Kindergarten

Children in kindergarten are given the opportunity to explore the world around them and learn how to ask questions about phenomena they are able to see, observe, and describe. What happens when two toy trucks crash? How do animals live in the desert? Will it be hot tomorrow? The questions the kindergarten students ask are natural entry points for science instruction and learning. Teachers pose additional questions to motivate and engage students as they learn about forces and interactions; what animals and plants need to survive, how animals and plants change and adapt to their environments, patterns in weather over time, and how sunlight affects the Earth.

In kindergarten as in transitional kindergarten, the goal of science learning for children is as much to develop foundational skills of language, analysis and reasoning, and representation or symbolization of ideas as it is to learn any particular facts. Students need activities that direct their attention to particular aspects of natural phenomena as well as support to use these situations to develop and refine their language and ideas about the world. Teachers will need to use language that students understand as they also build students' capacity to use the language of science and its many technical terms.

For many reasons, it is important for science instruction to develop kindergarten students' ability to observe phenomena carefully and with precision using relevant senses (using mainly sight, hearing, and touch; smell only when appropriate.) The ability to carefully observe phenomena is particularly useful as students learn to describe their observations in a scientific way, without distorting those observations by preconceptions and/or personal opinions, to support their claims and arguments. Through careful observation, students develop their ability to recognize patterns in their observations and recorded data. In addition, the ability to observe and report the visible components of a system or the parts of an investigation becomes important as students develop representational models or diagrams to describe the system or the investigation.

Table 1 summarizes the PEs included in each instructional segment and the crosscutting concepts that students may use as a tool to make sense of the disciplinary core ideas. These instructional segments are designed to be taught in this suggested sequence over the span of a school year, not taught individually. Where appropriate, PEs that integrate science ideas with engineering design are accompanied by one of the three PEs in K–2 engineering design. The engineering design PE (ETS1) has been chosen to best match the suggested integration. The PEs that suggest an explicit integration with engineering are indicated with an asterisk (*).

Table 1: Instructional Segments in Kindergarten.

	Highlighted SEP	Highlighted CCC	PEs addressed	DCI addressed
Instructional Segment 1: Forces and interactions: pushes and pulls	• Planning and carrying out investigations • Analyzing and interpreting data • Defining problems • Designing solutions	• Stability and Change • Cause and Effect	K-PS2-1 K-PS2-2* K-2-ETS1-1	PS2.A: forces and motion PS2.B: types of interactions PS3.C: relationship between energy and forces ETS1.A: defining and delimiting engineering problems
	Brief Summary			
	Pushing or pulling on an object can change its speed or direction of motion. An object in motion can be stopped or a non-moving object can start moving using pushes or pulls.			
Instructional Segment 2: Needs of animals and plants and their environment	**Highlighted SEP**	**Highlighted CCC**	**PEs addressed**	**DCI addressed**
	• Analyzing and interpreting data	• Systems • Patterns	K-LS1-1 K-ESS3-1	LS1.C: organization of matter and energy flow in organisms ESS3.A: natural resources
	Brief Summary			
	Animals and plants have needs to live and grow. These needs can be met in the environment where they live.			
Instructional Segment 3: Animals and plants can change their environment	**Highlighted SEP**	**Highlighted CCC**	**PEs addressed**	**DCI addressed**
	• Engaging in argument from evidence • Analyzing and interpreting data	• Stability and Change • Systems	K-ESS2.2 K-ESS3-3* K-2-ETS1-1	ESS2.E: Biogeology ESS3.C: Human impacts and Earth systems ETS1.A: defining and delimiting engineering problems
	Brief Summary			
	Plants and animals can change their environment to meet their needs. Humans also change their environment.			

Instructional Segment 4: Weather and climate	Highlighted SEP	Highlighted CCC	PEs addressed	DCI addressed
	• Analyzing and interpreting data • Defining problems • Designing solutions	• Patterns • Stability and Change	K-ESS2-1 K-PS3-1 K-PS3-2* K-2-ETS1-2 K-ESS3-2* K-2-ETS1-1	PS3.B: conservation of energy and energy transfer ESS2.D: weather and climate ESS3.B: natural hazards ETS1.A: defining and delimiting engineering problems ETS1.B: developing possible solutions
	Brief Summary			
	Weather can be described and patterns of weather can be recorded over time.			

Note that the order in which the instructional segments are taught in kindergarten is somewhat flexible, instructional segments 2 and 3 could be developed before instructional segment 1, but all three should be grouped together and could even be combined into a longer single instructional segment. The instructional segment on weather, instructional segment 4, requires some pre-planning and collection of weather observations over time, prior to the instructional segment. Because of this, and also because weather in California during the beginning months of the school year is generally rather uniform, this instructional segment is better placed later in the year. The collection of weather data can also be made relevant to questions in the context of instructional segments 2 and 3—in which students learn all living things need water and how living things may change their environment as they access or use the water in it. Students can then connect that need for water to their weather observations about where and when rain occurs.

Kindergarten-Instructional Segment 1: Forces and Interactions: Pushes and Pulls

Even very young children have an intuitive sense, or a mental model, that the motion of non-living objects is different from that of living ones. 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. Students entering kindergarten already have some knowledge regarding motion from playing with toys and applying a push or pull to get the toy moving. The purposes of instructional segment 1 are to capture and build on this

intuitive sense of how the world works and to develop a language of words and diagrams for talking and thinking about these experiences. Students will develop understanding that different strengths of pushes on a toy car will result in different motions of the toy car in a way that can be predicted by the strength of the push.

Kindergarten-Instructional Segment 1: Forces and Interactions: Pushes and Pulls
What happens when you push or pull on an object? *How can you make an object move faster or in a different direction?*
Highlighted Crosscutting Concepts: Stability and Change, Cause and Effect
Highlighted Science and Engineering Practices: • *Planning and carrying out investigations* • *Analyzing and interpreting data* • *Defining problems* • *Designing solutions*
CA NGSS Performance Expectations: 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.] 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.] 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 expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.*

Background for Teachers

In this instructional segment, kindergarten students experience their first formal process of science education as teachers begin to lay the groundwork for students to develop both interest in and capacity for studying science. Students' natural curiosity and questions about experiences occurring in the classroom and outside are the initial basis for this interest and must be used, developed, and refined. Science ideas and questions are introduced through situations and activities that direct student attention and interest to the ideas to be learned. Classroom norms for respectful participation should be emphasized at the very beginning of the school year to create a safe space for every student to contribute to the classroom learning experience.

This instructional segment should begin with investigations and descriptions of a variety of ways things move. These investigations are linked to the crosscutting concepts of ***stability and change*** and ***cause and effect***, which overlap significantly. The role of the teacher is to introduce situations and the language and ideas needed to discuss them and lead students to observe and think about how pushes or pulls can make a moving object speed up, slow down (change of speed), or change direction. The first focus is developing the idea that a push or a pull can make something do one of these three things (speed up, slow down, or change direction). The goal is then to lead students from that idea to the more general concept of a force. The language of push or pull suggests an actor (perhaps a person or an animal) that is providing the push or pull. When the ball bounces on the floor or collides with something and moves in a new direction, students will not likely see that this is similar to a push or pull they apply to the same ball. That is, they do not recognize that a wall or the floor is also pushing or pulling. To draw students' attention to this phenomena, the teacher asks students, "What made it change direction? What pushed it up (for the bouncing ball)?"

Using the language of cause and effect, the teacher allows students to recognize what they observe as the effect and then to ask questions to investigate the cause of the motion.

Description of Instructional Segment

At the beginning of the school year, the teacher frames the classroom culture and introduces norms for behavior, including collaboration, that students will follow throughout the year. Students need to experience talking about science ideas as a whole class and carrying out activities and discussing them in small groups. Teachers will need to explain what is expected of students in both situations.

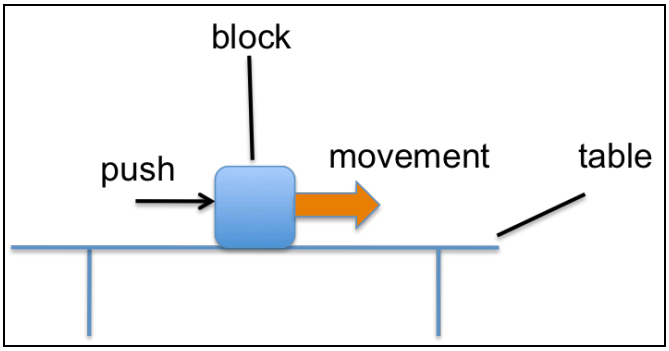
In this first instructional segment, students focus on developing language and diagrams to describe pushes and pulls (forces) on objects and the subsequent movement of those objects and to characterize changes in their motion. For example, students can investigate forces by observing the movement of a paper plate attached to a string when no one pulls the string and the movement of the plate as a student pulls the string in different directions. The teacher encourages the students to ask questions, to make predictions, and to investigate how objects are being pushed or pulled move. Students engage in describing, analyzing, and reasoning about what they observe; recording observations with diagrams; and making claims about the movement of objects that can be supported by their observations during investigations. When students observe a phenomena such as a change in the motion of a toy car, their questions about what provided the push or pull on the toy car can be answered through

ELA ELD Connection
As an introduction to motion and the use of push or pull on an object, the teacher reads aloud a selection of topic-related books. Students can ask and answer questions about the use of push and pull in motion prior, during, and after the investigations based on information from the books and from their observations. Possible texts could include: *Move It!: Motion, Forces, and You (Primary Physical Science)* by Adrienne Mason; *Motion: Push and Pull, Fast and Slow (Amazing Science)* by Darlene Stille; and *Forces Make Things Move (Let's-Read-and-Find-Out Science 2)* by Kimberly Brubaker Bradley.

their own careful observations and investigations. This process of seeing, questioning, and investigating occurs across activities in the instructional segments in this framework and supports student learning.

The simple diagram in Figure 1 represents how a push from a student on a wooden block resting on the table makes the block move forward. In the diagram, all the observable parts (the block and the table) are represented schematically and are labeled. The push is indicated with an arrow, and the movement of the block is indicated by a thicker arrow. Graphically distinguishing between the two arrows makes clear what is the cause (the push) and what is the effect (the movement). The diagram also shows that the direction of the movement is the same direction as the push.

Figure 1: Example of a diagram that the teacher can help students develop to represent how a push on a wooden block makes the block move forward.



In order for students to carry out investigations and develop language around patterns of the motion of objects, the teacher introduces situations that students can observe. The teacher poses questions that support the students to analyze the situations, draw diagrams to represent what happened, and talk about their diagrams using terminology appropriate for this grade level. At first, the teacher encourages

Mathematics Connection
Students can keep track of the results of their motion experiments in a table format, serving as a prelude to picture graphs introduced in Grade Two. They can compare results using "greater than/less than" vocabulary; for example "The ball went farther after it hit the cardboard tube than after it hit the bubble wrap." Students in Kindergarten have not yet been introduced to standard measurement, such as using a ruler.

description of motion and focuses attention on particular moments when the motion changes. The students set up additional situations in which they push or pull objects to observe, describe, and diagram. Once they have observed several situations, they can be asked to make predictions about a new but similar situation, using diagrams similar to those they have used to describe past observations.

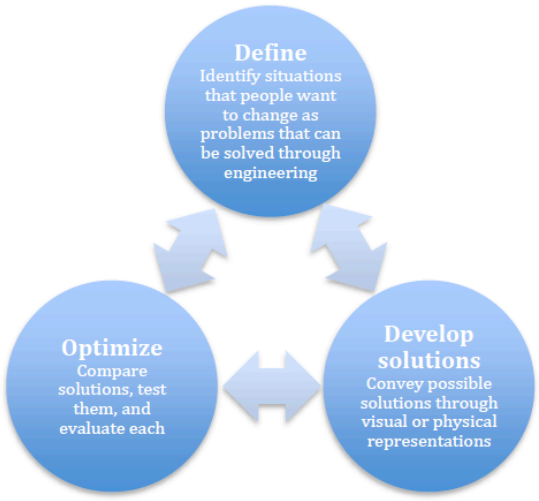
Based on these experiences, students understand that objects push or pull on other objects when they collide. Now the teacher introduces the idea that everything is pulled down towards the ground by the Earth, unless something else pushes or pulls it up. This phenomena can be demonstrated by a weight bouncing up and down on a spring. Students will need to observe and investigate this phenomena through multiple activities created by the teacher to understand the idea of the Earth pulling down on things. (The idea of one force balancing against another is not introduced here, just the idea that the Earth pulls things toward it.)

Engineering Connection

In this instructional segment, the students also have the opportunity to develop their first engineering project. The teacher defines a challenge students could collaboratively solve that is connected to the situations they observed earlier in the instructional segment. For example, the students could be asked to design a way to change the direction or decrease the speed of a ball that is moving towards a structure made of blocks, thus saving the structure from being destroyed. Because this is the first time students have been asked to develop an engineering project, the teacher will need to lead the class through the steps of the engineering design cycle (see Figure 2): 1) define the engineering problem; 2) develop a possible solution; 3) test and optimize the solution. The teacher may decide to model a design activity with an emphasis on the steps of the design process using language the students can emulate.

Figure 2 describes the engineering design process for K–2. In kindergarten, teachers guide students to look at situations or events that may be considered as "problems." The focus of the engineering design process is not to transform activities into competitions to see which solution is best. Rather, the idea is to have students collaboratively generate multiple ideas, design solutions, and test those solutions to determine if they are appropriate for the goal. Throughout the process, the emphasis is on developing students' collaboration and communication skills.

Figure 2: Engineering Design Cycle for Kindergarten Through Grade Two



(NGSS Lead States 2013e)

Once the students are familiar with the engineering design cycle, they are ready to begin. The teacher provides the materials (e.g., ramps, balls of different sizes, blocks books, paper tube rolls, string, and yarn) and structures the situation and task so that students can collaboratively work in small groups to design something that can achieve a desired result (for example, using a cardboard ramp to deflect a rolling ball coming from a pre-determined direction so that it hits a target). Teachers should provide opportunities for students to improve and refine their designs before introducing the idea of observing and recording how well the various designs (developed by different groups of students) achieve the desired outcome. As the students engage in this engineering design process, the teacher introduces and reinforces the words and ideas used to

describe what they are observing and doing. The teacher stresses both (1) the generality of the steps of the design process and (2) that to develop their designs, students will use what they learned from their science investigations of moving objects and how forces on them changed their motion.

Kindergarten Snapshot: Pushes and Pulls

Since the beginning of the school year, Mr. H has worked each day to establish a safe and respectful environment for his students to discuss ideas throughout their learning and have productive conversations in which *all* students participate. Mr. H recognizes that this is a necessary condition for students to talk about and ponder complex ideas before their ideas are fully developed and coherent. This stage of talking while "thinking on their feet" is important as a tool for continuous formative assessment that Mr. H uses to guide the development of students' ideas.

Mr. H introduced the norms for "Classroom Talk" at the beginning of the school year, and he constantly reinforces them at every occasion in which a Classroom Talk is occurs. The following are the norms that he established with the help of his students:

Classroom Talk Rules

- We can think and learn together by talking about our ideas.
- We talk to share ideas with others
- We listen carefully to learn from others.
- We have to ask questions when we do not hear or understand somebody.
- We have to take turns so everybody gets a chance to talk.
- Each person's thinking is different and unique.

Mr. H uses the "talk move" of asking students to repeat in his or her own words what one another student has said. He asks several students to repeat what the same

speaker has said, letting them know that each student's listening and speaking are important. This technique reinforces the idea that they are responsible for listening carefully to every speaker.

Mr. Hunt continues using Classroom Talk strategies as he starts a new hands-on science lesson around the topic of pushes and pulls. The goal of this learning sequence is to capture the enthusiasm for the world around them that students bring into the classroom, so that they can continue exploring their world with more expert eyes. He starts the day by singing the "Talk Song" to invite the students to a Classroom Talk circle. "Everybody have a seat, have a seat, have a seat. Everybody have a seat. Let's start talking" (sang to the tune of "London Bridge is Falling Down").

When everybody is seated in a circle, Mr. H pulls out a few objects from a bag, including a tennis ball, a small beach ball, a marble, a toy car, and a small cart. The students observe the objects, say the name of the objects, and tell what they could do with the object. Mr. H starts by recognizing what students already know before moving to the driving question for this learning segment: "What happens when you push or pull on an object?" Throughout this instructional sequence, Mr. H focuses on helping students develop the language required for precisely describing actions of motion, motion that they have experienced many times while playing. From their own experiences, students know that giving a big push to a slow moving toy car will make the car go faster and that pulling a cart to the right will make it move to the right.

Mr. H also brings the pushes and pulls discussion outside the classroom as the students play on playground structures (for example a student pushing gently another student on a swing). The students have opportunities to practice the new language as they work the school's outdoor garden (*pushing* a cart full of compost, *pulling* a weed out of the ground, *pushing* a small shovel in the soil). In addition, the students are encouraged to observe how other objects around the school can be moved (e.g., the food tray in the school cafeteria can be pushed or pulled or the classroom door needs to be both pulled and pushed to open or close).

The students discuss and share their outdoors and school experiences in the classroom during a Classroom Talk circle. Mr. H also uses the Classroom Talk to develop rich prepositional phrases such as "Maria pushes the cart slowly *around* the garden". He discusses the meaning of this sentence and provides opportunities for students to construct prepositional sentences using their push-pull science experiences. He also shows them where these types of sentences occur in the texts about pushes and pulls that he is reading to them.

Kindergarten-Instructional Segment 2: Needs of animals and plants and their environment

In this instructional segment, the teacher guides students to make observations in both classroom and natural settings to learn about what animals and plants need in order to survive. Walking through the school garden or play area, looking at ant farms, and watching fish in an aquarium or insects walking on the inside of a glass bowl provide students meaningful observations that lead to understandings regarding the needs of plants and animals.

Kindergarten-Instructional Segment 2: Needs of animals and plants and their environment
How do we know that something is alive? *What do animals and plants need to survive?* *Does what they need affect where they live*?
Highlighted Crosscutting Concepts: Patterns; Systems and System Models
Highlighted Science and Engineering Practices: • *Analyzing and interpreting data*
CA NGSS Performance Expectations: 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.]

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or 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.]

Background for Teachers

In general, all living organisms require energy and matter in order to live and grow, and the structural organization of every organism is such that matter and energy are efficiently captured, transformed, distributed, and eliminated as necessary throughout the parts of the organism. In kindergarten, students learn that plants need water and light to live and grow and that animals need food. Animals obtain food from plants or other animals. Students also learn that organisms survive and thrive in places that have the resources they need.

With support from the teacher, students develop the language they need to describe their observations, for example parts of plants and animals (leaves, stem, roots, flower, arms, wings, legs) and the environment where they live and grow. These investigations allow teachers to introduce the crosscutting concept of ***systems and system models*** to describe sets of objects or organisms in terms of their parts. Students demonstrate understanding of this crosscutting concept as they describe situations or organisms. For example, they may describe a tree as a system made of leaves, branches, a trunk, and roots.

Description of the Instructional Segment

The instructional segment begins with activities, observations, and discussion designed to develop the conceptual categories of plant and animal and living, non-living, and once-living things. For example, a leaf detached from the tree is now a dead organism, but it was alive while connected to the tree. Discussions and classroom readings focus on the idea life has a beginning, a period of growth, a period in which it can produce offspring, and eventual death.

Students also learn that during its life span each individual has needs in order to live and grow, but there are certain common needs for all animals (air, food, and water), and others common to all plants (air, water, and light). Students investigate what these needs are by identifying patterns through activities such as growing seeds of different plants or keeping a classroom pet. Bringing living organisms into the classroom (both plants and animals) allows students to learn how to take care of and appreciate these organisms while they grow. Furthermore, the use of living organisms makes concepts related to patterns and structure and function relationships more tangible for kindergarten students. (Note that the use of living organisms in the classroom while a very good experience for students might also raise some challenges. Teachers will need to check school policies and safety guidelines so that both organisms and students are safe.)

ELA ELD Connection
Guide students through a number of observations on what plants and animals need (e.g., ant farms, fish in an aquarium, plants growing, insects in a jar). The teacher lists all of the "needs" the class has discussed on a board, using words and pictures/symbols (e.g., sun, water, food). Students, individually or with a partner, draw a picture of a plant on half of a piece of paper, and an animal on the other half, that they observed. Then they draw and/or write the needs of the plant example and of the animal example next to each picture.

Students also observe the natural world beyond their classroom and community (e.g., through videos or online resources). They are prompted through questioning and discussions to make sense of their

Mathematics Connection
Kindergarten students use attributes to sort objects. In the vignette, "Needs of Animals and Plants and their Environment" students could sort the information cards by plant/animal, eats plants/animals/both, lives in

observations and organize them in patterns to develop a more general analysis about how plants and animals meet their needs, what aspects of their environment provide support or challenges in meeting these needs, and how plants and animals affect their environments in this process. Students should also have experiences observing some animals eating plants and others eating other animals. One example might include feeding brine shrimp or freeze-dried worms to the fish in the classroom aquarium. This enables students to witness one animal eating another, deepening their developing theories regarding the interactions between two different kinds of animals. Observing insects eating fruit might also broaden their understanding, for example stressing some animals only eat plants. Such observations allow students to begin to develop questions and ideas about the inter-relationship of organisms in their environment and the concept of flow of matter in an ecosystem, even though they are not required to explain these concepts in kindergarten.

The classroom discussions based on observations and the information from texts and other media (e.g., videos, online resources, posters) allow students to develop a model that represents the relationship between a variety of plants and animals and their environment. The crosscutting concept of ***patterns*** could be used in this context to organize the collected observations and information from the text.

Engineering Connection

This instructional segment does not contain a PE that explicitly integrates the engineering design process. However, teachers may find several opportunities in this instructional segment to highlight a practical problem for which students may then design a solution. For example, after reading a text about animals in a zoo being fed by humans, the teacher can prompt students to think about what type or shape of animal feeder may be more suitable for different animals. For animals that are able to climb, a feeder on a platform may be an appropriate design solution, but for animals that do not climb other solutions need to be designed. The same type of creativity could be applied if the

teacher challenges the students to design an appropriate enclosure for a small animal for the classroom.

As students work with plants, they can be challenged to create a container that will help keep a plant alive. To develop a successful design, they will need to consider the basic needs of plants, particularly the plant's need for sunlight and water. Teachers can show students examples of a broad variety of engineering designs associated with keeping houseplants appropriately watered. While the science concepts behind these products are beyond the scope of this instructional segment, these experiences allow students to observe the diversity of design solutions associated with the same problem, which is at the core of the creative process of engineers.

The following vignette is an example of how teaching and learning focused on the disciplinary core idea LS1.C Organization for Matter and Energy Flow in Organisms and the PE K-LS-1 From Molecules to Organisms: Structures and Processes might look in a kindergarten classroom.

Kindergarten Vignette

Needs of Animals and Plants and their Environment

Introduction

Ms. J plans to focus four lessons on instruction and learning on the disciplinary core idea LS1.C Organization for Matter and Energy Flow in Organisms and the PE K-LS-1 From Molecules to Organisms: Structures and Processes. She knows that kindergarten students are interested in animals and has many classroom resources to support the lessons, including picture books with animals in their natural habitats, informational texts about how animals live in different environments, and access to online resources that

allow students to observe animals in the wild. She hopes to instill in her students a respect for animal and plant life.

Day 1 – Needs of Plants and Animals

Mrs. J decided to adapt the materials from *The World Around Me*, a California Environmental Education Initiative (EEI) unit, as the foundation for a series of lessons focused on the needs of animals and plants and their environments. She introduces her students to the idea that most plants and animals live outside in the natural world and get the food, water, and air they need in many different habitats, such as deserts, forests, valleys, mountains, rivers, lakes, oceans, and coasts. She has students use media sources (videos, online resources) to obtain and evaluate information so they can investigate what different plants and animals need to survive. She also reads aloud texts about animals and plants and remains students that they can use the texts and other instructional resources (e.g., posters, animal puppets, toy figures of animals and plants) in the classroom resource area for more information.

In order to reinforce the crosscutting concept about ***patterns***, Mrs. J asks the students to think-pair-share a response to the following question, "What do plants and animals (including humans) need to survive?" Mrs. J writes students' response on the board in such a way that each animal is grouped with a specific type of food. As she reads back their responses, she asks students to notice the way she grouped their ideas. Mrs. J briefly discusses the meaning of the word *pattern*, something that happens in a regular and repeated way (for example, the seasons of the year). Students discuss the patterns they see in the different kinds of food needed by different types of animals, for example beavers eating plants, kingfishers eating fish, and turtles eating plants and insects.

Then, she asks the students to identify the places where different animals and plants can get what they need, for example, freshwater fish need to live in streams, rivers, and lakes to survive. This begins to develop their understanding of California Environmental 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. Learning some of the basics of California Environmental Principle I prepares students with some of the background they need to begin developing their understanding of California Environmental Principle II.

Mrs. J motivates the students by taking them on a virtual field trip (e.g., using videos, photographs, informational text, EEI unit resources) through California, making stops along the way to learn about some of California's unique places. The students work as a class to observe the features of river and lake habitats on *The World Around Me*: *R is for River* and *L is for Lake* alphabet cards in a classroom resources area. Mrs. J guides the students in a collaborative discussion about what they already know about rivers and lakes and records their comments.

Day 2 – Where Plants and Animals Live

Students participate in a shared research project as they "travel the river" on board a "boat", observing a variety of plants, animals, and human activities on their *River and Lake* information cards (#1–10). Working together in pairs, they closely examine their cards to identify the features of the animals and plants, as well as the places they live. Mrs. J facilitates a class discussion based on the photographs each pair studies. Students describe the features of their plants and animals. With Mrs. J's help, they identify them and explain where the different organisms live (e.g., in a river or lake, or on the land nearby). As pairs present their information, Mrs. J serves as the class scribe and makes a list of the plants, animals, and people, asking students to identify what these organisms need in order to live and grow. As the students identify the foods different animals eat, she asks them to identify where that food comes from, plants or other animals. Mrs. J also asks the students a question about what they think plants need to live and grow. As a follow-up question, Mrs. J guides the discussion about where the animals and plants get what they need, leading the students to identify they get these things from the places where they live.

Day 3 – Where Rivers and Lakes Come From

In order to reinforce the crosscutting concept about ***patterns***, Mrs. J briefly discusses the meaning of the word *pattern*, something that happens in a regular and repeated way (for example, the seasons of the year). She then asks students to recall examples of patterns they discussed about the different kinds of food needed by different types of animals, for example beavers eating plants, kingfishers eating fish, and turtles eating plants and insects. As they think about their examples of patterns, Mrs. J asks the students to use those patterns to help them answer scientific questions, such as, "What do plants and animals (including humans) need to survive?"

Returning to their earlier discussion about the features of rivers and lakes, Mrs. J shows the students images of water in different locations: mountains, lakes, fast flowing rivers, and the ocean. She leads the students in a discussion about the movement of water in these different places, encouraging them with questions about where rivers come from, helping them recognize many rivers, especially in California, start out as fast flowing streams on a hill or mountain. Students then trace the flow of rivers from their mountain origins to the coast and ocean. Referring to a wall map of the habitats of California, students identify the location of their city or town. Then, working collaboratively, the class uses the map to locate one or two major rivers and/or lakes near their community.

Day 4 – Plants, Animals, and Humans Need Water

As the class brainstorms ways in which people are connected to rivers and lakes, Mrs. J makes notes. Going deeper, the students identify the different ways people use the water they get from rivers and lakes, including basic survival needs, such as for drinking and watering gardens, as well as everyday uses like bathing, washing dishes, fishing, and boating. As they discuss how important the water from rivers and lakes is to their daily lives, students begin to develop an understanding of the essence of California Environmental Principle I—people depend on natural systems for their survival. This activity also helps to support students' developing understanding about what humans,

other animals, and plants need to survive.

Students draw and label, with adult support, what they know about the plants and animals that live in and around rivers and lakes in their *E is for Earth* workbooks. Mrs. J puts the students' drawings in the classroom resource area, so students can refer to them as they begin to develop their models of the relationships between the needs of different plants and animals (including humans) and the places they live.

Mrs. J shares the unit learning objectives with the educational support personnel in the expanded learning program at her school and discusses with them how they can reinforce the key concepts in the unit by providing additional opportunities for students to explore and investigate.

(Note: The EEI Curriculum Unit, *The World Around Me*, is comprised of six lessons that provide opportunities for students to investigate the plants, animals, and humans in coastal areas, oceans, deserts, forests, valleys, and mountains, allowing teachers, if they wish, to focus on environments near where they live.)

Performance Expectations		
K-LS1-1 From Molecules to Organisms: Structures and Processes 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.]		
Science and engineering practices	**Disciplinary core ideas**	**Cross cutting concepts**
Analyzing and Interpreting Data Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	**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	**Patterns** Patterns in the natural and human designed world can be observed and used as evidence.

	animals. Plants need water and light to live and grow.	

California's 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.

Concept b. The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.

Connections to the CA CCSS for ELA/Literacy: RI.K.1, W.K.7, SL.K.3, L.K.6

Vignette Debrief

The CA NGSS require that students engage in science and engineering practices to develop deeper understanding of the disciplinary core ideas and crosscutting concepts. The lessons give students multiple opportunities to engage with the core ideas in life sciences related to what plants and animals need to survive, helping them to move towards mastery of the three components (SEPs, DCIs, CCCs) described in the CA NGSS performance expectations.

In this vignette, the teacher focused on one PE but in the four lessons described above she only engaged students in selected portions of this PE. To fully master this PE, students will need additional learning opportunities.

Students were engaged in the science and engineering practice of **analyzing and interpreting data**. Life sciences lend themselves well to the developing students' abilities to make observations and collect data which they can analyze and interpret.

The students analyzed and interpreted information they gathered from alphabet cards and media sources (videos, online resources) to begin developing their understanding that all animals need food in order to live and grow. This analysis also gave them an opportunity to identify the foods different animals eat and where that food

comes from, plants or other animals. Students' analysis of the information they gathered during a virtual "field trip" also helped them recognize that plants need water and light to live and grow.

Students also examined the crosscutting concept of ***patterns*** as they identified examples of patterns in the different kinds of food needed by different types of animals, including humans. The inclusion of the needs of humans in the study of patterns provided a foundation for learning about California Environmental Principle I, Concept b, T*he goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.*

CA NGSS Connections to English Language Arts

Students used the alphabet cards from *The World Around Me* to observe the features of river and lake habitat and then participated in a class discussion about lakes and rivers, which connects to CA CCSS for ELA/Literacy Standards RI.K1 and SL.K.3. They used information from the alphabet cards and from media sources for a shared research project on where certain plants and animals live and what they need to live and grow. The students then drew pictures and added labels, with adult support, to summarize what they knew about where plants and animals live, which connects to CA CCSS for ELA/Literacy Standard W.K.7. As they learned about different types of animals and plants and their features, students acquired and used new words, which connects to CA CCSS for ELA/Literacy Standard L.K.6

RI.K.1 With prompting and support, ask and answer questions about key details in text.

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).

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

L.K.6 Use words and phrase acquired through conversations, reading and being read to, and responding to texts.

Resources for the Vignette

- California Education and the Environment Initiative. 2011. *The World Around Me*. Sacramento: Office of Education and the Environment.

Kindergarten-Instructional Segment 3: Animals and plants can change their environment

The focus of this instructional segment is to provide students with experiences by which they can observe that animals and plants have the capacity to change the environment around them in order to meet their needs for survival. This concept lays the foundation for students' further understanding that living organisms have significant impacts on the processes occurring on Earth (for example, changes in atmospheric conditions due to the production of oxygen due to photosynthesis).

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Kindergarten-Instructional Segment 3: Animals and plants can change their environment
How do animals and plants change their environment to survive? *What do we (humans) do that changes our environment?* *What can we do to modify our impact on the environment?*
Highlighted Crosscutting Concepts: Stability and Change, Systems and System Models
Highlighted Science and Engineering Practices: • *Engage in argument from evidence* • *Analyzing and interpreting data*
CA NGSS Performance Expectations: 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.] 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.] 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 expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

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Background for Teachers

As conditions on Earth change, so do organisms as they adapt and evolve in response to those changes to better meet their needs. In kindergarten, students observe phenomena of how plants and animals (including humans) can change their environment such as the shape of the land or the flow of water. An example of a plant changing the land can be observed when the roots of a tree displace the concrete path around the tree.

Description of the Instructional Segment

In this instructional segment students begin to develop the notion of what constitutes an ecosystem, which involves both the physical environment and the living things within that environment and the multiple interactions between them. For kindergarten students, it is not necessary to strongly distinguish between what is geographic and what is biological in the environment.

Building on the knowledge developed in the prior instructional segment, students explore their world through observation and describe their observations in terms of the organisms and other things that are contained in the observed system. Read-alouds of texts and class discussions of multiple cases where animals or plants change their environment in some way (or not at all) allow student to use the

ELA ELD Connection
Select four or five books about different ecosystems to read aloud to the class. For example, the living in a biome series by Carol L. Linden has numerous topics, such as *Life in a Forest, Life in an Ocean, Life in a Desert, Life in a Stream, Life in a Rain Forest, Life in a Pond*. As each book is read, ask similar questions about the biome; for example: What does ____ (animal or plant) need to survive? Where does _____ live? How does ____ change their environment? Divide students into small groups, with each group assigned a different book, to compose (through dictation and/or pictures) an explanatory piece about their biome, including some text-based details.

crosscutting concept of ***stability and change*** to determine in which systems the organisms change their environment and in which systems they do not. Such examples include an animal digging holes for shelter or hiding food and thereby moving around the seeds of plants (for example, squirrels burying acorns), animals over-grazing and thereby killing certain plants, or animals hunting and killing other animals. The idea that plants can also impact their environment is introduced in this instructional segment. For example, plants provide needed shade to other plants or animals, or the roots of plants help limit erosion of a stream bank or hillside. To develop this idea, teachers ask leading questions and focus attention on a few examples before asking students to observe other impacts of plants on the environment.

To help students recognize these plant-related impacts, teachers can ask, "Why do you think the sidewalk is raised or broken near the trees on the sidewalk?" or "After a rainstorm, why does mud run into the gutter from an empty lot, but not from a yard with lawn?" These questions allow students to make observations about the roots of the tree or the grass. They connect the broken sidewalk with the root pushing up the concrete because they can see the root of the tree underneath the sidewalk. They recognize that the roots of the grass in a lawn hold the dirt together and the lawn acts like a sponge.

These and other similar observations allow teachers to develop students' ideas of cause-effect relationships. To reinforce the use of the crosscutting concepts ***systems and system models*** from instructional segment 1, students can develop visual models (drawings) representing the relationship between animals or plants and the elements in their ecosystem. One example of a visual model is a sequence of drawings illustrating how a tree near a concrete sidewalk breaks the concrete as it grows.

The instructional segment then addresses impacts of humans on the environment, particularly in the local environment of the school and the area around it, such as a nature area or park. For example, teachers can focus students' attention on natural resources that they use frequently, such as water. Teachers can determine students'

Mathematics Connection
Kindergarten students use attributes to sort objects. In the vignette, "Animals and Plants Can Change their Environment," could sort different conservation activities into the categories Reduce, Reuse, and Recycle.

prior knowledge about how humans affect the environment by asking them, "How can we save water at school and at home?" or "What happens if we leave the hose running in the school garden?" This type of discussion can help students build their understanding of the ideas identified in California Environmental Principle II, *The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.* Learning about these relationships encourages students to expand their thinking to consider both positive effects of humans in an ecosystem (e.g., watering plants in the park) and negative impacts (e.g., trash, pollution, new construction that reduces the availability of natural or agricultural areas).

Engineering Connection

Students complete the instructional segment by exploring how to apply their learning to collaboratively develop and communicate solutions to each other for reducing the impact of humans in an environmental context relevant to their local community. The teacher guides students to review the instructional resources they used during this and the previous instructional segment to define a problem they want to address and then develop a possible engineering solution. Students make drawings or physical models of their designs and use them to communicate their ideas to others.

The following vignette is an example of how teaching and learning focused on the disciplinary core ideas ESS2.E: Biogeology and ESS3.C Human Impacts on Earth Systems and the PEs K-ESS2-2 Earth's Systems and K-ESS3-3 Earth and Human Activity might look in a kindergarten classroom.

Kindergarten Vignette

Animals and Plants Can Change their Environment

Introduction

Ms. W has developed five lessons for her kindergarten students that focus on animals and plants, the environments in which they live, and how animals and plants impact their environment. She wants her students to understand that humans and other animals use resources that come from their environment. She plans to introduce the idea of natural systems of plants and animals and how these systems are affected by the plants and animals that live in them.

She has collected a number of resources to support instruction and learning, including informational texts that she will read aloud to the students, videos, online resources, and picture books. There are posters of many different kinds of animals and their environments on the walls and toy animals in bins in the student exploration areas.

Day 1 – Animals and Plants Changing Their Environment

Ms. W decided to use a California Environmental Education Initiative (EEI) unit, *A Day in My Life*, as the foundation for lessons focused on how animals and plants can change their environment. She starts by teaching her kindergarten class "The Faucet Song," a poem about water, to help them discover where water comes from and where it goes. Ms. W conducts a demonstration of a dripping faucet. She has a couple bowls of water, several large paper cups, a small measuring cup, eyedroppers, and a large vase. With the assistance for one or more other adults, she has each student use an eyedropper to take water from a bowl and drop 12 water drops into a paper cup. When each child has done this (she has 30 students), she tells them that this is how much water is wasted from a leaky faucet in one hour. She pours the water from the paper cups into the measuring cup to measure it, then pours the water into the large vase. Then, she fills the measuring cup with the amount of water leaked in an hour and pours it into the large vase 23 more times to show what is wasted in 24 hours or one day. As she pours in each hour's worth, her students realize that it is a large amount. The large vase is almost full.

She has them imagine seven large vases full of water and tells them that would be how much water leaked in a week! They are amazed by how much water is wasted by a leaky faucet that just goes drip, drip, drip.

Day 2 – Resources We Use.

Ms. W reads the students a poem from the *A Day in My Life* big book and points out individual words. Once they have become familiar with the poem and the way it sounds, the students begin to read along. As she continues to read, Ms. W asks the class to use body motions to model the way water moves, first as rain coming from the sky, then as melting snow flowing into rivers and underground, and finally to our homes.

Ms. W facilitates a class discussion during which she helps the students begin to identify sources of water and its role in our lives. As they examine photographs in a display of Water, Stream, and Snow information cards, Ms. W records students' thoughts about why water is important to people and where the water they use comes from. The teacher asks them several more questions about what other things they use in their everyday lives (e.g., paper bags, juice boxes, paper towels, bottled water).

Writing the word *Resources* on the board to help build their academic vocabulary, Ms. W asks students to discuss with a partner water and the other resources they use. The students use the Water, Stream, and Snow information cards as references for their discussion. With prompting and support from the teacher, the students work in teams to develop two questions to ask the whole class about resources they use. As the teams of students ask their questions, Ms. W writes their questions on the board and records the answers given by the other students.

Day 3 – Products People Use

In order to begin building students' science and engineering practices associated with **obtaining, evaluating, and communicating information**, Ms. W has the class look

at the Paper, Logs, and Trees information cards and identify the sources of a resource they are very familiar with, paper. She leads the class in a discussion of the photographs on the cards and asks the students to put into their own words the idea that resources, such as paper, come from trees that grow in forests.

To further build their skills in obtaining, evaluating, and communicating information, Ms. W calls students' attention to two more sets of information cards, Bread, Wheat, and Soil and Water, Stream, and Snow. Ms. W asks them to examine and then use the cards to identify three things: a product people use, the source of the material used to make the product, and the natural system the resource comes from. As the students gather this information from the information cards, Ms. W has another opportunity to reinforce the crosscutting concept about ***patterns***.

Day 4 – Humans Impact the Environment

Ms. W initiates students' investigation of how humans impact the environment, by asking questions such as, "What happens to a forest when we cut down trees to make paper?" "What happens if we leave the hose running in the school garden?" and "What happens when we drop trash on our school grounds?" She makes notes on the board about the students' ideas about these human impacts.

To move the students beyond simply identifying water and paper as things they may use every day, Ms. W guides the students into a discussion of where these things come from: lakes, rivers, mountains, and forests. She asks the students to work in pairs to think about the questions, "What happens if we cut down too many trees in a forest?" and "What might happen if we use too much water?" As they begin to recognize that using things like paper in their daily lives affects the natural systems those resources come from, students start to develop an understanding of the essence of California Environmental Principle I—people depend on natural systems.

Ms. W writes the words *conserve, reduce*, *reuse*, and *recycle* on the board and

asks students what they think these words mean—"to avoid wasting something," "using less of something," "using something over again," and "using something over again by making it into a different thing." She reads aloud a text that includes these words to support the students' acquisition of academic language.

Day 5 – Conserving Resources

Revisiting students' discussions about using water, Ms. W asks them to brainstorm ideas about, "How can you save water at school and at home?" and "How can you save paper in the classroom?" Under the word *Conserve* on the board, she records the students' suggestions: turn off the water while brushing your teeth (reduce); turn the faucet all the way off so it does not drip (reduce); do not waste paper (reduce); use both sides of a paper for drawing (reuse); put used paper into a recycling bin (recycle).

As a strategy for strengthening the students' writing skills, Ms. W gives the students an assignment in which they will use a combination of drawing, dictating, and writing to compose an informative/explanatory text, a conservation mini-poster. Ms. W distributes paper for the mini-posters with the words *reduce*, *reuse*, and *recycle* printed across the top. The students begin by coloring and tracing the words and then add a small drawing based on one of the topics they discussed during the lessons, such as saving water. They dictate or write a sentence about their drawing. Ms. W displays the mini-posters and invites parents and other adults who visit the classroom to ask students to talk about their poster and briefly explain the words *resources*, *conserve*, *reduce*, *reuse*, and *recycle*.

(Note: EEI Curriculum Unit: *A Day in My Life*, is comprised of four lessons that introduce some of the key resources students use, the origins of those resources, the natural systems the resources are part of, and ways that resources can be conserved.)

Performance Expectations

K-ESS2-2 Earth's Systems
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.]

K-ESS3-3 Earth and Human Activity
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.]

Science and engineering practices	Disciplinary core ideas	Cross cutting concepts
Obtaining, Evaluating, and Communicating Information Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world.	**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.	**Patterns** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. **Systems and System Models** Systems in the natural and designed world have parts that work together.

California's 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.

Concept c. The quality, quantity and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.

Principle IV: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.

Concept a. Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.

Connections to CA CCSS for ELA/Literacy: RI.K.1, W.K.2, SL.K.3, L.K.6

Vignette Debrief

The *CA NGSS* require that students engage in science and engineering practices to develop deeper understanding of the disciplinary core ideas and crosscutting concepts. The lessons give students multiple opportunities to engage with the core ideas in life sciences related to how plants and animals (including humans) can change the environment and how humans can reduce their impact of on the land, water, air, and/or other living things in the local environment, helping them to move towards mastery of the three components (SEPs, DCIs, CCCs) described in the CA NGSS performance expectations.

In this vignette, the teacher selected two PEs but in the five lessons described above she only engaged students in selected portions of these PEs. To fully master these PEs, students will need additional learning opportunities.

Students were engaged in a number of science and engineering practices with a focus on **obtaining, evaluating, and communicating information**. Life sciences lend themselves well to developing students' abilities to gather information from firsthand activities, consider the importance of data, and communicate what they have learned to others.

The students gathered information from information cards, teacher read-alouds, and class discussions to begin developing their understanding that plants and animals (including humans) can change their environment. They built on this information through focused discussions about how the things students use in their daily lives affect natural systems. Students brainstormed ideas about how they could reduce their use of resources such as water and paper.

Students examined the crosscutting concepts of ***patterns*** as they identified examples of products people use and their sources in natural systems, this also supported their developing understanding of California Environmental 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*. As students discussed the ***systems and system models*** crosscutting concept in relation to their developing knowledge that things people do to live comfortably can affect the world around them, they also began to develop a foundational understanding of California Environmental Principle II, The *long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.*

CA NGSS Connections to English Language Arts

Students obtained scientific information from several sets of information cards and from teacher read-alouds to gather key details about natural resources so they could ask and answer questions. They collected this information during discussions about the products they use, the resources used to make those products, and the natural systems from which the resources came. These activities connected to CA CCSS for ELA/Literacy Standards RI.K.1and SL.K3. Students' work also connected to CA CCSS for ELA/Literacy Standard W.K.2 as they created mini-posters that helped develop their abilities to write and supply information about conserving natural resources. Students' discussions, listening to texts read by the teacher, and creation of mini-posters provided opportunities for them to use new words and phrases, which is connected to CA CCSS for ELA/Literacy Standard L.K.6

RI.K.1 With prompting and support, ask and answer questions about key details in a text.

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.

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

L.K.6 Use words and phrases acquired through conversations, reading and being read to, and responding to texts.

Resources for the Vignette

- California Education and the Environment Initiative. 2011. *A Day in My Life*. Sacramento: Office of Education and the Environment.

Kindergarten-Instructional Segment 4: Weather and climate

The focus of this unit is weather, something kindergarten students can observe and record each day and begin to see patterns over time. The relevance of weather to students' lives—is it too rainy to play outside today?—makes the topic engaging for them. This unit also links to prior units as students discuss how weather can affect living things and the environment in which they live.

To ensure that students collect sufficient data to recognize weather patterns, they will need to make and record observations throughout the school year, beginning in the first month of school.

Kindergarten-Instructional Segment 4: Weather and climate
What is the weather like today and how it is different from yesterday? *Can I predict tomorrow's weather?* *How does the sun heat up materials in my classroom?* *How can I protect myself form the sunlight?* *How do we prepare for severe weather?*
Crosscutting concepts: Patterns, Stability and Change
Highlighted Science and Engineering Practices:

- *Analyzing and interpreting data*
- *Define problems*
- *Develop solutions*

CA NGSS Performance Expectations:

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.]

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-ETS1-2. 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-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-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 expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

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Background for Teachers

In this instructional segment, students develop an understanding of variation in local weather as observed through patterns in weather conditions, such as sunny and warm days at the beginning of the school year and cloudy and rainy days during fall and winter. These observations and descriptions of local weather over time allow students to develop a definition of weather as the combination of sunlight, wind, snow or rain, and temperature that is characteristic of a particular region at a particular time of the year.

ELA ELD Connection
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 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.

The effect of sunlight on Earth's surface is also explored in this instructional segment as students begin to understand the sun is a source of energy for our planet and that the energy from the sun is transferred to Earth. The sun's radiation is the energy that travels across space from the sun to the Earth. The materials on the Earth's surface absorb this energy and are heated. At the molecular level, the radiation is being transferred to the motion of the particles in the materials. This motion energy, or heat, is then emitted by the materials to their surrounding environments as they cool down. Students can observe the effect of this transfer by touching different materials that have been exposed to sunlight and comparing them to the same type of objects that were not exposed to determine which objects are warmer, but are not expected to understand the science behind this phenomenon.

In order for this instructional segment to be successfully taught, it is important for students to observe and record data about local weather over a period of a week or so at different times during the year. To allow more significant comparison of patterns of

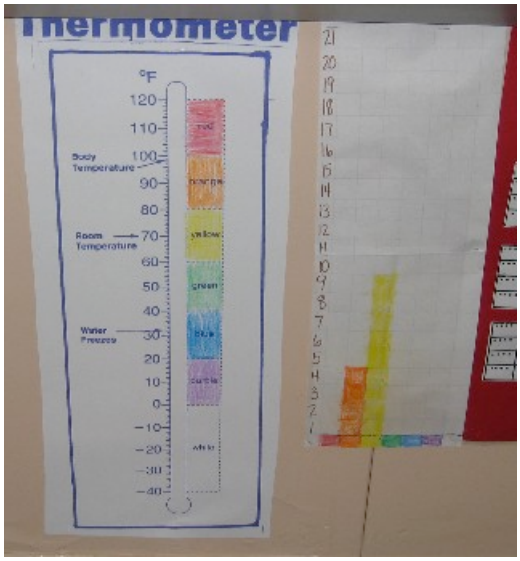
data, teachers should schedule weather observations when there is some variability in the weather. These observations and data recording can be built into earlier instructional segments and, where possible, connected to them (for example introducing wind as a source of forces on objects in the pushes and pulls instructional segment, linking weather observations to the impacts of weather on the environment and on living things in that environment in instructional segments 2 and 3).

Description of the Instructional Segment

In this instructional segment, students are introduced to weather as a phenomenon they can observe and that has patterns. Students are expected to develop understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for, and respond to, severe weather-related events such as storms, droughts, or floods. The crosscutting concepts of ***patterns*** and ***stability and change*** are the most useful for the students to use to organize their observations. A variety of local weather data can be collected including rainfall, temperature, and wind speed by using rain gauges, thermometers, and anemometers. Students collect data that is both qualitative (such as sunny, cloudy, rainy, and warm days) and quantitative (number of sunny or rainy days, amount of rainfall). This data collection prepares them for the idea of weather forecasting at the end of the instructional segment.

Mathematics Connection
Students in kindergarten work with numbers up to 20. They fluently add and subtract within 5. As students collect data on the weather, they could tell whether there were more sunny days or more cloudy days during the school week. They could also tell how many more days were sunny than were cloudy.

In schools with expanded learning programs, students can collect data in the expanded learning program to add additional information about weather and temperature. Students analyze the new data and may see different patterns, which deepens their understanding.



(Terence Blog 2014)

The instructional segment continues with students observing how the sun heats up different materials, such as sand, soil, and water, in different ways. Students collect information using thermometers or touching objects at different times during the day, such as at the very beginning of the school day and after lunch. Students can make observations about how the materials cool down at different rates (qualitative only, faster or slower) when the sun is no longer warming them. They also observe the patterns of change in shaded areas as the sun moves across the sky during the day. As an outdoor experience, students can investigate how the different materials (e.g., blacktop, lawn, playground equipment) that make up the school's playground are being heated differently depending on the time of day or the amount of shade on the playground.

In the final part of this instructional segment, the teacher provides video and pictorial resources that students use to gather information about different types of weather in different regions of the US. In particular, students discuss weather and news reports about how certain regions are affected by severe or extreme weather during certain periods of the year. After they have identified some weather patterns, students discuss what information weather scientists use to forecast weather and how forecasts of severe weather events can be used so communities can prepare for and reduce the

impacts of weather. These discussion should focus on local risks (e.g., fire driven by hot weather and winds, landslides driven by deforestation and rain storms, coastal erosion by large waves driven by storms, local flooding in severe rain.)

Engineering Connection

As the teacher guides the students to recognize that too much sun is not a pleasant condition for living organisms, the students identify where this problem may occur in a particular area of their school. They then work in groups, with the assistance of the teacher, to discuss the problem and develop a design solution—a structure to reduce the warming effect of the sun by providing shade in that area. This task allows students to apply their prior learning. First, the students are asked to draw a picture of structure they could build to create shade. Then, they are given a range of materials to select from (e.g., cardboard, wooden craft sticks, clay, tape, blocks, fabric) to build and test a small-scale model of their designed structure. In groups, students present their design drawing and small-scale model and explain how it might be built.

To further classroom collaboration, the students work together to combine the best ideas of various groups and decide on a few final designs. Groups of students build shade structures based on the final designs, still in a small enough scale to be manageable for their age. The students then test their shade structures to determine how well they worked. For example, they could measure the temperature of a container of water in the direct sun and one under each structure to compare the effectiveness of the shade structures. This movement from theoretical design and models to actual building enables students to see themselves as engineers and builders.