Grade One

Students in grade one continue to explore phenomena related to life sciences, physical sciences, and Earth and space sciences to find relationships between observed patterns and the reasons of those patterns through the crosscutting concepts of ***structure and function*** and ***cause and effect***. Allowing ample time for students to discuss data from their own investigations and compare and contrast those data with the data of other students increases not only their capacity for identifying and justifying patterns but also their capacity to engage in the scientific and engineering practices using appropriate academic vocabulary. These capacities are further supported by students' increased use of models to explain, represent, and support claims with argument from evidence.

Table 2 summarizes the PEs included in each instructional segment and the crosscutting concepts students may use as a tool to make sense of the disciplinary core ideas. Where necessary, PEs integrating science ideas with engineering design are accompanied by one of the three PEs in K-2 engineering design. The engineering design PE has been chosen to best match the suggested integration. The PEs that suggest an explicit integration with engineering are indicated with an asterisk (*). Teachers should note that instructional segment 4 will require students to begin to collect observations of patterns of change in the sky (e.g., the time and location of sunset) over an extended period of time prior to the beginning of the actual discussion of these observations.

681 Table 2: Instructional Segments in Grade One
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	Highlighted SEP	Highlighted CCC	PEs addressed	DCI addressed
Instructional Segment 1: Family and family behavior	• Constructing explanations and designing solutions • Obtaining, evaluating and communicating information	• Patterns	1-LS3-1 1-LS1-2	LS3.A: inheritance of traits LS3.B: variation of traits LS1.B: growth and development of organisms
	Brief Summary			
	Offspring of plants and animals look similar to their parents. Parents have behaviors that help offspring to survive.			
Instructional Segment 2: Meeting survival needs	**Highlighted SEP**	**Highlighted CCC**	**PEs addressed**	**DCI addressed**
	• Analyzing and interpreting data	• Structure and Function	1-LS1-1* K-2-ETS1-2	LS1.A: structure and function LS1.D: information processing ESS3.A: natural resources
	Brief Summary			
	All organisms have external parts that they can use to capture and convey information to help them survive and grow.			
Instructional Segment 3: Light and sound properties and uses	**Highlighted SEP**	**Highlighted CCC**	**PEs addressed**	**DCI addressed**
	• Planning and carrying out investigations • Constructing explanations and designing solutions	• Systems and System Models • Cause and Effect	1-PS4-1 1-PS4-2 1-PS4-3 1-PS4-4* K-2-ETS1-3	PS4.A: wave properties PS4.B: electromagnetic radiation PS4.C: information technologies and instrumentation
	Brief Summary			
	Sound can make matter vibrate and vibrating matter can produce sound. Light allows objects to be seen and has different properties. Both sound and light can be used to communicate information.			
Instructional Segment 4: Patterns of motion of objects in the sky	**Highlighted SEP**	**Highlighted CCC**	**PEs addressed**	**DCI addressed**
	• Analyzing and interpreting data • Planning and carrying out investigations	• Patterns	1-ESS1-1 1-ESS1-2	ESS1.A: the universe and its stars ESS1.B: Earth and the solar system
	Brief Summary			
	The Sun, moon, and stars move in the sky according to patterns that can be observed, described, and predicted. Seasonal patterns of sunrise and sunset can also be observed, described, and predicted.			

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Grade One-Instructional Segment 1: Family and family behavior

In this instructional segment, students begin to develop their understanding of how the characteristics of one generation of organisms are related to the previous generation. In order to accomplish this, students observe organisms of the same species (both plants and animals) and determine which characteristics can be similar or different. Because students will connect the notion of family in the animal world to their own experience of family, it is important to discuss the variety of human families, including adoptive parents, children raised by grandparents, and other broadened family structures that go beyond those observed in the animal world, but like animal families provide mutual support for survival. When discussing that young plants and animals are like their parents, the teacher must take care to differentiate between biological connections and the social connections of human families.

Grade One-Instructional Segment 1: Family and family behavior
How does a family behave to support family members to survive and to thrive? *How are parents and their children similar and different?* *Why do animals or plants look like their parents?*
Highlighted Crosscutting Concepts: Patterns
Highlighted Science and Engineering Practices: • *Constructing explanations and designing solutions* • *Obtaining, evaluating, and communicating information*
CA NGSS Performance Expectations: Students who demonstrate understanding can: 1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. [Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.] 1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. [Clarification Statement: Examples of patterns of behaviors could include the

signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]

Background for Teachers

Many characteristics of the offspring are inherited from their parents, such as the size of the leaves of a new plant that are similar to but smaller than the leaves of the parent adult plant. Similarly, young animals are very much, but not exactly, like their parents and also resemble other animals of the same kind.

As organisms progress through their lives from birth to adulthood, characteristic behaviors change so that organisms can increase their chances to reproduce and transfer their genetic information to their offspring. In many kinds of animals, parents and offspring engage in behaviors that help the offspring survive. In plants, reproduction may be accomplished by developing specialized body structures and/or depend on animal behavior.

Description of the Instructional Segment

This instructional segment starts with the teacher introducing the notion of family in animals by showing a variety of examples (e.g., picture books, read-aloud informational texts, posters, videos, and online resources) in which students can identify the parents and their offspring. These observations develop the model of the family or herd as a system of organisms within which parents behave in ways that support the survival of their offspring. From these observations, students are able to recognize the patterns that relate the offspring to their biological parents. Students are also provided with opportunities to discuss the ways in which young animals do and do not look like their parents. These discussion may be small group discussions or teacher-facilitated class discussions.

ELA ELD Connection
To introduce the concept that young plants and animals look like their parents, divide the class into two groups – the children and the parents. Use sets of picture cards that show a plant or an animal in the beginning of its lifespan and a matching card of the same plant or animal in adult stage. Students need to find their matching partner by asking questions (not by showing the picture on the car), such as, "My ___ (plant or animal) has a green stem. Does your picture have a green stem?" If no, they can find another student to ask the question. If yes, then another categorizing question can be asked. One way to organize the students is to have inside/outside circles, with the students with parent cards on the inside and students with the children cards on the outside. The process should be modeled first, and possible questions to ask each partner can be brainstormed and discussed. Once the two pictures are paired together, students can then discuss (record?) how the parent and the children are similar and how they are different.

Students also make related observations using grown plants and younger plants that have been grown from the seeds of the same parent plant. In schools with gardens or sufficient space in the classroom, students can collect seeds from adult plants to grow and observe during the school year. Students can also observe plants in and around the school, their home, and their neighborhood. Students should examine the color and shape of the leaves and flowers (if available) and their location on the plants to determine that the offspring plants are very similar but not identical to the parent plant.

The parent-offspring model is then broadened as students consider the patterns of behaviors offspring produce to communicate with their parents and the responses of the parents. Patterns of behavior could include sounds and vocalizations of the offspring (e.g., crying, chirping) that prompt a response behavior in the parent (such as feeding, comforting, or protecting).

The following vignette is an example of how teaching and learning focused on the disciplinary core idea LS1.B: Growth and Development of Organisms and the PE 1-LS1-2. From Molecules to Organisms: Structure and Processes might look in a first-grade classroom.

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Grade One Vignette

Family Behavior of Penguins

Introduction

Mrs. G has developed an instructional segment on Family and Family Behavior to further students' understanding of disciplinary core idea LS1.B: Growth and Development of Organisms. She chooses several key informational texts that the students will read or heard read aloud throughout the instructional segment. Her students have already made observations, conducted investigations, and developed evidence-based accounts to explain that young plants and animals are alike but not exactly like their parents. She is now concentrating on PE 1-LS1-2, Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. In this set of lessons, students will make observations of phenomena related to parents' behavior, but rather than experiencing hands-on observations, the students are applying the science and engineering practice of r **obtaining, evaluating, and communicating information** by using written texts).

Mrs. G traditionally does a language arts instructional segment on penguins in the winter that motivates and engages students. This year, she decides to integrate language arts with science and social science as her students study polar animals. She will also have her students participate in a Web-chat with NASA scientists who are studying animal behavior in Antarctica. The scientists will answer the students' questions about penguins and how scientists make and record observations.

Day 1 – Maps and Globes as Models

Mrs. G begins by teaching map skills to her students as they collaborate to identify continents and oceans on a large classroom map. The goal of the

instructional segment is to locate Antarctica on the map and compare its features with California's. Students also locate Antarctica using a globe and compare and contrast the use of a map and a globe to locate regions on Earth. She teaches them that a globe is a model of the Earth, and models are representations that help us observe things and relate them to one another.

Day 2 – Asking Questions to Gather Information

Mrs. G begins the language arts portion of her lesson by reminding her students of the differences between statements and questions. In order to prepare for the Web-chat, she has each student prepare a question for the NASA scientists. As a group, the students organize their questions into categories related to the instructional segment: how young penguins communicate their needs to their parents, how penguin parents help their offspring survive; and how the scientists record their observations and identify patterns. Because their Web-chat time is limited, the students decide as a class which questions to ask based on what they want to learn.

Day 3 – Obtaining Information from Scientists

Mrs. G leads the Web-chat as students ask their questions. Her students learn about what penguin parents do to protect their offspring in Antarctica's harsh environment. They are very excited to learn what scientists do to study animal behavior in Antarctica and the challenges that they encounter. Mrs. G records the Web-chat so that later, with her help, the students can access the answers to their questions.

Days 4 – 9 – How Different Animals Care for their Offspring

Penguin Chick, an informational text, describes the parenting behavior of Emperor Penguins. As she introduces the book, Mrs. G directs her students to focus on what the penguin chicks need to survive (food and warmth) and how the parents provide it. She tells her students that they will be using the pictures and the words in the book to learn about penguin families.

Mrs. G starts the lesson by reviewing with students how to use the illustrations in a text to describe key ideas. Then, she does a picture walk with the *Penguin Chick*, covering the words. She asks the students what they saw in the book about how penguin parents care for their offspring. With her assistance, the students record, in words and drawings, what they learned in their science notebooks.

In her next lesson, Mrs. G tell the students that they will add information to the science notebooks using details in a text of *Penguin Chick* to describe key ideas. She reads *Penguin Chick* aloud to the students. She helps students record in their science notebooks what they learned from the text next to what they learned from the pictures. She concludes the lessons by asking her students if what the learned through the text was different than what the learned through the pictures. The students discuss this question in small groups and then as a whole class.

Mrs. G continues to focus the students on the main idea and details in the text and what they have recorded in their science notebooks. Students work in groups to write paragraphs that describe the penguins' behavior and their environment. This task allows the teacher to assess how well the students understand and relate details in the text. Her lessons continue with descriptions of events from the book. She has students focus attention on descriptions in texts of the father penguin taking care of the egg in his brood patch while the mother penguin travels to get food and the mother penguin regurgitating the food to her newborn penguin chick when she returns. Mrs. G emphasizes the sounds offspring make and how the parent responds. These observations will be recalled when she introduces sound later in the year.

Finally, she instructs the students on writing skills so they can complete their own paragraph about penguins that includes some facts about penguins and provides some sense of closure.

Mrs. G wants her students to see that many of the behaviors the penguin parents have for their chick's survival exist in other polar animals, too. Over the course of several lessons, she shows the students videos about polar bears, their environment in the Arctic, and how polar bear parents care for their cubs. She also

reads aloud informational text about polar bear behavior and has students look at age-appropriate books about polar bears. She points out both polar bear and penguin parents must keep their offspring warm in a harsh environment and encourages her students to examine the differences in how they do this. Through a facilitated classroom discussion, she helps her students understand both polar bears and penguins feed their offspring, but that mammals and birds do this differently.

As a culminating activity, Mrs. G assigns a writing task in which her students pretend to be wildlife biologists studying patterns in penguin and polar bear family behavior. At this point, she reviews with the students their Web-chat with the scientists to remind them of how scientists obtain information. She encourages her students to collaborate as they write about how by looking at patterns of behaviors in penguins and polar bear families it is possible to observe that both types of animals face many of the same challenges, but meet their needs differently.

Performance Expectations

1-LS1-2. From Molecules to Organisms: Structure and Processes
Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

Science and engineering practices	Disciplinary core ideas	Cross cutting concepts
Obtaining, Evaluating, and Communicating Information *Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world.*	**LS1.B: Growth and Development of Organisms** *Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring survive.*	**Patterns** *Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.*

Connections to the CA CCSS for ELA/Literacy: RI.1.2, RI.1.7, W.1.2

Vignette Debrief

In this language-intensive instructional segment, the students focused on the science and engineering practice of **obtaining, evaluating and communicating information**. This practice, applied to sources provided by the teachers (informational texts, videos, and a live Web-chat with scientists), allows students to answer their own questions related to animals living in polar regions and gather information about penguin and polar bear behaviors. Observing the behaviors of the two types of animals towards their respective offspring allows students to determine a pattern between the needs of the offspring and how that need is communicated to and met by the parent.

The culminating performance task calls for students to develop a written text that aims at synthesizing some of the learning they have encountered by focusing on using patterns of behaviors to compare and contrast challenges and needs of penguins and polar bears.

CA NGSS Connections to English Language Arts and Mathematics

As students used informational text to obtain information about penguins and polar bears they identified the main topic and retold key details from the text. In their first encounter with the book *Penguin Chick*, they obtained information from the illustrations. In their second encounter, they obtained information from the word in the text. These activities connect to the CA CCSS for ELA/Literacy Standards RI.1.2, RI.1.6, and RI.1.7. The students used what they learned to write paragraphs about animal behavior, working both collaboratively and on their own. These writing activities connect to CA CCSS for ELA/Literacy Standard W.1.2.

RI.1.2 Identify the main topic and retell key details of a text.

RI.1.6 Distinguish between the information provided by pictures or other illustrations and information provided by words in a text.

RI.1.7 Use the illustrations and details in a text to describe its key ideas.

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.

Resources for the Vignette

- Tatham, Betty, and Helen K. Davie. 2002. *Penguin Chick*. New York: HarperCollins Publishers.

Grade 1-Instructional Segment 2: Meeting survival needs

This instructional segment builds on the ideas about the survival needs of plants and animals developed in kindergarten and on discussions of behaviors of parents that help offspring survive from instructional segment 1 in grade one. Through observations, read-aloud texts, and videos, students develop the language to describe the external parts of organisms, both animals and plants and their functions.

Grade 1-Instructional Segment 2: Meeting survival needs
How do plants and animals (including humans) use their senses and their external parts and features to aid their survival and growth? *How do plants and animals depend on one another for survival?* *How do humans mimic animal or plant features in objects they design?*
Highlighted Crosscutting Concepts: Structure and Function
Highlighted Science and Engineering Practices: • *Analyzing and interpreting data*
CA NGSS Performance Expectations: Students who demonstrate understanding can: 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.] K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. *The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

Background for Teachers

Students recognize that different body parts of animals are used to see, hear, grasp objects or food, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants. From these observations, students focus on designing a possible solution to a human problem by mimicking the external parts of animals or plants.

Description of the Instructional Segment

This instructional segment has the primary goal of allowing students to observe organisms in order to design a solution to a human problem that could be solved in multiple ways by borrowing ideas from the structure of the external parts of animals. Students are prompted with multiple examples to develop their own models to build their understanding of and apply the crosscutting concept of ***structure and function***. The students' models describe and explain how the shape of external body parts of an animal can be used to help them survive. Animal examples should include those that use multiple senses and the characteristics that support them (for example, the big ears of prey species used to detect sound for early awareness of predators or the fins on a fish that allow it to move quickly in water). Capabilities based on body structures and shape (e.g., claws used to dig or climb, beak shape related to specific food choices, long necks to reach food) should also be used as examples.

ELA ELD Connection
Read literature books, which could include *What If You Had Animal Teeth?* and *What If You Had Animal Hair?* by Sandra Markle and Howard McWilliam and *What Do You Do With a Mouth Like This?* and *What Do You Do With a Tail Like This?* by Steve Jenkins and Robin Page. Discuss and record how the different external parts and features of the animals aid in their survival and growth. Students could select one or more different parts of an animal(s) and create (or draw) a new animal. Each student should be able to explain the importance of each feature.

In this instructional segment, students benefit from closely observing real organisms to identify which body parts are associated with which function. For example, by studying crayfish in a classroom aquarium students can make claims supported by evidence demonstrating different body parts of the crayfish serve different purposes for the survival of the animal. Students can also obtain evidence from texts, videos, and online resources. They can record what they learn in drawings in which body parts are labeled and their function is identified. With teacher support, they can also create tables of information (see Table 3).

Table 3: Crayfish: how is the structure of a body part related to its function?	
Function	**Structure or behavior**
Get food	Mouth that opens, claws to grab.
Move	Lots of legs, body
Protect/defend, dig in ground, grab/hold food	Claws
Sensing the environment	Eyes, antenna
Gas exchange	Gills, skin

(Gomez-Zwiep and Polcyn 2015)

The idea that many tasks require an animal to apply a force to move or break open an object is connected the kindergarten instructional segment on forces. Learning about the structure and function of body parts engages students in performing simple research using books and other content-rich materials to find information, evaluate if it is relevant to answer classroom questions, and communicate information to each other, which is an application of the science and engineering practice, o**btaining, evaluating, and communicating information**.

The teacher introduces the ideas that plant pollination and seed dispersal are important to plant survival in this instructional segment. As students view videos, read texts and picture books, and listen to read-alouds about plants, the teacher prompts students to observe specific ***structure and function*** relationships between plants and their seed dispersal mechanisms. For example, plants such as dandelions and milkweed have seeds that are light and easily blown away by the wind. The seeds of maple trees and elms are wing-shaped to float along the wind. Some plants, such as fruit trees, depend on animals to disperse their seeds.

Mathematics Connection
Students could be challenged to create a model of a seed that depends on wind to disperse it (for example a dandelion seed). On a breezy day, the seed models could be flown to determine which models go the farthest. Students measure how far the model flew in standard or non-standard units. Questions that could be asked are: Which model flew the farthest? What about its design allowed it to fly farther? (Students could also be asked to put the models in order of how far they flew.

Dandelion

Milkweed

Maple

(Ragesoss 2007; Wikimedia Commons 2006; Didier Descouens 2012)

Engineering Connection

Finally, the instructional segment culminates with students developing an engineering design solution based on the idea that the great diversity of structure and function relationships in nature gives humans ideas that can be used as design examples for objects that solve a problem (bio-mimicking). For example, students might be asked

to design something to keep them warm or protect a part of their body. Students can draw on what they learned about how a penguin's feathers and a polar bear's fur protect them from the extreme cold of their environments to design coats with many layers of insulation. Their observations of the crayfish's claws could be the basis for designing a tool for digging in the dirt or picking up toys. (For information on the design process for kindergarten through grade two, see Figure 2.)

Grade One-Instructional Segment 3: Light and sound properties and uses

In this instructional segment, students have experiences with both sound and light that help them develop an understanding of how these two wave phenomena occur and how sound and light can be used to transfer information from one place to another. (At this grade level, students are not required to learn features of waves such as frequency, amplitude, or wavelength.) Students describe waves as regular patterns of motion as they observe the movement of the surface of a container full of water (such as a bucket or large bowl) when the surface is gently tapped with a finger. When waves move across the surface, the water goes up and down in place; it does not move in the direction of the wave, as students can observe by placing small pieces of paper on the surface of the water and watching the paper's movements.

Grade One-Instructional Segment 3: Light and sound properties and uses
Why do things look different in different light? *What happens when materials vibrate?* *How can we tell if light and sound travel from one place to another?* *How do we use light and sound?*
Highlighted Crosscutting Concepts: Cause and Effect, Systems and System Models
Highlighted Science and Engineering Practices: • *Planning and carrying out investigations* • *Constructing explanations and designing solutions*
CA NGSS Performance Expectations: Students who demonstrate understanding can: 1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

[Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]

1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.
[Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.]

1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.
[Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] [Assessment Boundary: Assessment does not include the speed of light.]

1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*
[Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]

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.

Background for Teachers

A sound wave is created when matter vibrates, and sound makes matter vibrate. When we hear a sound, we have perceived the vibration of the molecule of air inside our ears making our eardrum vibrate. The sound wave was originally created at a source, for example from a vibrating loudspeaker in a radio, and it propagated through the air (compressing and vibrating its gas molecules) until the vibration reached our ear.

Regarding light waves, students do not generally think about light as something that moves from place to place, but rather as something that fills a space and is either off or on. The purpose of activities in this instructional segment is to develop evidence that supports the idea that light travels from a source to an object and is either absorbed by or bounces off the object. Students learn that they see the object and its color because only light of that particular color bounces off and reaches their eyes. This understanding requires step-by-step conceptual development through the introduction of a series of situations and opportunities for students to observe light phenomena and discuss how light behaves.

Many light sources emit light in all directions. This is an important idea for explaining how the whole room seems to be full of light. However, it is useful to start with light sources that emit a narrow a beam, such as a laser (for example, a laser pointer) or a flashlight (with obvious reflections and shadows), to develop the idea of how light travels.

Other ideas that student need to develop are that objects look black when no light bounces off them and cannot be seen by people when it is really dark. There are a multiplicity of details students can observe, using light sources of different colors. For example, students can observe that a green object looks black in a red light and begin to understand this occurs because the object absorbs red light. Students can also observe that a prism spreads out the colors with incoming white light, sending different colors in slightly different directions. Note that at this grade level, it is not necessary to go beyond the observation of phenomena related to light of different colors and it is not necessary to introduce lenses or curved mirrors.

All of the investigations and observations above support the development and use of the crosscutting concepts of ***systems and system models*** and ***cause and effect***. For example, the system that allows a student to see an object is described by its components including the object, the light source, the light traveling from the source, and the eyes of the student.

To understand systems such as the one that allows them to see an object, students will need to develop a model in which the path of light is represented. They can use the model to explain things such as how the size of the shadow of a leaf changes as the leaf is moved closer to or further from the light source or why the shadows in a room with more than one light source have lighter and darker parts. These cause-effect observations allow students to develop the idea that light travels from the source, is reflected by an object, and is then absorbed by a detector.

The next part of this instructional segment begins to develop a similar set of ideas for sound. Here the idea that sound travels from a source (the speaker) to a detector (the ear or a recording device) is more likely to match students' perception, but students still need carefully designed activities, discussions, and models to refine and clarify their pre-conceptions about sound. For example, students may think they can hear noises from the next-door classroom because the sound travels through the air and enters into their classroom from underneath the door or through the air vents.

Description of the Instructional Segment

This instructional segment builds on the introduction of human and animal senses of sight and hearing in instructional segment 2. Students investigate and model the behavior of light and objects (shadows, transmission through some media but not others, and reflection on mirrors) to develop an explanation of these phenomena and how objects are seen. Students should develop an understanding that that light travels in a straight path from a source to an object and from the object to the eye (or camera), where it is detected. The examples include observations to develop the ideas that light can be one color (e.g., a laser light) or a mix of many colors; light from the sun contains all the colors of the rainbow; and the color an object appears to be depends not only on the properties of the object, but also on the color of light that shines upon it.

Students will also perform investigations with sound (e.g., various musical instruments, tuning forks) to understand the properties of sound (e.g., variety of sound

pitch, travel of sound in all directions from a source to an object that can detect it) Student activities should involve observations that make the connection between the sound and vibration of an object or medium through which the sound travels (solids and liquids are the only media emphasized here, not gases).

Engineering Connection

The instructional segment provides opportunities for students to develop explanations of how humans detect light and sound with our eyes or ears and with various technology to assist them. Students learn how human use light and sound to gather information about our surroundings and to communicate information to others. Students can then design and build a simple device using sound or light to communicate from one side of the classroom to the other. For example, students can design communication devices using paper cups and strings and make an observation that the "signal" (their voice) is most clearly transmitted when there is tension in the string. Small pieces of paper could be attached to the string, like little flags, to show the vibration is being transmitted through the string.

Mathematics Connection

When students design and construct the paper-cup-and-string communication device, students could experiment with different lengths of string to find the optimal or longest length that still allows communication. Students in Grade One do not use standard units of measure, but understand the concept of re-iterated units to measure length. For example, students could choose among a paper clip, a craft stick, or a yard stick as a unit of measure.

Grade One Snapshot: Sounds Wild

Mr. K, a first grade teacher, has created an interdisciplinary instructional

segment called Sounds Wild to demonstrate to his students how animals use special parts of their bodies to make sounds. Through this instructional segment, Mr. K helps his student connect what they learned about the function of different animal body parts to how animals make sounds

He engages the students by reading two stories about crickets and the sounds they make: *I Wish I Were A Butterfly* by James Howe and *The Very Quiet Cricket* by Eric Carle. To learn what real crickets sound like, the students watch a video of live crickets. . Students draw diagrams of a cricket and label its body parts, paying particular attention to the wings as the source of the cricket's sound. The students use construction paper to develop a large-scale model of a cricket and add a strip of sandpaper to the edge of a wing to simulate the chirping effect. During a music lesson, students continue exploring how sound is generated by playing scrapers, a simple musical instrument that mimics the way crickets make sounds.

Mr. K presents a combination of stories, informational texts, and videos as resources students use to study the rattle of rattlesnakes, the howling of coyotes, and screech of bats. The students learn about the specific external part of the body in the animal that vibrates to produce sound and can locate the sound-producing body part on pictures of the animal Mr. K connects music to science with an engineering design challenge: students design and build their own sound instruments. The shakers, scrapers, and string instruments they create communicate the students' understanding of the process in which the animals create sound and that sound is caused by vibrations.

In anticipation of instructional segment 4, students should also begin making observations of the light from the sun and the moon. Their observations should include and record data on how the sun's position on the horizon and the time at sunrise and sunset change from day to day and how the brightness, shape, and times of appearance of the moon change over the month. These observations should be recorded starting at the beginning of the year, but are not discussed in detail until instructional segment 4. Teachers may choose to interweave some of the content of

that instructional segment into this one or even to combine the two as a single instructional segment.

Grade One-Instructional Segment 4: Patterns of Motion of Objects in the Sky

The purpose of this instructional segment is for students to make observations of the sun, moon, and stars and develop ways to record, describe, and organize their patterns of motion. At this stage of their learning, it is more important for students to recognize through their own observations that there are predictable patterns of change, and thus there is something that needs an explanation, than to learn through lecture or texts.

Grade One-Instructional Segment 4: Patterns of Motion of Objects in the Sky
When will the sun set tomorrow? *How does the moon's appearance change over each month?* *Are there stars in the daytime?*
Highlighted Crosscutting Concepts: Patterns
Highlighted Science and Engineering Practices: • *Analyzing and interpreting data* • *Planning and carrying out investigations*
CA NGSS Performance Expectations: Students who demonstrate understanding can: 1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.] 1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

Background for teachers

Students can begin to develop the roots of the explanations through observations such as looking at the moon and the sun when both are visible at the same time. They develop a model to explain any relationship they can see between the position of the sun and the shape of the bright and shadowed parts of the moon, if they imagine the moon as a ball. Students build on what they learned about how light travels in instructional segment 3 to develop their models.

Description of the Instructional Segment

In order for part of this instructional segment to be successful, it is important that students record data about the amount of daylight throughout fall, winter, and spring so they can draw comparisons between observations at different times of the year. Data on sunrise and sunset times and the locations of planets and stars can be found in a number of sources, including local newspapers and online resources.

Students' observations of the time of sunrise or sunset over multiple days across the year are analyzed using the same point of reference to develop a model for the pattern of change students observe. Students use this pattern to predict whether the time of sunset or sunrise will be later or earlier than the previous day for the next few days. The model should be visual, such as a graph of times of sunset for several days or a clock face marked with sunset times for successive days. (First-grade students are not expected to develop an explanatory model that can justify these differences.) Other visual representations could also be used, such as pictures of the same landscape or outdoor feature that have been taken at the same time of the day, but during different times of the year. Class discussions and reading should include children's stories from their own

ELA ELD Connection
Student can become familiar with the necessary vocabulary and the different phrases of the moon through a series of read-aloud books, such as *The Moon Book* by Gail Gibbons; *Faces of the Moon* by Bob Crelin; *Phases of the Moon* by Gillian M. Olson; and *The Moon Seems to Change* by Franklyn M. Bradley.

experiences and literature that emphasize how the length of day is different at different times of the year.

Observations of the moon may include features such as when it rises and sets, whether it is ever visible by day, and how its apparent shape changes over the month. These student observations can be recorded and analyzed over a period of months. One way to record the observations is through a series of photographs taken throughout the day over a period of several months. Students choose a pattern to analyze and discuss what kinds of predictions they can make based upon these observations. Observations of the phases of the moon can be linked to the instructional segment 3 investigations of how we see objects only when they are lit up (by internal or external sources) and how light travels and reflects. Students should begin to understand that the apparent change in the shape of the moon could be related to where the light is coming from and where we are looking from, but it is not the intent of this instructional segment that students develop or memorize a model that gives a full explanation of this phenomenon.

Connecting to the properties of light from instructional segment 3, students can also make observations about when it is possible for them to see stars. Students learn that stars are always present in the sky even if we cannot see them. Teachers ask students questions about their observations, such as “At what time of day will you be able to see stars? How much light is around them?” Alongside these observations, students investigate whether they can see a small dim light when it is placed so the light from it passes close to a much brighter light on its way to the observer. Based on these two sets of observations, students can discuss whether they think the stars could be still shining during the day or whether the fact the students cannot see means they are not there, not “on”.

The following vignette is an example of how teaching and learning focused on the disciplinary core idea ESS1.A: The Universe and its Stars and the PE 1-ESS1-1Use observations of the sun, moon, and stars to describe patterns that can be predicted

1031 might look in a first-grade classroom.
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Grade One Vignette

Patterns of Motion of the Sun

Introduction

Mrs. H is planning an instructional segment of study in which students observe the patterns of motion of objects in the sky, specifically the Sun. She wants her students to observe and then describe the movement of the Sun in the sky throughout a school day. The observation of these regular patterns of movement across multiple days will provide students a foundational understanding of disciplinary core idea ESS1.A: The Universe and Its Stars. This instructional segment also allows a strong connection between the crosscutting concept of ***patterns*** and the science and engineering practice of **analyzing and interpreting data**. She considers this instructional segment to be a natural link to what the students have learned in mathematics about time and plans to include concepts related to time measurement to integrate mathematical concepts.

Day 1 - Shadows

Mrs. H begins her instructional segment on Groundhog Day (traditionally celebrated on February 2nd). As the school day begins, she reads a story about the groundhog and its shadow to engage the students. She tells them that they will be observing their shadows over the next few days. Immediately after reading the story, Mrs. H takes the students outside to a paved section of the school grounds. The students will return to this location to observe and measure their shadows during the week. The students work in partners to trace their shadows. Students put two chalk Xs to mark the position of the feet where one student is standing while the other traces the shadow on the pavement. They are amazed at the length of their shadows!

Just before lunch they return to their traced shadows, place their feet on the Xs, and trace the new position of their shadow. “It’s so short!” Mrs. H asks the students to predict where and how long their shadows will be in a few hours. At the end of the school day, the students return one more time to trace the new position of their shadows. Before they leave school for the day, the students compare their predications with the actual position and length of their shadows.

Days 2-5 – Observations and Patterns

The students observe the position of their shadows and measure the length of the shadow from the position of their feet to the head of the shadow at the same three times each day for three days during the week. With assistance from Mrs. H, the students record the length and position on charts she has prepared for them. The chart has places for students to write the date, the time, and the length of their shadow and to draw a picture of position of the shadow. By recording the time of their observations, students practice telling and writing time by the hour and half hour, a connection to mathematics.

Mrs. H can also work with the expanded learning program at the school so that students measure shadows during the late afternoon to provide students with more opportunities to identify patterns based on additional observations and recording of information.

When the students analyze the data in their charts, they can see that there is a pattern between the length of the shadow and the time of day, but that every day throughout the week the length of the shadow does not change much. Mrs. H knows they are ready for an explanation.

Mrs. H explains how the Earth rotates each day, and night is really Earth’s shadow. She encourages the students to realize the position of the Sun in the sky shows the amount the Earth has rotated. This is proven by the changes in their shadows’ position. Mrs. H leads the students to understand that when the Sun is

close the horizon in the morning, their shadows are longer than they are at noon when the Sun is nearly overhead.

Mrs. H wants her students to create a model to take home to share what they have learned with their families. She distributes pieces of heavy paper, glue sticks, and pieces of cardboard to serve as the base on which the students build their models. She asks, “Is there a way to design a smaller scale model that could be set outside to show how the size and position of shadows change?” The students work in groups to design and test models. One model the students might create is to cut the heavy paper into the shape of a student, glue the shape onto an edge of the base, and draw shadows of different lengths onto the base. The students label the drawings with the time of day the shadow was made.

Once the students have completed their models, Mrs. H asks the students to write an informative text about their observations and the models they created to explain what they learned. She reminds them to look at the charts in which they recorded their observations and think about the patterns they noticed before they begin to write.

Instruction and learning about the universe and the stars is not yet complete. Mrs. H started with the Sun because the observations could be made during the school day, .but the students still need to observe the stars and the moon.

Performance Expectation
1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.

Science and engineering practices	**Disciplinary core ideas**	**Cross cutting concepts**
Analyzing and Interpreting Data	**ESS1.A: The Universe and its Stars** Patterns of the motion of the sun, moon, and stars in	**Patterns**

	the sky can be observed, described, and predicted.	

Connections to the CA CCSSM: 1MD.3

Connections to the CA CCSS for ELA/Literacy: W.1.2

Vignette Debrief

The CA NGSS require that students engage in science and engineering practices to develop deeper understanding of the disciplinary core ideas and the crosscutting concepts. The lessons give students multiple opportunities to engage in the core ideas in Earth and space science, helping them to move towards mastery of the three components (SEPs, DCIs, CCCs) described in the CA NGSS performance expectation.

In this vignette, the teacher selected one PE and in the lessons described above, she engage the students in only a portion of the PE. Students will need additional learning opportunities to fully master this PE. The students were engaged in the science and engineering practices with a focus on **analyzing and interpreting data** and the cross cutting concept of ***patterns***.

The students observed the motion of the Sun by collecting and recording information about the length and location of their shadows. They created a model to explain the patterns they discovered through their observations.

CA NGSS Connections to English Language Arts and Mathematics

Students use information they collected and recorded to write informational/explanatory texts to accompany their models. This connects to the *CA CCSS for ELA/Literacy* Standard W.1.2. As they recorded their observations of their shadows, they wrote down the time of their observations. This connects to the *CA CCSSM* Standard 1.MD.3

W.1.2 Write informative/explanatory texts in which they name a topic, supply facts

about the topic, and provide some sense of closure. **1.MD.3** Tell and write time in hours and half-hours using analog and digital clocks.
Resources for the Vignette Teacher-selected book on Groundhog's Day

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