Integrated STEM Unit Planner

Grade 1 Science

Protect a Water Balloon

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PreK-12STEM

Community Training & Assistance Center (CTAC)

Tracy Unified School District

About the Integrated STEM Units

The integrated STEM units are a product of the partnership between Community Training and Assistance Center (CTAC) and Tracy Unified School District (TUSD) in California, funded in part through the Education Innovation and Research (EIR) program of the U.S. Department of Education in 2018. Teacher leaders came together to develop innovative units that align to STEM standards for student learning—namely the Next Generation Science Standards (NGSS) for California Public Schools, the Computer Science Content Standards derived from the national K-12 Computer Science Framework, and the California Common Core State Standards.

Each integrated unit brings together the following:

- an engineering design challenge
- one or more computational artifacts
- core science and math content
- language building opportunities
- engagement supports

Students in each grade level, pre-kindergarten through twelve, engage with the unit for about one or two months as part of their required coursework. The units are integrated and self-contained as a means to provide all students with equitable STEM experiences.

About the Partners

Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading teachers from the district contributed to the development of the units. Computer Science integrations resulted with support from the San Joaquin County Office of Education and Bootstrap of Brown University.

Terms of Use

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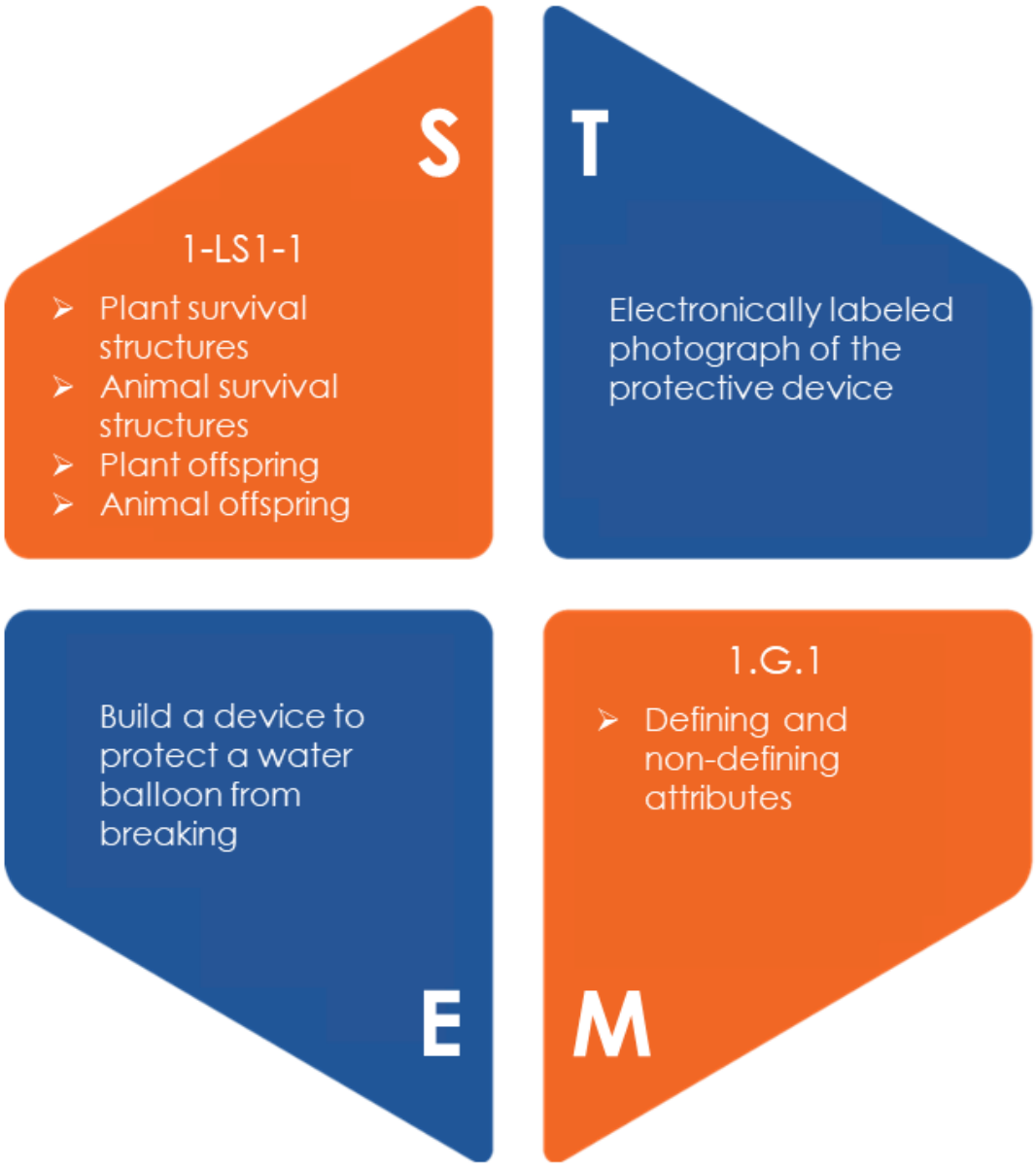
Big Picture

Unit Emblem



Focal Standard

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.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing a short video of heavy winds bending palm trees (Caters Clips, 2019)[i] (https://bit.ly/30egcXj). Students will learn about plant survival structures as they consider the essential question: What do we know about plants and animals that can be used to help solve a human problem?

This will lead to the introduction of the design challenge: To build a device to protect a water balloon from damage. Students will begin to ***ask*** questions like: How do humans get hurt? What do we do to try to stay safe? How do plants and animals protect themselves? How can we use that information to protect people?

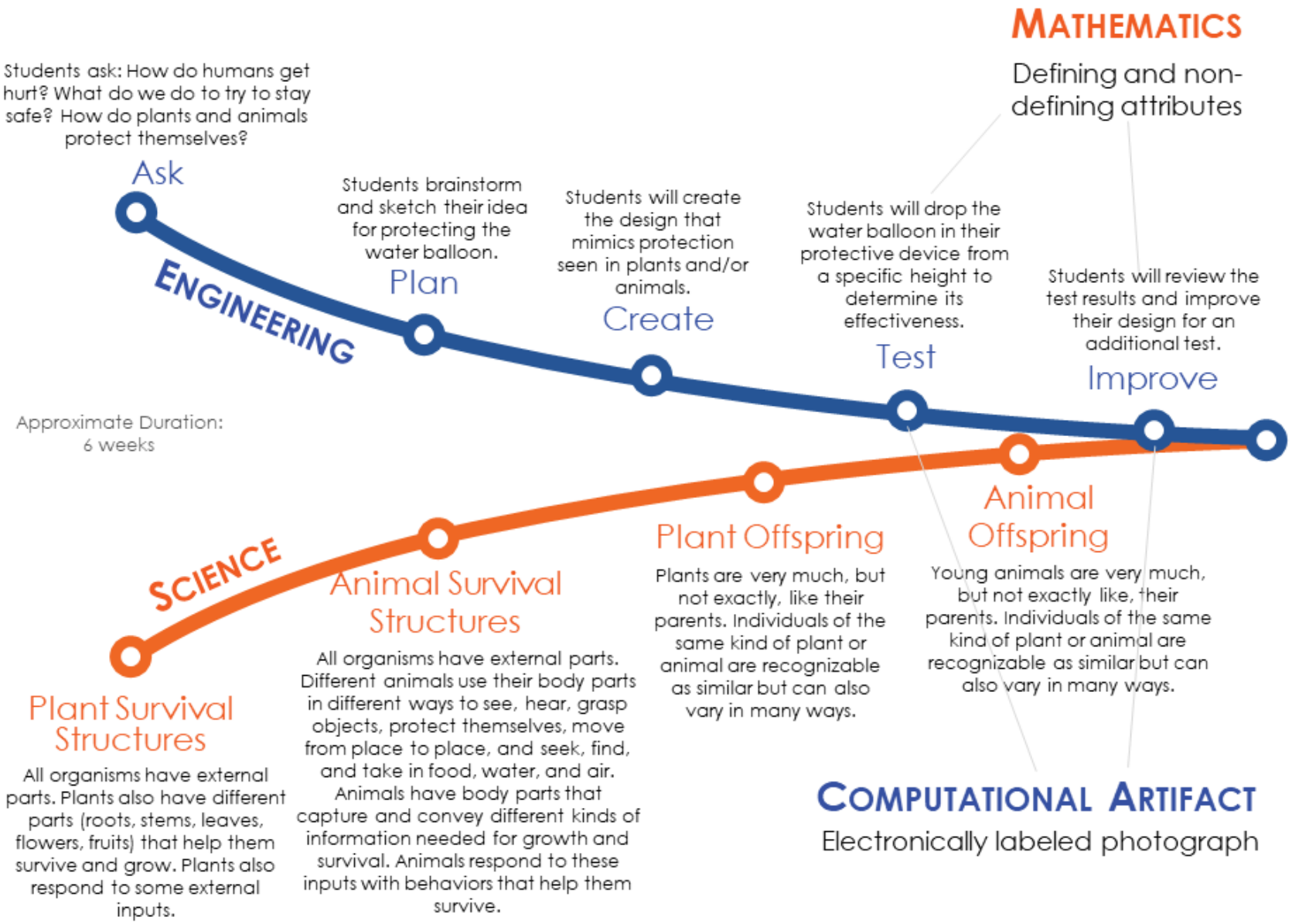
Sequence 2: Students will learn more about survival techniques used by animals. Based on this learning, students will brainstorm for possible solutions and draw a design of a device for protecting the water balloon. They will ***plan*** how they will build their model.

Sequence 3: Students will consider the materials available and begin to ***create*** their device. Students will continue to learn about survival techniques and plant offspring.

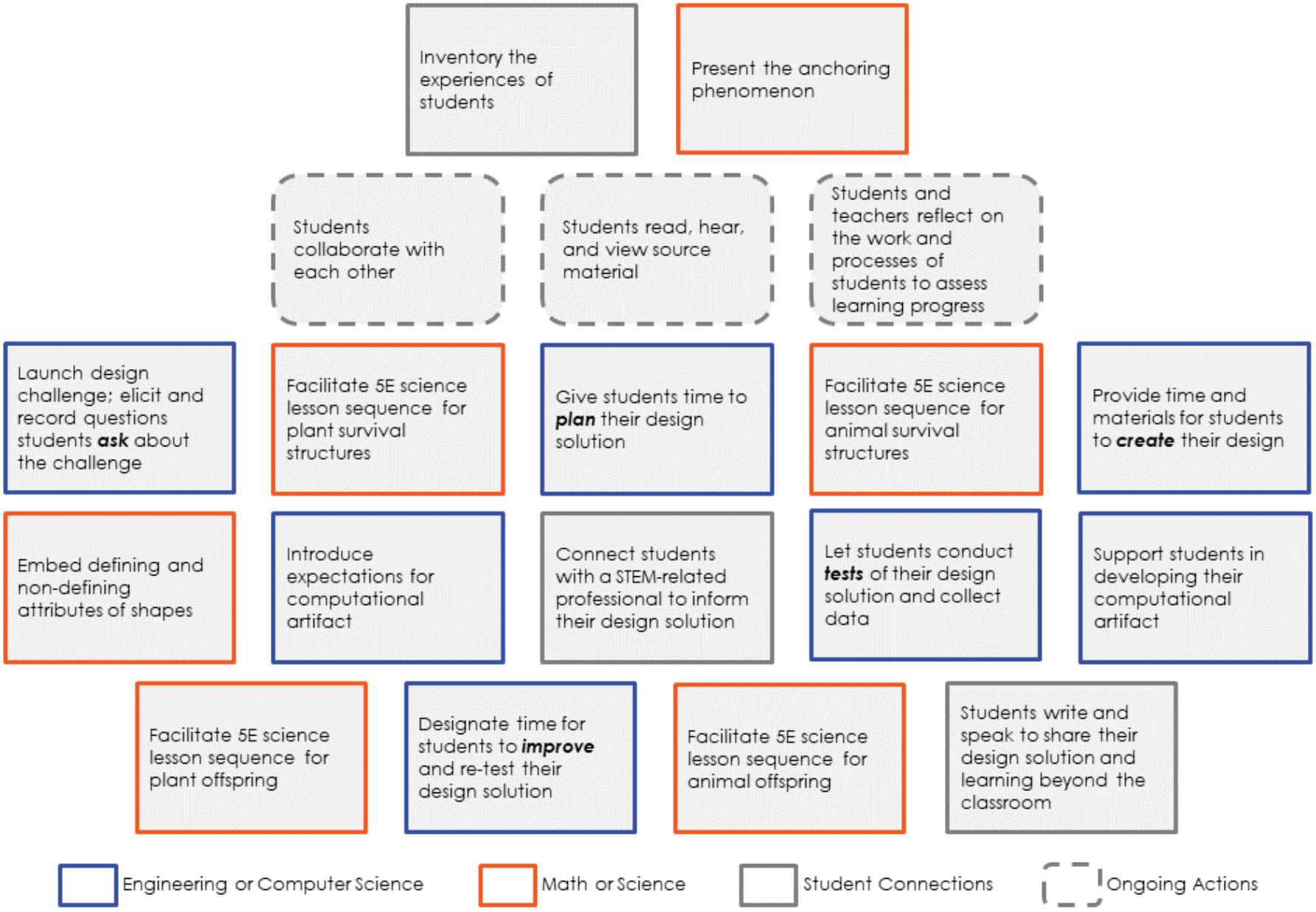
Sequence 4: Students will learn more about animal offspring and similarities between parents and the offspring. Students will ***test*** the effectiveness of their design by dropping their water balloon from a given height. They will record their observations as well as observations of the work of their fellow students.

Sequence 5: Students will reflect on what they learned from their test and observations of others and will revise the plan to ***improve*** their model.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Build a device to protect a water balloon from breaking.

Type of Engineering: Product Design Engineering

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *How do humans get hurt? What do we do to try to stay safe? How do plants and animals protect themselves? How can we use that information to protect people?*	**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. • A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) • Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
Plan *Students brainstorm and sketch their idea for protecting the water balloon.*	**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. • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)
Create *Students will create the design that mimics protection seen in plants and/or animals.*	
Test *Students will drop the water balloon in their protective device from a specific height to determine its effectiveness.*	**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. • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)
Improve *Students will review the test results and improve their design for an additional test.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create an electronically labeled photograph of the water balloon protective device.

Computational Artifact

Definition: Anything created by a human using a computational thinking process and a computing device. A computational artifact can be, but is not limited to, a program, image, audio, video, presentation, or web page file. (Source: College Board, 2016)

- An electronically labelled photograph

Hardware

Definition: The physical components that make up a computing system, computer, or computing device. (Source: MDESE, 2016)

- Computer with camera

Software (includes programs, applications, websites, etc.)

Definition: Programs that run on a computing system, computer, or other computing device. (Source: k12cs.org)

- Microsoft Word or PowerPoint

Standards

- **K-2.DA.8** Collect and present data in various visual formats.
- **K-2.DA.9** Identify and describe patterns in data visualizations, such as charts or graphs, to make predictions.

Science

Focal Standard

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.]

Related Content Standards

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.]*

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing a short video of heavy winds bending palm trees (https://bit.ly/30egcXj)

Content Outline

Below is a content outline for the science content in this unit. It includes the key concepts within the unit along with an approximate number of days it would take to facilitate a sufficient amount of student learning experiences. For each key concept, key learnings appear, which come from the grade band endpoints in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (source: https://www.nextgenscience.org/framework-k-12-science-education). The storyline begins with an anchoring phenomenon.

Key Concept	Key Learnings	# of Days
Plant Survival Structures	• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots,	6

Key Concept	Key Learnings	# of Days
	stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1) • Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	
Animal Survival Structures	• All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, 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 and grow. (1-LS1-1) • Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	6
Plant Offspring	• Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1) • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	6
Animal Offspring	• Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1) • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	6

Science and Engineering Practices	Crosscutting Concepts
1. Asking questions and defining problems **2. Developing and using models** **3. Planning and carrying out investigations** **4. Analyzing and interpreting data** 5. Using mathematics and computational thinking **6. Constructing explanations and designing solutions** 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information	**1. Patterns** 2. Cause and effect 3. Scale, proportion, and quantity 4. Systems and system models 5. Energy and matter **6. Structure and function** 7. Stability and change

Note. Bolded items are called out specifically in the standards cluster for this unit.

Mathematics

Description of Student Engagement

Students will describe their protective device in terms of defining and non-defining attributes.

Standards for Mathematical Content

1.G.1. Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size); build and draw shapes to possess defining attributes.

Standards for Mathematical Practice

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

MP.3 Construct viable arguments and critique the reasoning of others.

MP.4 Model with mathematics.

MP.5 Use appropriate tools strategically.

MP.6 Attend to precision.

MP.7 Look for and make use of structure.

MP.8 Look for and express regularity in repeated reasoning.

Note. Bolded items are emphasized in this unit.

English Language Arts and Development

Reading Standard: Key Ideas and Details

RI.1.3 Describe the connection between two individuals, events, ideas, or pieces of information in a text.

RL.1.2 Retell stories, including key details, and demonstrate understanding of their central message or lesson.

Reading Standard: Integration of Knowledge and Ideas

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

Writing Standard: Text Types and Purposes

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.

W.1.3 Write narratives in which they recount two or more appropriately sequenced events, include some details regarding what happened, use temporal words to signal event order and provide some sense of closure.

Speaking and Listening Standard: Comprehension and Collaboration

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.

Language: Conventions of Standard English

L.1.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

L.1.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Unit Vocabulary

The following terms reflect the core vocabulary students should understand and use in this unit.

- **balance**: Balance means a steady position or condition. (Source: https://www.merriam-webster.com/dictionary/balance)
- **disperse**: To disperse means to break up and scatter. (Source: https://www.merriam-webster.com/dictionary/disperse)
- **external parts**: External parts or structures are the visible components of a plant or animal. This would include things like the stem, leaves, and flowers of plants and the arms, legs, eyes, and ears of animals.
- **flower**: A flower is the part of a plant that is often brightly colored, that usually lasts a short time, and from which the seed or fruit develops. (Source: https://www.merriam-webster.com/dictionary/flower)
- **fruit**: A fruit is the part of a plant that has the seeds in it (such as the pod of a pea, a nut, a grain, or a berry). (Source: https://www.merriam-webster.com/dictionary/fruit)
- **grow**: To grow means to spring up and develop to maturity. (Source: https://www.merriam-webster.com/dictionary/grow)
- **leaves**: Leaves are the flat and typically green parts of a plant that grow from a stem or twig. (Source: https://www.merriam-webster.com/dictionary/leaf)
- **mimic**: To mimic means to imitate (something or someone) very closely. (Adapted from: https://www.merriam-webster.com/dictionary/mimic)
- **offspring**: Offspring are the young of a person, animal, or plant. (Source: https://www.merriam-webster.com/dictionary/offspring)
- **pangolin**: A pangolin is a mammal with scales and a general appearance of an anteater.
- **pattern**: A pattern is the regular and repeated way in which something is done [or something appears]. (Source: https://www.merriam-webster.com/dictionary/pattern)
- **problem**: A problem is something that is difficult to deal with : something that is a source of trouble, worry, etc. (Source: https://www.merriam-webster.com/dictionary/problem)

- **quill**: A quill is a hollow sharp spine of a porcupine or hedgehog [or a large bird]. (Adapted from: https://www.merriam-webster.com/dictionary/quill)

- **resource**: A resource is supply of materials, energy or goods that can be used by others. Natural resources are those materials humans can use that exist in the environment.

- **roots**: Roots are the part of a plant that grows underground, gets water from the ground, and holds the plant in place. (Source: https://www.merriam-webster.com/dictionary/roots)

- **scales**: Scales are the small stiff plates that cover much of the body of some animals (as fish and snakes). (Source: https://www.merriam-webster.com/dictionary/scales)

- **shell**: A shell is the hard outer covering of an animal, insect, etc., that protects it. (Source: https://www.merriam-webster.com/dictionary/shell)

- **similar**: Similar means to be almost the same as someone or something else. (Source: https://www.merriam-webster.com/dictionary/similar)

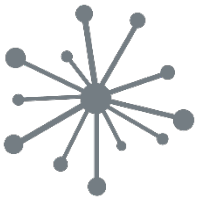
- **stable**: Stable means not changing or fluctuating. (Source: https://www.merriam-webster.com/dictionary/stable)

- **stem**: A stem is the main stalk of a plant that develops buds and shoots and usually grows above ground. (Source: https://www.merriam-webster.com/dictionary/stem)

- **survive**: To survive means to remain alive or to continue to live. (Source: https://www.merriam-webster.com/dictionary/survive)

- **thorn**: A thorn is a hard sharp leafless point on the stem or branch of a plant (as a rose bush). (Source: https://www.merriam-webster.com/dictionary/thorn)

Assessment Tools



Student Experience Inventory

Teachers can use the following prompts with students prior to the beginning of the unit or early in the unit in order to learn about students' experiences that relate to the unit. Teachers can make informed instructional decisions based on this learning, enabling tailored opportunities for students to make their own meaning.

Student Prompts

1. Tell me about a time you got hurt.
2. Have you ever seen someone else or experience getting poked by a plant or bush yourself?
3. Talk about a time when you saw a puppy. (What did you notice? Did you see on of the parents of the puppy? What did you notice about that?)
4. Who do you live with? How alike or different are you to others who are around you?
5. Think about someone else who is important to you with whom you share some common characteristics. How are you similar?

Aligned Learnings

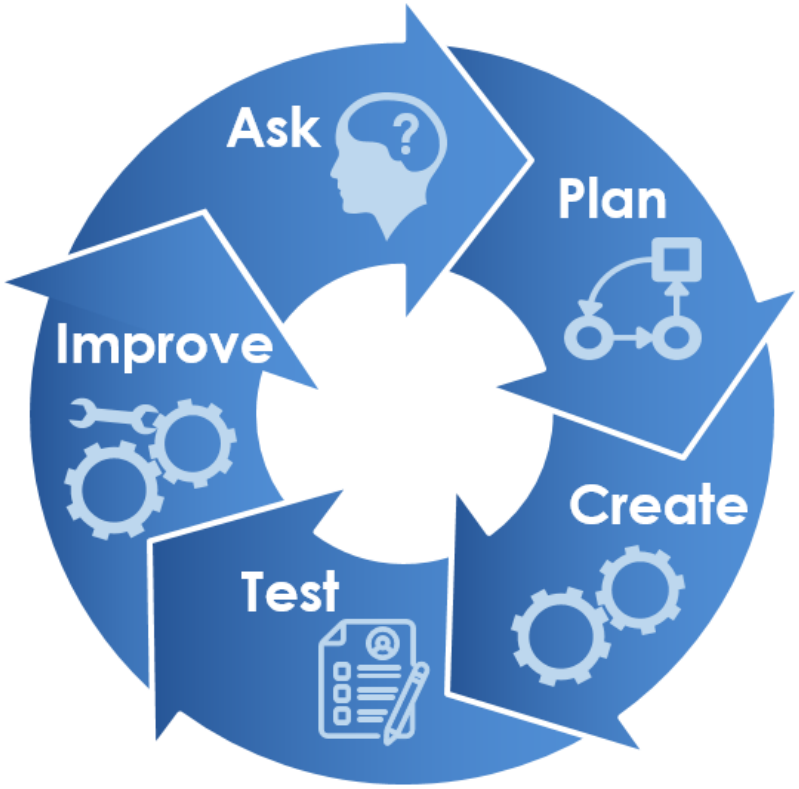
1. Responses to this item provide insight into students' experiences with personal protection from harm. 1-LS1-1
2. Responses to this item provide insight into students' experiences with plant protective devices. 1-LS1-1
3. Responses to this item provide insight into students' experiences with animal offspring. 1-LS3-1
4. Responses to this item provide insight into students' experiences with similarity in offspring. 1-LS3-1
5. Responses to this item provide insight into students' experiences with similarity across humans who might not be related. 1-LS3-1

Student Self-Assessment of Engineering

Improve:
Here is what would make my design better and why…

Ask:
Here is what I am wondering about before I plan my design…

Plan:
Here are my design ideas for the project…



Test:
Here are the data I collected…

Create:
Here is what I think about what I made compared to what I planned, and here is what I think will happen when I test it…

I am doing the work of a product design engineer.

One-Point Design Challenge Rubric

Criteria serve as a primary reference point throughout the engineering design process. Teachers use the criteria **to communicate expectations** and **to guide students**. With teacher guidance, students use the criteria to inform and reflect on their work.

Approaches Expectations *Notes on how to improve the project*	**Meets Expectations** *Criteria indicating success*	**Exceeds Expectations** *Notes on how project goes beyond expectations*
	Engineering Students participate in the 5-part engineering design process, use data, and make thoughtful improvements to their design. (K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3)	
	Computer Science Students create an electronically labelled photograph of the water balloon protective device (K-2.DA.8, K-2.DA.9)	
	Collaboration Students contribute and support others with honesty and kindness (SL.1.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.1.2, W.1.3). Students will share thoughts, read, and listen to learn from others. (SL.1.1)	
	Science Students use observations to construct evidence-based accounts that young organisms are like but not exactly like their parents. Students will be able to demonstrate how the physical traits of an organism can be used to solve a human problem. (1-LS-1)	

Engagement

Community and Career Connections

During the unit, students engage with STEM professionals who can inform students' work at some point during the engineering design process. The interaction with STEM professionals serves a few purposes:

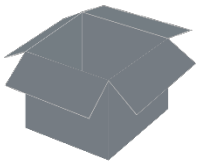
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

Below are a few potential STEM-related professionals that align to one of California's 15 industry sectors for Career and Technical Education:

- **Fire Fighter** (Public Services)
- **Construction Worker** (Building and Construction Trades)
- **Artist working with glass or metal** (Arts, Media, and Entertainment)

The interactive experience will ideally be co-constructed by the teacher and professional. In coordinating with the professional, a few questions appear below that can be used to guide the planning and live interaction with students:

- **Fire Fighter** (Public Services)
  - What kind of protective clothing do you wear when you are fighting a fire?
  - How do you protect your breathing when you go into a fire?
  - What protection device do you wear on your face?
  - Is the equipment heavy? Can you still move around well when you are wearing all the equipment?
- **Construction Worker** (Building and Construction Trades)
  - What kind of special shoes do you wear on the job? Why do you wear them?
  - Do you wear hard hats all the time? Why do you wear them?
  - Why do construction workers wear reflective vests?
  - Are there protections in the tools that you use to prevent you from injuring yourself?
  - What else do you do on the job to protect yourself from injury?
- **Artist working with glass or metal** (Arts, Media, and Entertainment)
  - What kind of protective eye gear do you wear when working with glass/metal?
  - Are there dangers to your hands? What do you do to protect them?
  - How did you learn about what you needed to do to complete your art while make sure you are safe?
  - What tools do you use? Are there any limits or protections built into your tools to ensure that you cannot injure yourself? What are those?



Materials List

The items in the materials list below reflect total quantities for a class of 32 students, allowing for 8 groups of 4 students.

Permanent Equipment:

- ☐ 1 tub of linking pop cubes (for non-standard measuring, from site)

Consumable Equipment:

- ☐ 160 durable water balloons
- ☐ 200 cotton balls
- ☐ 64 paper bowls
- ☐ 64 paper plates
- ☐ 160 pipe cleaners
- ☐ 32 rolls of clear tape
- ☐ 160 paper straws
- ☐ 1 roll of aluminum foil
- ☐ 32 coffee filters

Consumable Equipment (from home or site as available):

- ☐ sticky notes
- ☐ empty egg cartons
- ☐ colored pencils, crayons, markers
- ☐ 8 rolls of paper towels

Distance Learning Modifications

In distance learning, the design challenge will be conducted by students individually at home. Student collaboration will need to occur remotely with a modified materials list.

Modified Materials List (student totals):

- ☐ 5 durable water balloons
- ☐ 6 cotton balls
- ☐ 2 paper bowls
- ☐ 2 paper plates
- ☐ 5 pipe cleaners
- ☐ 1 roll of clear tape
- ☐ 5 paper straws
- ☐ 2 square foot of aluminum foil
- ☐ 3 coffee filters

Endnotes

[i] Caters Clips. (2019, June 10). *Dust devil shakes palm trees.* YouTube. https://www.youtube.com/watch?v=LZBGa4HJq5s