops a language of words and diagrams for talking and thinking about these experiences. The segment includes three activity sequences in which students progressively refine a model of motion:

- We can change the motion of objects (marble track).
- Pushes and pulls cause objects to speed up, slow down, or change direction (kickball and tug of war).
- Pushes and pulls can have different strengths and directions. The bigger the push or pull, the faster the motion (school-yard box challenge).