Integrated STEM Unit Planner

Kindergarten Science
Create an Environmental Tool

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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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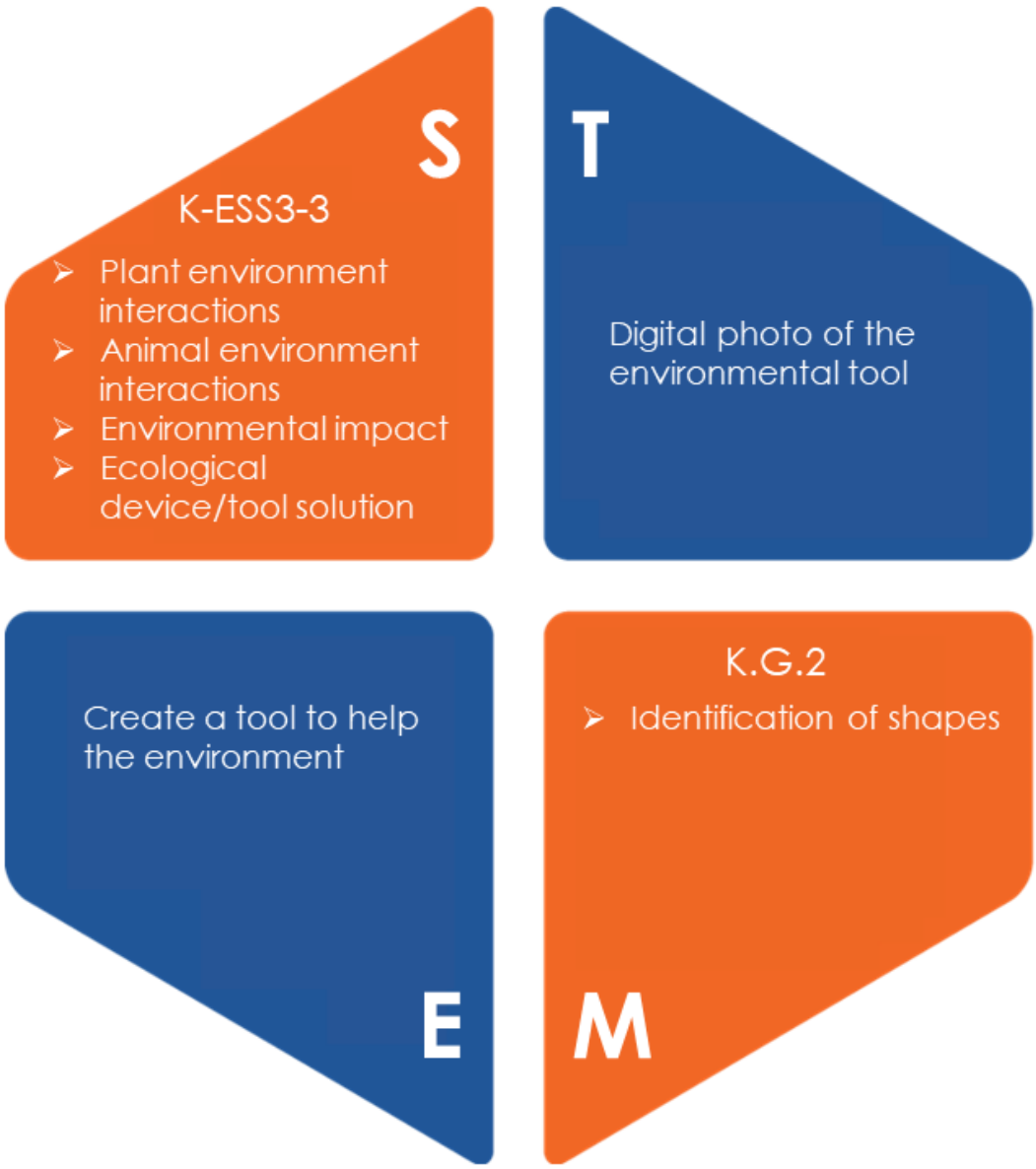
Big Picture

Unit Emblem



Focal Standard

K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing pictures of a trashed landscape or by having students take pictures of trash in their own neighborhood. Draw out students' observations and any questions or wonderings they have about how the trash got there and what it is doing to the environment.

During the entry event, teachers introduce the driving essential question: How can humans help the environment? Students will begin by learning about how plants and animals interact with and change their environment with their presence.

This will lead to the introduction of the design challenge: To create a 3-dimensional tool or to make improvements to an existing 3-dimensional tool that will reduce humans' impact on the environment. They will consider the case of a dripping faucet and how much water is wasted because of the drip. Students will begin to ***ask*** questions like: Where did all that water come from? Can we use that water? What would happen if we didn't catch it in the tub?

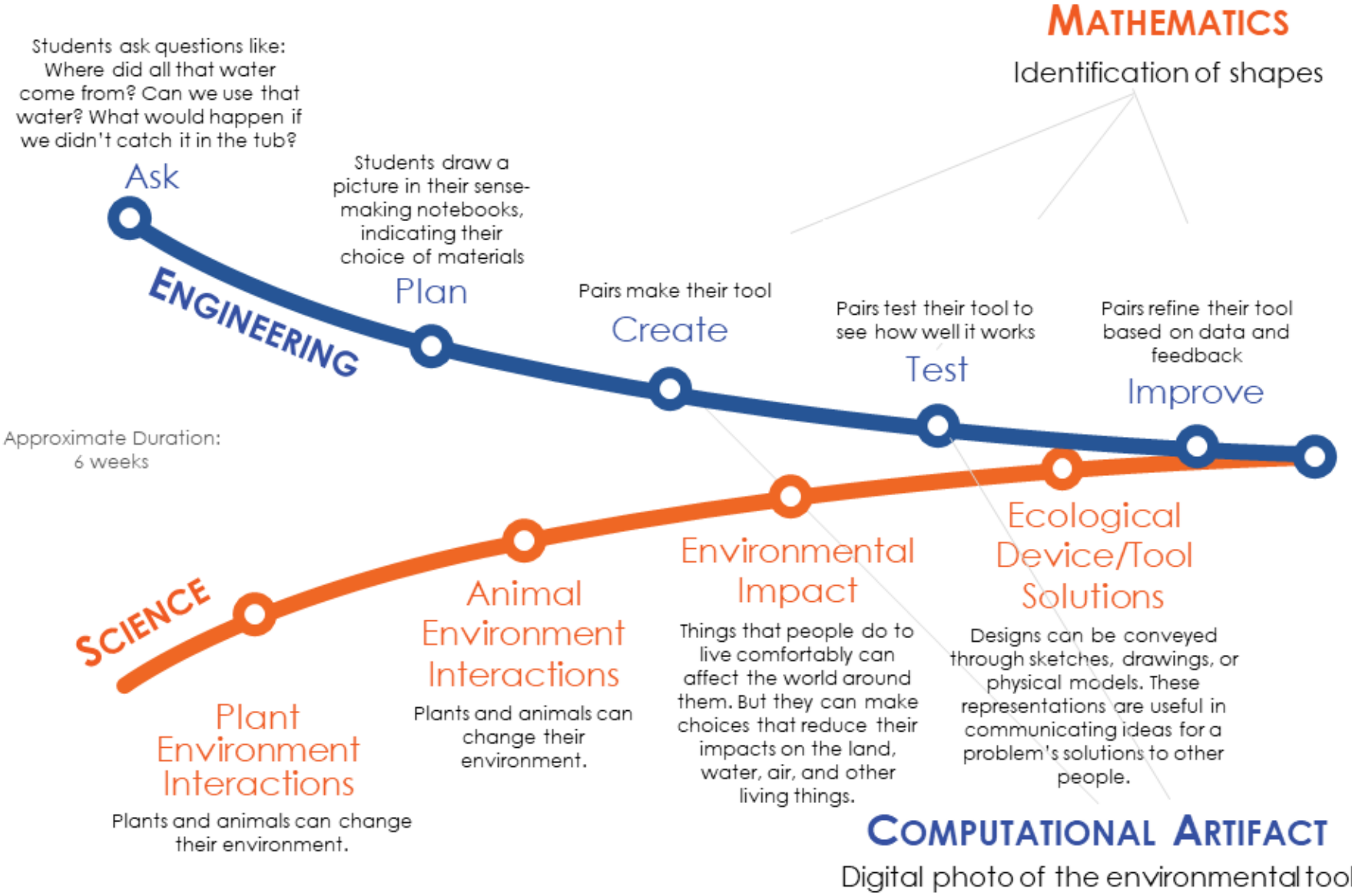
Sequence 2: Students will learn more about how humans impact their environment through either use of or over-use of resources as well as depositing trash that is not naturally part of the environment. Students will sketch out ideas for their tool by drawing a picture in their sense-making notebook and will begin to ***plan*** their model.

Sequence 3: Students will consider the materials available and begin to ***create*** their environmental protection tool as they continue to learn about possible impacts humans have on land, water and air.

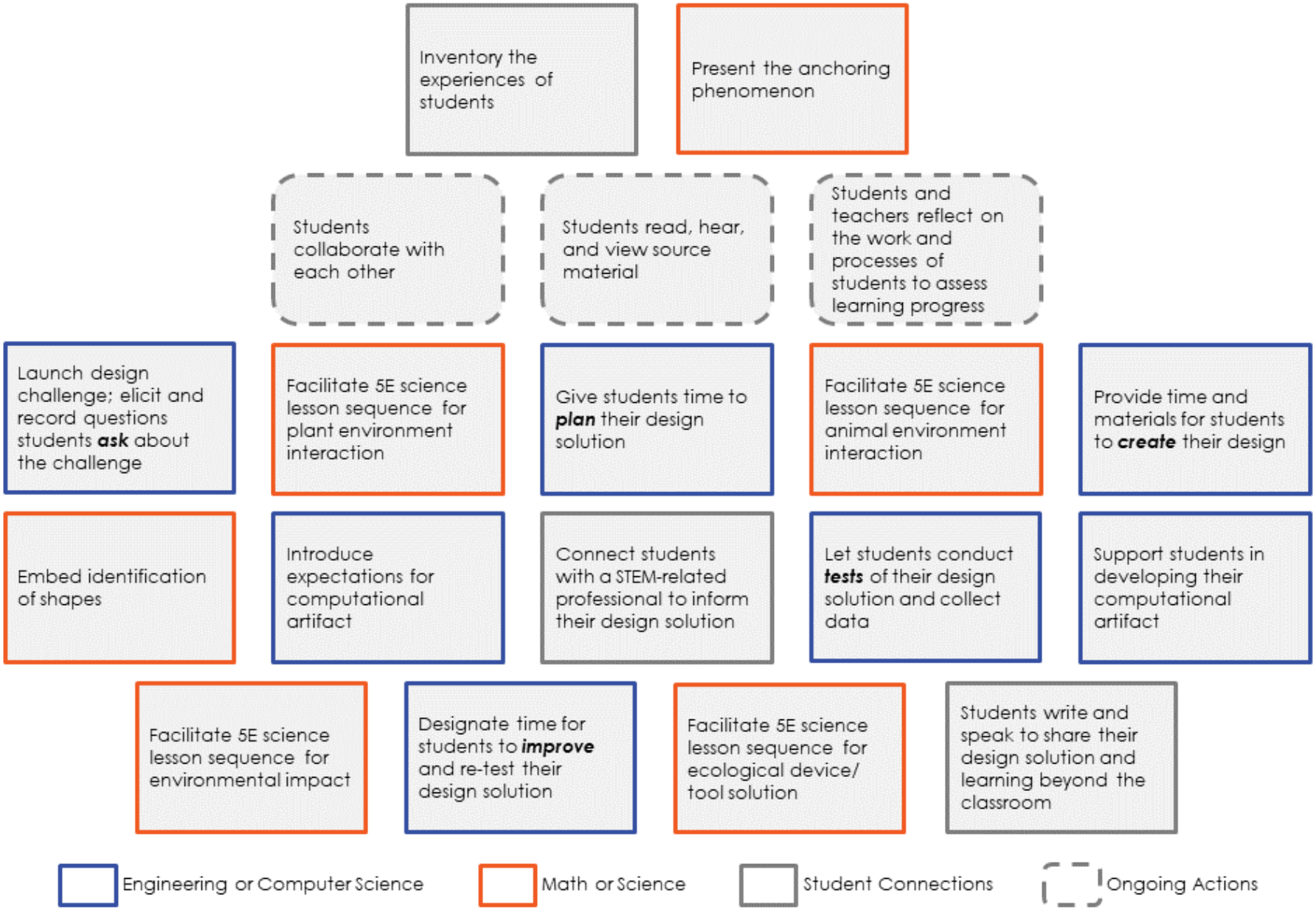
Sequence 4: Students will learn about ecological tools and devices that can serve to alter any negative impacts humans might have on the environment. Students will ***test*** the effectiveness of their design by conducting multiple tests of their tool and record the outcomes.

Sequence 5: Students will reflect on how effective their tool was in their tests by looking at the data and will revise the plan to ***improve*** their model.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create a 3-dimensional tool or make improvements to a 3-dimensional tool that will reduce humans' impact on the environment

Type of Engineering: Mechanical Engineer

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *Where did all that water come from? Can we use that water? What would happen if we didn't catch it in the tub?*	**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 draw a picture in their sense-making notebooks, indicating their choice of materials*	**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 *Pairs make their tool.*	
Test *Pairs test their tool to see how well it works.*	**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 *Pairs refine their tool based on data and feedback.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

1. Students will take digital photos of their tool and add informational text that explains how their tool helps the environment.

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)

- Digital photo of tool with an explanation of its benefit

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)

- Camera software

Standards

- **K-2.DA.7** Store, copy, search, retrieve, modify, and delete information using a computing device, and define the information stored as data.
- **K-2.AP.11** Model the way programs store data.
- **K-2.CS.3** Describe basic hardware and software problems using correct terminology.

Science

Focal Standard

K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. [Clarification Statement: Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]

Related Content Standards

K-ESS2-2 Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing them pictures of a trashed landscape or having students take pictures of trash found in their own neighborhood. Examples might include:

- National Park Service webpage (2018)[i] https://www.nps.gov/deva/learn/remove-your-trash.htm
- National Park Service quiz (2020)[ii] https://www.nps.gov/goga/learn/nature/living-with-trash.htm

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 Environment Interactions	• Plants and animals can change their environment. (L-ESS2-2)	7

Key Concept	Key Learnings	# of Days
Animal Environment Interactions	• Plants and animals can change their environment. (L-ESS2-2)	7
Environmental Impact	• Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (K-ESS3.3, K-ESS2-2)	7
Ecological Device/Tool Solutions	• 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. (secondary) (K-ESS3-3)	9

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 identify the shapes of objects used to create their environmental tool.

Standards for Mathematical Content

K.G.2 Correctly name shapes regardless of their orientations or overall size.

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.K.2 With prompting and support, identify the main topic and retell key details of a text.

Writing Standard: Text Types and Purposes

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.

Speaking and Listening Standard: Comprehension and Collaboration

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

- **SL.K.1.a** Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
- **SL.K.1.b** Continue a conversation through multiple exchanges.

Language: Conventions of Standard English

L.K.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

- **L.K.1.c** Form regular plural nouns orally by adding /s/ or /es/ (e.g., dog, dogs; wish, wishes).
- **L.K.1.e** Use the most frequently occurring prepositions (e.g., to, from, in, out, on, off, for, of, by, with).
- **L.K.1.f** Produce and expand complete sentences in shared language activities.

L.K.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

- **L.K.2.a** Capitalize the first word in a sentence and the pronoun I.
- **L.K.2.b** Recognize and name end punctuation.
- **L.K.2.d** Spell simple words phonetically, drawing on knowledge of sound/letter relationships.

Language: Vocabulary Acquisition and Use

L.K.5 With guidance and support from adults, explore word relationships and nuances in word meanings.

- **L.K.5.c** Identify real-life connections between words and their use (e.g., note places at school that are colorful).

Unit Vocabulary

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

- **behavior**: A behavior is anything that an organism does involving action and response to stimulation or the response of an individual, group, or species to its environment. (Source: https://www.merriam-webster.com/dictionary/behavior)

- **environment**: The environment is the surrounding conditions or forces (as soil, climate, and living things) that influence a plant's or animal's characteristics and ability to survive. (Source: https://www.merriam-webster.com/dictionary/environment)

- **evidence**: Evidence is information or a sign that supports proof that something is true. For example, data collected from a test run of an environmental tool can provide evidence that the tool works. (Adapted from: https://www.merriam-webster.com/dictionary/evidence)

- **impact**: An impact is a powerful or major influence or effect. (Source: https://www.merriam-webster.com/dictionary/impact)

- **interaction**: Interaction refers to the action or influence of things on one another. (Source: https://www.merriam-webster.com/dictionary/interaction). For example, people interact with each other by talking and influencing others. People also interact with their environment by using resources and removing them from the environment but they can also interact by putting things back in the environment, such as by planting trees.

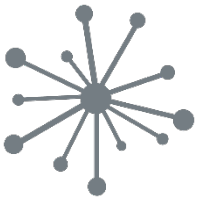
- **recycle**: To recycle means to makes something new out of something that has been used before. (Source: https://www.merriam-webster.com/dictionary/recycle)

- **reduce**: To reduce means to make something smaller in size, amount or number. (Source: https://www.merriam-webster.com/dictionary/reduce)

- **relationship**: A relationship describes the way in which two or more people, groups, countries, etc., talk to, behave toward, and deal with each other. (Source: https://www.merriam-webster.com/dictionary/relationship). This also applies to the way in which plants and animals interact with their environments.

- **reuse**: To reuse means to use something again. (Source: https://www.merriam-webster.com/dictionary/reuse). For example, we reuse our glasses we drink from when we finish our drink, wash the glass, and put on the shelf until the next use.

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. Describe a place outside where you have fun. What makes it fun?
2. What are some things in nature (or in the environment) you have used?
3. What kinds of things does your family recycle?
4. What kinds of things have you built before? What did it help you do?

Aligned Learnings

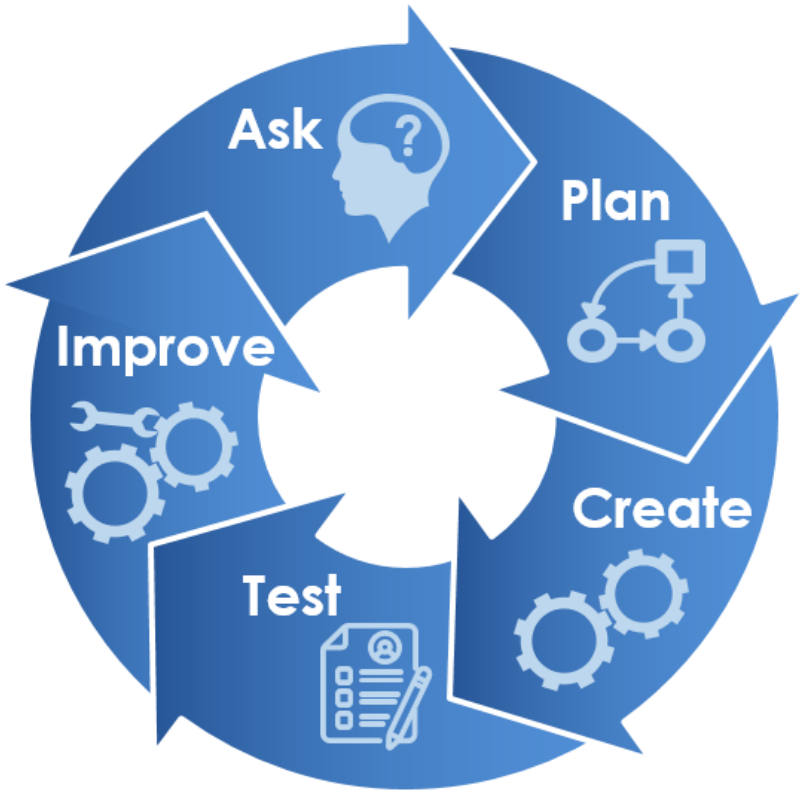
1. Responses to this item provide insight into how students interact with their environment outside. K-ESS2-2, K-ESS2-3
2. Responses to this item provide insight into students' impact on the environment. K-ESS2-2, K-ESS2-3
3. Responses to this item provide insight into students' experiences with recycling. K-ESS2-3
4. Responses to this item provide insight into students' experiences with engineering things to address a problem, need, or want. K-2-ETS1-1, K-2-ETS1-2 (plan and create)

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 mechanical 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 take a digital photo of their tool and provide an explanation. (K-2.DA.7, K-2.AP.11, K-2.CS.3)	
	Collaboration Students contribute and support others with honesty and kindness (SL.K.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.K.2). Students will share thoughts, read, and listen to learn from others. (SL.K.1)	
	Science Students ask questions about the negative impact humans have on their environment. Student communicate solutions to reduce humans' impact on land, air, water and/or other living things in the local environment. (K-ESS3-3, K-ESS2-2)	

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:

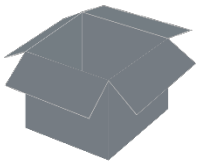
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Waste Management Employee** (Public Services)
- **Arborist** (Agriculture and Natural Resources)
- **Groundskeeper at a park or a zoo** (Hospitality, Tourism, and Recreation)

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:

- **Waste Management Employee** (Public Services)
  - How do you separate waste materials that are to be composted and those that are to be recycled?
  - How good are people in our area at separating out their recycling?
  - What happens to items that are meant to be recycled?
  - What are some things that people try to throw away that really are damaging to the environment? What do you do if you find those things in the trash?
  - How could people help reduce trash overall?
- **Arborist** (Agriculture and Natural Resources)
  - Would you please explain what an arborist does?
  - What are the benefits of trees in the environment?
  - How do trees help reduce pollution and clean up the air?
  - What are some other ways that trees can help the environment, people, plants, and other animals?
- **Groundskeeper at a park or a zoo** (Hospitality, Tourism, and Recreation)
  - What kinds of trash do you see people leave behind the most?
  - What harm can that trash do to the plants and animals in your area?
  - What happens if you see someone throw something down on the ground when it should have been put in the proper trash or recycling bin?
  - Do animals ever get into the trash and throw it around? What do you do to try to keep the trash safe from animals getting at it?



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:

- ☐ 16 small plastic shovels or scoops

Consumable Equipment:

- ☐ 320 cotton balls
- ☐ 160 pipe cleaners
- ☐ 1 roll of aluminum foil
- ☐ 96 sheets of cardstock
- ☐ 32 rolls of clear tape
- ☐ 64 (1-gallon) zip bags

Consumable Equipment (from home or site as available):

- ☐ construction paper
- ☐ poster board
- ☐ yarn or string
- ☐ plastic packaging bags from FedEx or Amazon

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):

- ☐ 10 cotton balls
- ☐ 5 pipe cleaners
- ☐ 1 10 x 10 square of aluminum foil
- ☐ 3 sheets of cardstock
- ☐ 1 roll of clear tape
- ☐ 2 (1-gallon) zip bags

Endnotes

[i] National Park Service (2018, August 11). *Remove your trash.* https://www.nps.gov/deva/learn/remove-your-trash.htm

[ii] National Park Service (2020, October 14). *Quiz: Living with trash.* https://www.nps.gov/goga/learn/nature/living-with-trash.htm