Integrated STEM Unit Planner

Pre-Kindergarten and Transitional Kindergarten Science Repurpose Some Refuse

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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

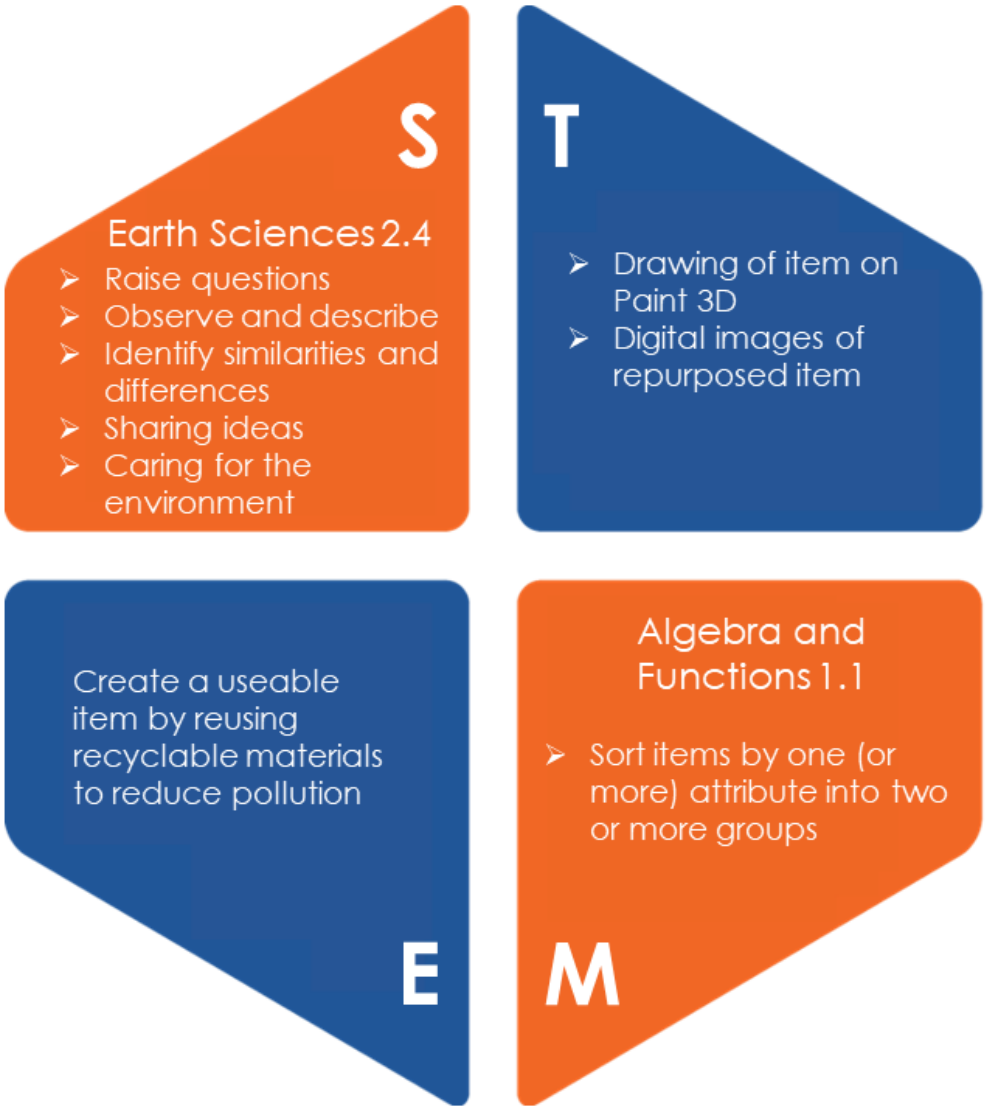
Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading 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

Contents

Big Picture

Unit Emblem



Focal Standard

Earth Sciences	
2.0 Changes in the Earth	
At around 48 months of age	*At around 60 months of age*
2.4 Develop awareness of the importance of caring for and respecting the environment, and participate in activities related to its care.	**2.4 Demonstrate an increased awareness and the ability to discuss in simple terms how to care for the environment, and participate in activities related to its care.**

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing them images of trash. Many photos are available online. One option may be to show this short video of garbage and where it goes in landfills (see https://bit.ly/3nBhm77) (Leveque, 2016)[i]. Teachers will begin a discussion of scientific inquiry and thinking like a scientist by encouraging students to raise questions about what they have seen on the video as well as around their own neighborhoods. Teachers will introduce the driving essential question: How can I help reduce pollution?

This will lead to the design challenge: to create an object reusing recyclable materials. Students will begin to ***ask*** questions about the challenge such as: What are things that pollute the environment? How can we change garbage into something useful?

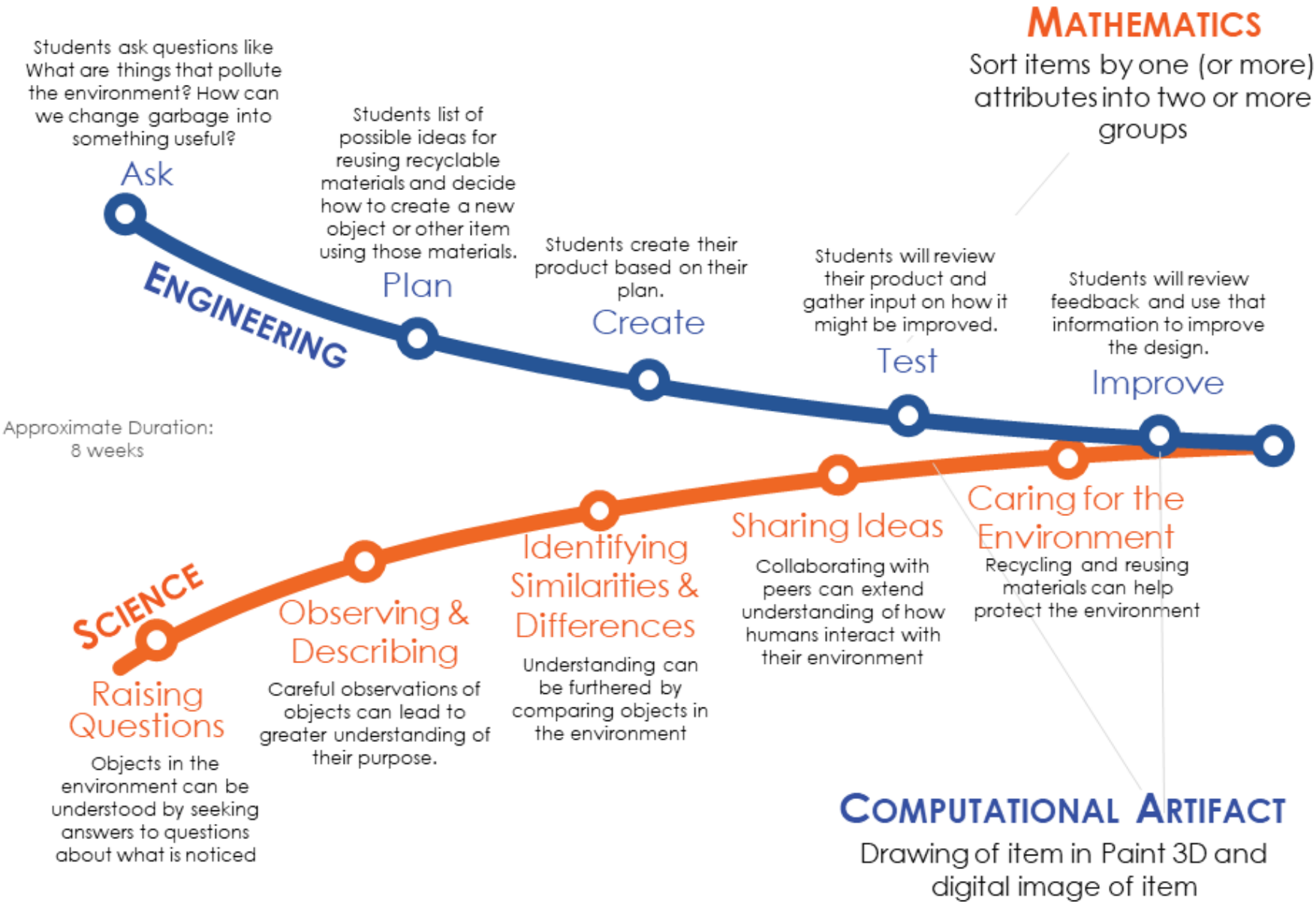
Sequence 2: Students will learn more about scientific inquiry and practice their skills of observation and description. Students will begin to plan their recyclable object, survey available materials, and draw up a ***plan*** their object.

Sequence 3: Students will learn how to compare objects in their environment by looking for similarities and differences. They will use this new learning as they work to ***create*** their object.

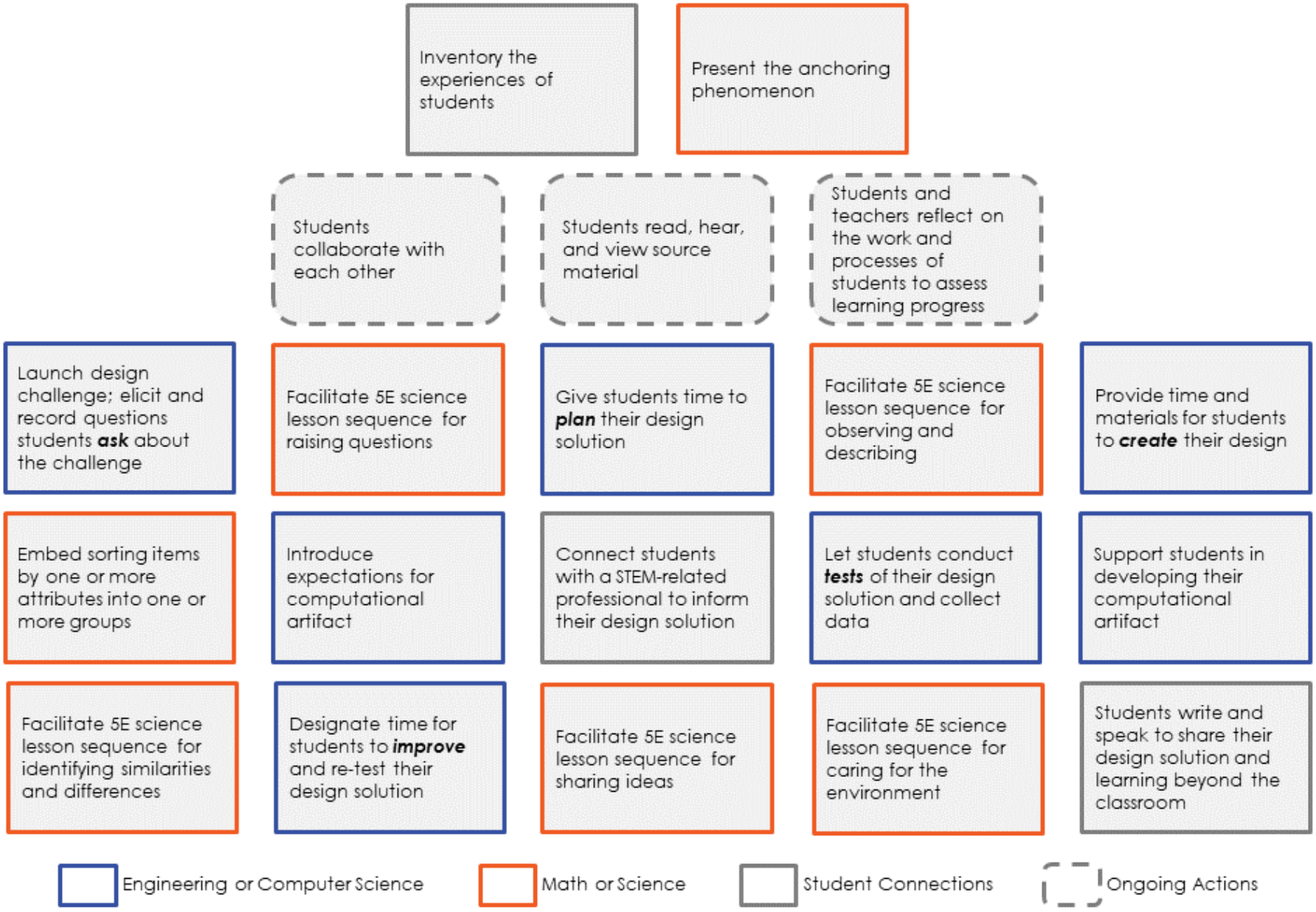
Sequence 4: Students will share their ideas with others and use others' opinions to ***test*** the effectiveness of their object. They review their observations as well as observations of the work of their fellow students.

Sequence 5: Students will learn more about how items we have used can be recycled and/or reused in other ways. Teachers may wish to show this brief video about reuse and recycling (from the Environmental Protection Agency (n.d.[ii]), see https://bit.ly/3jMmDHZ). Students will reflect on what they learned from their test and observations of others and will revise the plan to ***improve*** their object.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create a useable item using recyclable materials to reduce pollution.

Type of Engineering: Environmental Engineering

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *What are things that pollute the environment? How can we change garbage into something useful?*	**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 list of possible ideas for reusing recyclable materials and decide how to create a structure or other item using those 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 *Students create their product based on their plan.*	
Test *Students will review their product and gather input on how it might be improved.*	**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 feedback and use that information to improve the design.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students use Microsoft Paint 3D to sketch their repurposed item. Students also take digital pictures of their repurposed item using the camera on their 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)

- 3D drawing in Microsoft Paint 3D
- Digital images

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 Paint 3D

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.

Foundations in Science

Focal Standard

Earth Sciences	
2.0 Changes in the Earth	
At around 48 months of age	*At around 60 months of age*
2.4 Develop awareness of the importance of caring for and respecting the environment, and participate in activities related to its care.	**2.4 Demonstrate an increased awareness and the ability to discuss in simple terms how to care for the environment, and participate in activities related to its care.**

Related Content Standards

Scientific Inquiry	
1.0 Observation and Investigation	
At around 48 months of age	*At around 60 months of age*
1.1 Demonstrate curiosity and raise simple questions about objects and events in their environment.	1.1 Demonstrate curiosity and an increased ability to raise questions about objects and events in their environment.
1.2 Observe objects and events in the environment and describe them.	1.2 Observe objects and events in the environment and describe them in greater detail.
1.4 Compare and contrast objects and events and begin to describe similarities and differences.	1.4 Compare and contrast objects and events and describe similarities and differences in greater detail.
2.0 Documentation and Communication	
2.2 Share findings and explanations, which may be correct or incorrect, with or without adult prompting.	2.2 Share findings and explanations, which may be correct or incorrect, more spontaneously and with greater detail.

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by Teachers engage students with an anchoring phenomenon by showing them pictures of trash. Many photos are available online. One option may be to show this short video of garbage and where it goes in landfills (see https://bit.ly/3nBhm77) (Leveque, 2016, see Endnote i).

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[1]	# of Days
Raising Questions	• Demonstrate curiosity and an increased ability to raise questions about objects and events in their environment. (Scientific Inquiry 1.1)	5
Observing and Describing	• Observe objects and events in the environment and describe them in greater detail. (Scientific Inquiry 1.2)	5
Identifying Similarities and Differences	• Compare and contrast objects and events and describe similarities and differences in greater detail. (Scientific Inquiry 1.4)	5
Sharing Ideas	• Share findings and explanations, which may be correct or incorrect, more spontaneously and with greater detail. (Scientific Inquiry 2.2)	5
Caring for the Environment	• Demonstrate an increased awareness and the ability to discuss in simple terms how to care for the environment, and participate in activities related to its care. (Earth Sciences 2.4)	5

[1] Key learnings are drawn from the standards designed for students who are 60-months of age. Address the parallel standards for younger students by reviewing the 48-months standards in the table above.

Foundations in Mathematics

Description of Student Engagement

Students will sort the items they collect for recycling based on attributes observed (e.g., size).

Standards for Mathematical Content

Algebra and Functions (Classification and Patterning)	
1.0 Children begin to sort and classify objects in their everyday environment.	**1.0 Children expand their understanding of sorting and classifying objects in their everyday environment.**
At around 48 months of age	*At around 60 months of age*
1.1 Sort and classify objects by one attribute into two or more groups, with increasing accuracy.	1.1 Sort and classify objects by one or more attributes, into two or more groups, with increasing accuracy (e.g., may sort first by one attribute and then by another attribute).

Foundations in Language and Literacy

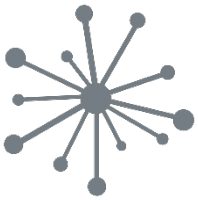
Listening and Speaking	
1.0 Language Use and Conventions	
At around 48 months of age	*At around 60 months of age*
1.1 Use language to communicate with others in familiar social situations for a variety of basic purposes, including describing, requesting, commenting, acknowledging, greeting, and rejecting.	1.1 Use language to communicate with others in both familiar and unfamiliar social situations for a variety of basic and advanced purposes, including reasoning, predicting, problem solving, and seeking new information.
1.2 Speak clearly enough to be understood by familiar adults and children.	1.2 Speak clearly enough to be understood by both familiar and unfamiliar adults and children.
Reading	
1.0 Concepts of Print	
1.1 Begin to display appropriate book-handling behaviors and begin to recognize print conventions.	1.1 Display appropriate book-handling behaviors and knowledge of print conventions.
1.2 Recognize print as something that can be read.	1.2 Understand that print is something that is read and has specific meaning.
2.0 Phonological Awareness	
	2.1 Orally blend and delete words and syllables without the support of pictures or objects.
Writing	
1.0 Writing Strategies	
1.1 Experiment with grasp and body position using a variety of drawing and writing tools.	1.1 Adjust grasp and body position for increasing control in drawing and writing.

Unit Vocabulary

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

- **container (bins, trash cans)**: A container is an object (such as a box or can) that can hold something. (Source: https://www.merriam-webster.com/dictionary/container)
- **environment**: The environment is the air, water, and land in or on which people, animals, and plants live. (Source: https://dictionary.cambridge.org/us/dictionary/english/environment)
- **invention**: An invention is a useful new device or process. (Source: https://www.merriam-webster.com/dictionary/invention)
- **magnifying glass**: A magnifying glass is a specially shaped piece of glass that is attached to a handle and is used to make an object look larger than it is. (Source: https://www.merriam-webster.com/dictionary/magnifying%20glass)
- **measure**: A measure is something (as a yardstick or cup) used in determining size, capacity, or quantity. (Source: https://www.merriam-webster.com/dictionary/measure)
- **pollute**: To pollute means to make (land, water, air, etc.) dirty and not safe or suitable to use. (Source: https://www.merriam-webster.com/dictionary/pollute)
- **recycle**: To recycle means to make something new from (something that has been used before). (Source: https://www.merriam-webster.com/dictionary/recycle)
- **recyclable items (cartons, aluminum, plastic)**: Items that are recyclable have been used before but can be saved and reused in current form or combined with other items to create a new product.
- **reduce**: To reduce means to make (something) smaller in size, amount, number, etc. (Source: https://www.merriam-webster.com/dictionary/reduce)
- **reuse**: To reuse means to use something again. (Source: https://www.merriam-webster.com/dictionary/reuse)
- **trash**: Trash is used to describe things that are no longer useful or wanted and that have been thrown away. (Source: https://www.merriam-webster.com/dictionary/trash)

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. Think about a time when you were outside and noticed something (e.g., a plant, an animal, or something else outside). What did you notice? Did you wonder anything about it?

2. What kinds of things do you like to do outside?

3. At home, what do you do with trash? (Additional prompts: How do you know something is trash? Where do you put it?)

Aligned Learnings

1. Responses to this item provide insight into students' experiences with their environment. (Scientific Inquiry 1.1, 1.2)

2. Responses to this item provide insight into students' experiences with events in their environment. (Scientific Inquiry 1.2)

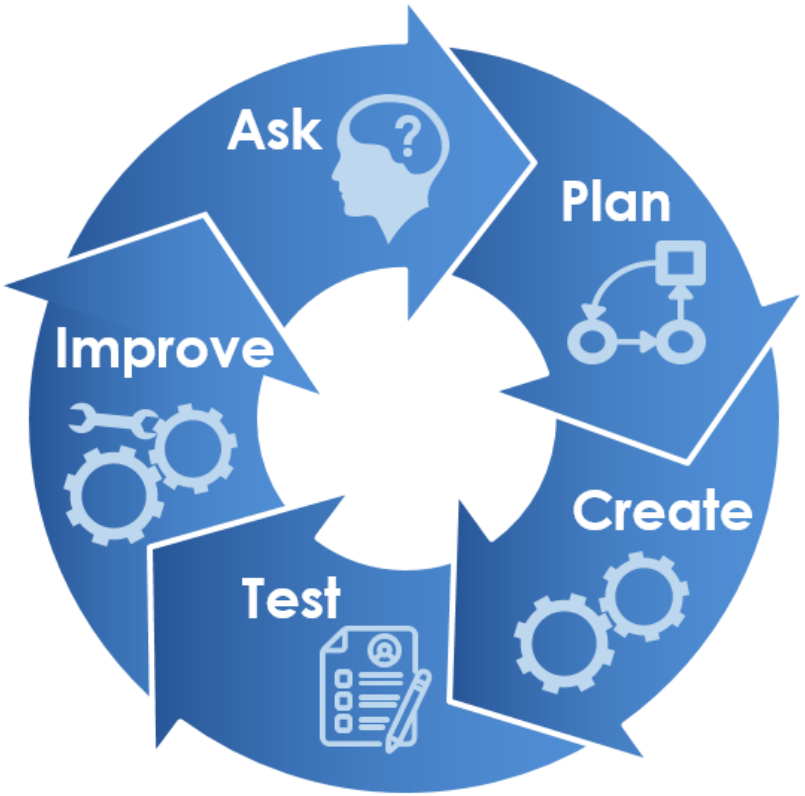
3. Responses to this item provide insight into students' experience with thinking about trash. (Earth Sciences 2.4)

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 an environmental 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 a Paint 3D sketch of their device and take digital images of their repurposed item. (K-2.DA.8, K-2.DA.9)	
	Collaboration Students contribute and support others with honesty and kindness (Listening and Speaking 1.1 and 1.2)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (Writing 1.1). Students will share thoughts, read, and listen to learn from others. (Listening and Speaking .1)	
	Science Students will make observations and measurements and draw inferences and conclusions about their environment (Observation and Inquiry 1.1, 1.2, .4, Documentation and Communication 2.2, Earth Sciences 2.4)	

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:

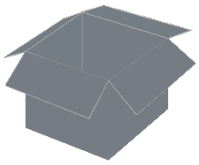
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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 Worker** (Public Services)
- **Fast Food Restaurant Manager** (Hospitality, Tourism, and Recreation)
- **Newspaper Distribution Manager** (Information and Communication Technologies)

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 Worker** (Public Services)
  - What kinds of thing does your company recycle?
  - Once you sort recyclables, where do they go?
  - Are there some things people can recycle that they forget about? Or, are there some things that people think can be recycled but they cannot?
  - Is there much difference in how much one house recycles when compared to another? If someone does not have a lot of recycling, does that usually mean they have a lot more trash?
- **Fast Food Restaurant Manager** Hospitality, Tourism, and Recreation)
  - Does your company recycle waste that comes from your restaurant?
  - What kinds of products do you use that are made of recycled materials (i.e., cups, napkins, etc.)?
  - Does someone at your restaurant sort recyclables, does that happen somewhere else, or do you have different bins in the store for different kinds of recyclables that the people can use?
  - Have there been any changes in how you package up food that have been designed to reduce waste?
- **Newspaper Distribution Manager** (Information and Communication Technologies)
  - How do you know how many papers to print any day?
  - When someone goes back to newspaper boxes to put in the new papers, what happens to the old papers?
  - Is the newspaper printed on paper that has been recycled? Why or why not?
  - On an average day, how many papers are not bought? Does that impact how many your print?



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 (classroom totals):

- ☐ 8 hand lenses (magnifiers)
- ☐ 1 balance scales
- ☐ 4 sorting bins
- ☐ Non-standard units of measure (e.g., pop cups, paper clips, circus peanuts., Linker cubes)

Consumable Equipment (classroom totals):

- ☐ 32 non-latex gloves (extra small)
- ☐ 32 rolls of clear tape
- ☐ 1 box of about 100 rubber bands
- ☐ 200 pipe cleaners
- ☐ 1 skein of yarn or string (44 yard length)
- ☐ 200 googly eyes

Consumable Equipment (from home or site as available):

- ☐ Recyclable materials (e.g. paper, bottles, cans, etc.)

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):

- ☐ 1 hand lens (magnifier)
- ☐ 1 pair of non-latex gloves (very small)
- ☐ 1 roll of clear tape
- ☐ 10 rubber bands
- ☐ 6 pipe cleaners
- ☐ 1 yard of yarn or string
- ☐ 10 googly eyes

Endnotes

[i] Leveque, M. (2016, March 29). *Solid waste and landfills – Environmental Video for K-5th graders.* YouTube. https://www.youtube.com/watch?v=mRGNoKxT82A

[ii] Environmental Protection Agency (n.d.). *Tackling forever chemicals: EPA actions to address PFAS pollution.* YouTube. https://www.youtube.com/watch?v=2wfF4g4C7PA