The sequence of instructional segments in this example (table 3.3) is driven by the need to collect data about slowly occurring natural processes: a garden that grows slowly (IS1) and changes in the sky (e.g., the time and location of sunset) over a large portion of the year (IS4).

Grade One Instructional Segment 1: Plant Shapes

In kindergarten, students recognized patterns in what plants need to survive (K LS1–1). In this instructional segment, they look more closely at the shapes and parts of plants and begin to ask questions about what purpose these parts serve, how the shape of the parts helps them accomplish this purpose, and how the shapes of young plants are similar to the shapes of their parents.

GRADE ONE INSTRUCTIONAL SEGMENT 1: PLANT SHAPES

Guiding Questions

- How can we tell different types of plants apart?
- How do these differences help the plants?

Performance Expectations

Students who demonstrate understanding can do the following:

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.]orns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

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.*]

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.

Performance expectation introduced, but not assessed until later segments:

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.*] (IS4)

GRADE ONE INSTRUCTIONAL SEGMENT 1: PLANT SHAPES

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.*] (IS3)

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

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
[SEP-1] Asking Questions and Defining Problems [SEP-2] Developing and Using Models [SEP-3] Planning and Carrying Out Investigations [SEP-4] Analyzing and Interpreting Data [SEP-6] Constructing Explanations (for science) and Designing Solutions (for engineering)	LS1.A: Structure and Function LS3.A: Inheritance of Traits LS3.B: Variation of Traits ESS1.A: The Universe and its Stars PS4.B: Electromagnetic Radiation ETS1.B: Developing Possible Solutions	[CCC-1] Patterns [CCC-6] Structure and Function

Highlighted California Environmental Principles and Concepts:

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

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

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

CA CCSS Math Connections: 1.MD.2

CA CCSS for ELA/Literacy Connections: W.1.1, 8; SL.1.4

CA ELD Standards Connections: ELD.PII.1.6

Before embarking on any of the scientific practices, students need to appreciate science as the study of the world around them. Children are natural scientists and are innately curious. This instructional segment focuses that desire for exploration on plants. Different students have different levels of experience observing plants in nature. Some schools are situated in urban settings where plants are rare while other families might have backyard

vegetable gardens. To give all students a common library of observations, students embark on a schoolyard nature hunt with the instructions to collect as many natural objects as they can. They can pull weeds growing in sidewalk cracks, pluck blades of grass, collect fallen leaves, and gather a handful of sand from the sandbox. Back in the classroom, they look for **patterns [CCC-1]**. Can they sort the objects into different categories based on these patterns (such as plants, rocks, and animals)? Which objects might come from plants? How can they tell? Since different schoolyards have different natural elements, the hunt could be extended as a homework assignment to collect natural objects from around the neighborhood, or a teacher may need to accumulate a small collection to share with the students. Students might discover different seedpods or a range of leaves (figure 3.5). Students write an observation about what they see (given a sentence frame, if necessary) and **ask a question [SEP-1]** related to their observation (e.g., What causes those leaves to be red? What is inside an acorn? Why is some bark smooth and other bark rough? Why do different plants have different shape leaves?) At this stage, the focus is on stimulating curiosity and asking questions, so teachers do not need to know all the answers. Many of the questions will remain unanswered until much later in students' careers, which reflects the practice of professional scientists who often have questions that they do not have enough information to answer. Teachers can maintain a nature table with a rotating collection of found objects throughout the year. They can refer to objects on the table when related concepts come up later in the year, or they can photograph them for future reference. The goal of these activities is to focus student attention on natural phenomena around them.

Figure 3.5. Diverse Seeds and Leaves Collected by Students at a School with a Garden

Sources: Descouens 2012; M. d'Alessio; Mdf 2006; Ross 2007

Opportunities for Mathematics Connections

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 nonstandard units. Questions that could be asked include the following: 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.

CA CCSSM: 1.MD.2

Students next focus on observing specific structures within plants. The best way to do this is to grow plants in small pots or planter boxes outside the classroom, or, alternatively, mini or herb gardens in plastic containers grown inside. Growing food can introduce healthy eating habits (CA Health Education Standards K1.1.N) and ways that humans depend on things that grow for our own survival (EP&C I). A variety of vegetables, including leafy greens (lettuce), root vegetables (radishes), and climbing vines (snap peas) grow well in autumn gardens in California. These plants have very different shapes (both above and below ground) when they are fully grown. Students **conduct an investigation [SEP-3]** tracking how the plants change over time. Does a tiny baby lettuce look like lettuce they buy in the store? If they pick a radish when it is young, how is it similar to one picked later? Students should be able to **provide evidence to support the argument [SEP-7]** that young plants are similar to their parents (1-LS3-1). This argument forms the foundation for the concept of inheritance that students will investigate during grade three.

Engineering Connection: Using Bio-Mimicking to Solve a Problem

Nature gives humans ideas that can be used as design examples for objects that solve a problem (bio-mimicking). Students should be able to use plant structures to **design [SEP-6]** something that solves a problem they have at school. For example, students design a coat rack that has enough hooks to hold their jackets. How thick should the base be? How should it connect to the ground in order to be stable? Students can look at trees to help decide. Perhaps they want to send a message across the schoolyard. Students could design a message carrier based on the shape of seeds that disperse in the wind. Or perhaps they want to construct a new rope ladder for their playground structure. How will they attach it? They can look to the tendrils of a snap pea. Students should be able to describe how the **structure of their object helps achieve its function [CCC-6]**, possibly illustrating it with a simple sketch or diagram showing their invention and the plant structure that inspired it (K–2 ETS1–2).

Sample Integration of Science and ELD Standards in the Classroom

Students 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 (1-LS1-1). As they investigate mimicking solutions for clothing or equipment inspired by nature, the teacher guides them to combine clauses, through a process of examining a text for the ways an author combines ideas and then trying it out together using joint construction. The result is sentences such as the following: (1) a turtle hides under its shell *when* threatened by a predator; (2) *although* the turtle may be turned upside down, the shell provides protection; and (3) biking helmets protect us *because* we design them to resemble turtle shells. Prior to this lesson, during designated ELD time, students at the Emerging and early Expanding levels of English proficiency have practiced combining similar sentences in more simple ways: A shell protects a turtle. A helmet protects a person riding a bike. A shell protects a turtle, and a helmet protects a person riding a bike. The teacher supports students' understanding through using pictures, highlighting cognates (e.g., *protect/proteger*), and allowing students to use their home language in partner discussions.

CA ELD Standards: ELD.PII.1.6
Source: Lagunoff et al. 2015, 240–241

Students know from kindergarten that plants need light to survive (K-LS1-1), so what happens when taller plants begin to shade shorter plants? Teachers can introduce the concept that thin leaves are translucent and allow some light to pass through them so that plants below them can still survive while thicker leaves are more opaque and block more light. This observation is one form of an **investigation [SEP 3]** into the how light interacts with different materials (1-PS4-3; though students are not ready to be assessed on this performance expectation until they complete a more detailed investigation in IS3). Many people associate science practice with *experiments*, but CA NGSS uses the term *investigation* because students do not necessarily have to manipulate things in order to gather evidence. Students make observations at different times of day to determine when specific plants are in the shadow of another plant. Repeating the observation over several days allows students to recognize that the Sun moves following a predictable pattern and has natural cycles (EP&C III). In fact, by **analyzing [SEP-4]** a few days of observations about the exact time when a plant starts being shaded, students should be able to predict when it will be shaded on a subsequent day (1-ESS1-1). Students can also begin observing the amount of daylight during the autumn that they can later compare to winter and spring (1 ESS1 2).