Integrated STEM Unit Planner

Kindergarten Science
Design a Sun-Blocking Structure

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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

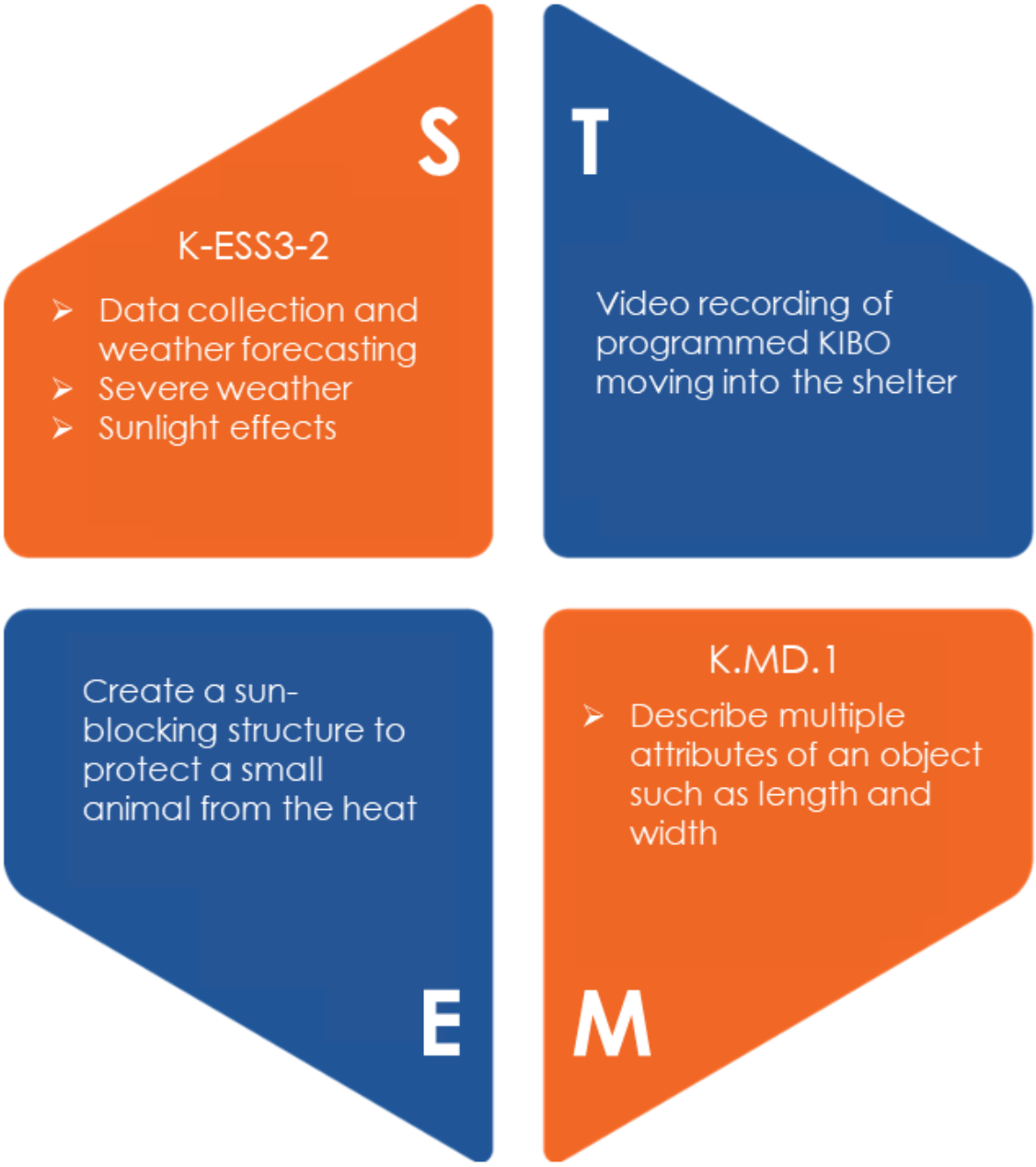
Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading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

K-ESS3-2 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. [Clarification Statement: Emphasis is on local forms of severe weather.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing pictures of animals in their shelters in the wild (e.g., birds in nests, bears in their dens, meerkats in their dens, etc.). After students observe the images, teachers facilitate students thinking through an inquiry anchor chart (notice, wonder) which will be revisited throughout the unit.

During the entry event, teachers will present the essential driving question: How does weather change over time? Students will consider how the weather is different each day from the previous day or previous month and begin to learn about collecting data of weather conditions and using that to forecast future weather.

The design challenge will be introduced: to create a shelter that will protect a rabbit from the warming effects of the sun. Students will ***ask*** questions such as: Why does a rabbit need shelter? How do we keep the rabbit from getting too warm? What materials could we use?

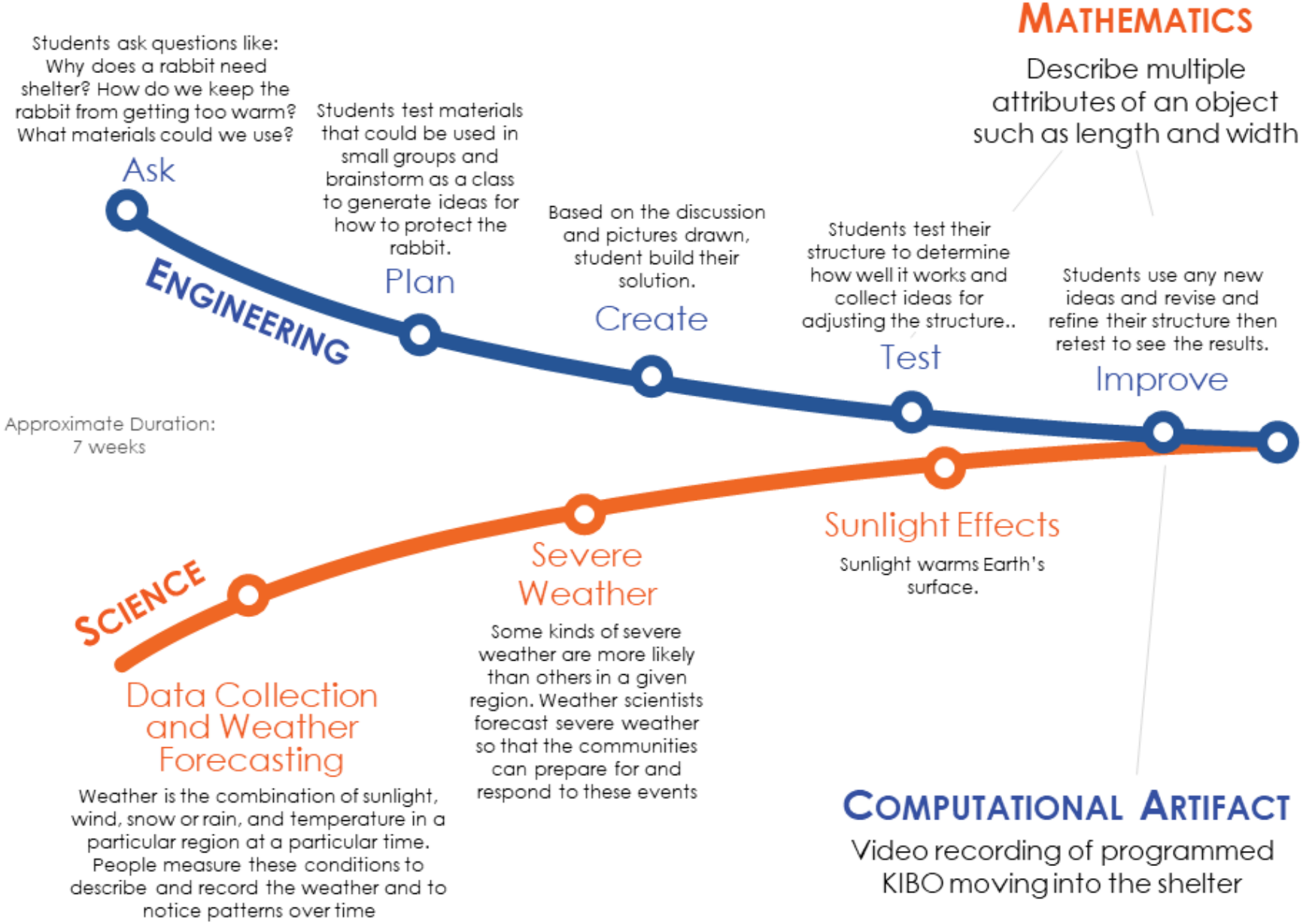
Sequence 2: Students will learn about severe weather such as heat waves and thunderstorms. Students will sketch out ideas for their shelter by drawing a picture in their sense-making notebook and will begin to ***plan*** their model.

Sequence 3: Students will consider the materials available and being to ***create*** their structure as they continue to learn about the effects sunlight can have on plants and animals.

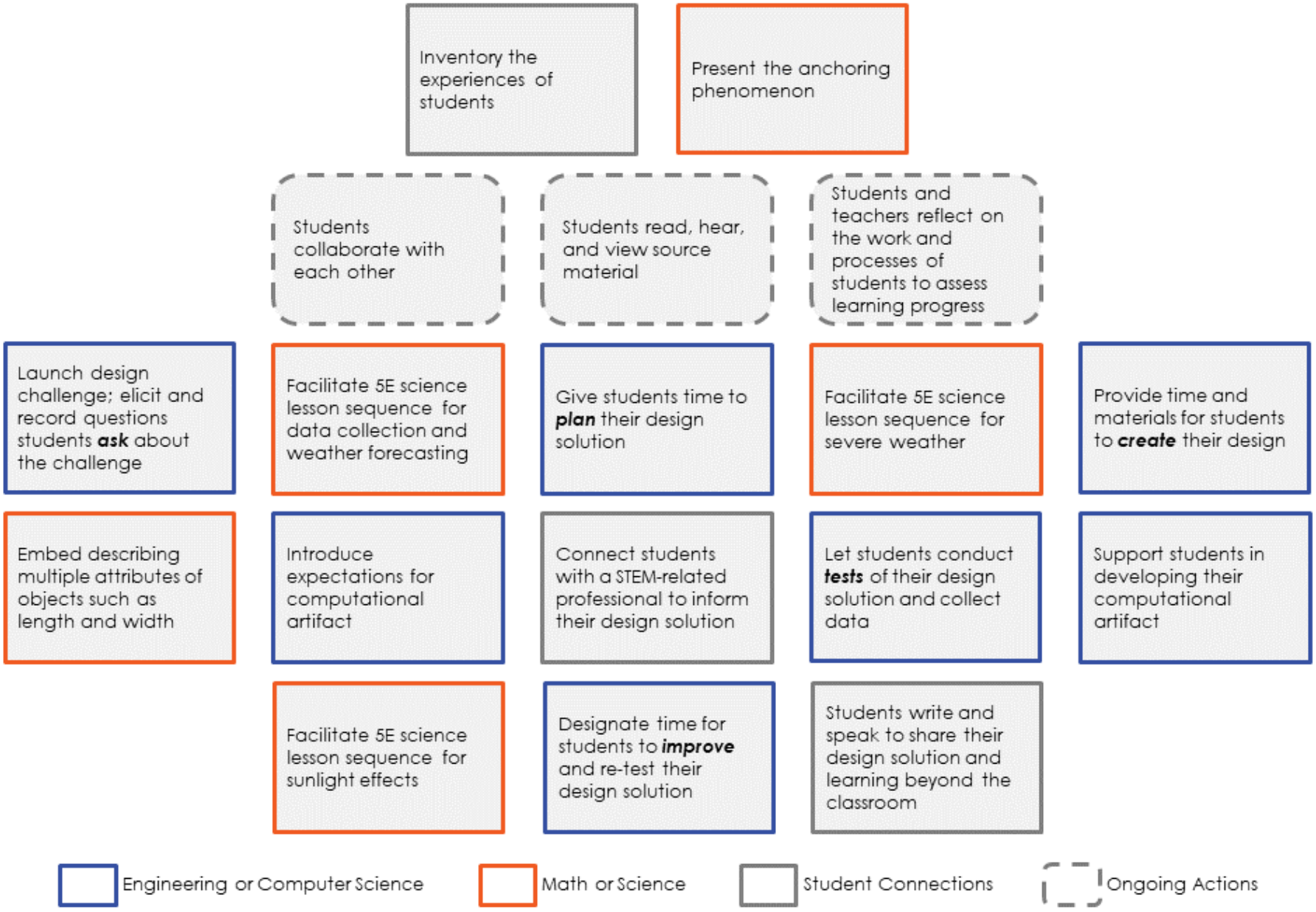
Sequence 4: Students will ***test*** the effectiveness of their design and program a KIBO to seek protection under their shelter.

Sequence 5: Students will reflect on feedback and ideas from their peers and revise the plan to ***improve*** their shelter.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create a sun blocking structure to protect a small animal

Type of Engineering: Civil Engineer

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *Why does a rabbit need shelter? How do we keep the rabbit from getting too warm? What materials could we use?*	**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 test materials that could be used in small groups and brainstorm as a class to generate ideas for how to protect the rabbit.*	**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 *Based on the discussion and pictures drawn, student build their solution.*	
Test *Students test their structure to determine how well it works and collect ideas for adjusting the structure.*	**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 use any new ideas and revise and refine their structure then retest to see the results.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students program KIBO to be a rabbit and go under the shelter from the sun.

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)

- Video recording of a programmed KIBO programmed moving into the shelter

Hardware

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

- Computer
- Kinderlab Robotics KIBO

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

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

- Video recording 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.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

K-ESS3-2 Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. [Clarification Statement: Emphasis is on local forms of severe weather.]

Related Content Standards

K-ESS2-1 Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include description of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [*Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler*.]

K-PS3-1 Make observations to determine the effect of sunlight on Earth's surface. [Clarification Statement: Examples of Earth's surface could include sand, soil, rocks, and water.] [*Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler*.]

K-PS3-2 Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. [Clarification Statement: Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the Sun.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing pictures of animals in their homes in the wild (e.g., birds in nests, bears in their dens, meerkat in their dens, etc.). Here are a couple of examples:

- Wargo Nature Center worksheet[i]
  https://www.anokacounty.us/DocumentCenter/View/24910/Animal-Homes-Week
- National Park Service webpage[ii]
  https://www.nps.gov/cagr/learn/kidsyouth/mammals.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
Data Collection and Weather Forecasting	• Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary) (ETS1.A, ESS3-2)	35 (ongoing)
Severe Weather	• Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)	10
Sunlight Effects	• Sunlight warms Earth's surface. (PS3.B)	10

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

During the engineering design process, students describe the length of their shelter and the length of the distance traveled by the KIBO.

Standards for Mathematical Content

K.MD.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

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.1 With prompting and support, ask and answer questions about key details in a text.

Reading Standard: Integration of Knowledge and Ideas

RI.K.9 Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.

Writing Standard: Text Types and Purposes

W.K.3 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.

Writing Standard: Production and Distribution of Writing

W.K.5 With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.

W.K.6. With guidance and support from adults, explore a variety of digital tools to produce and publish writing, including in collaboration with peers.

Writing Standard: Research to Build and Present Knowledge

W.K.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

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.

SL.K.2 Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.

Language: Conventions of Standard English

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

Language: Vocabulary Acquisition and Use

L.K.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on kindergarten reading and content.

- **L.K.4.a** Identify new meanings for familiar words and apply them accurately (e.g., knowing duck is a bird and learning the verb to duck).
- **L.K.4.b** Use the most frequently occurring inflections and affixes (e.g., -ed, -s, re-, un-, pre-, -ful, -less) as a clue to the meaning of an unknown word.

Unit Vocabulary

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

- **forecast**: To forecast is to predict (weather conditions) on the basis of correlated meteorological observations. (Source: https://www.merriam-webster.com/dictionary/forecast)

- **lightning**: Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. (Sourced from NOAA[1]: https://bit.ly/3AWS48f)

- **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)

- **precipitation (rain, snow)**: Precipitation is water that falls to the earth as hail, mist, rain, sleet, or snow. (Source: https://www.merriam-webster.com/dictionary/precipitation)

- **severe weather (excessive heat, flash flood, high winds, drought)**: Severe weather occurs when weather conditions are not normal, or typical for the area or the time of year. Typically, there is some danger associated with severe weather for harm to people, animals or crops. Teachers may wish to the examples in parentheses to explain severe weather to the students.

- **shelter**: A shelter is a structure that covers or protects people or things. (Source: https://www.merriam-webster.com/dictionary/shelter)

- **structure**: A structure is something (such as a house, tower, bridge, etc.) that is built by putting parts together and that usually stands on its own. (Source: https://www.merriam-webster.com/dictionary/structure)

- **temperature**: (hot, warm, cool, cold): Temperature is degree [amount] of hotness or coldness as measured on a scale. (Source: https://www.merriam-webster.com/dictionary/temperature). Perceptions of whether it is hot or warm, cool or cold are fairly subjective and may not be consistent from one person to another.

- **thermometer**: A thermometer is an instrument for determining temperature. (Source: https://www.merriam-webster.com/dictionary/thermometer)

- **thunderstorm**: A thunderstorm is a rain shower during which you hear thunder. Since thunder comes from lightning, all thunderstorms have lightning. (Sourced from NOAA: https://bit.ly/3hR6xvV)

[1] NOAA = National Ocean and Atmospheric Association

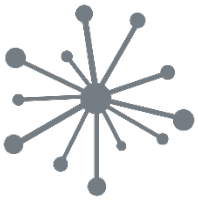
- **thunder**: Lightning causes thunder. When the electricity from lightning is in the air, it overheats the air, and the air explodes outward, making the loud sound that we hear. (Adapted from NOAA: https://bit.ly/3AWS48f)

- **weather**: Weather is the state of the air and atmosphere in regard to how warm or cold, wet or dry, or clear or stormy it is. (Source: https://www.merriam-webster.com/dictionary/weather)

- **wind direction**: Wind direction is typically reported in terms of whether the wind is coming from the north, south, east or west.

- **wind speed (no wind, gentle wind, strong wind)**: Wind speed is generally reported in miles per hour as measured by an anemometer. This is an instrument with paddles and wheels that turn when blown by the wind. Perceptions of wind are somewhat subjective, like temperature, but may be specifically categorized as high winds by the local meteorological service.

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 about a time you had fun outside.
   (Additional Prompts: Where were you? What did you do? What was it like outside…Sunny or cloudy? Rainy or clear? Windy or calm? Hot or cold?)

2. Have you heard someone giving information about the weather? If so, what do you remember?
   (Additional Prompts: Have you seen the weather report on the news? Have you heard people on the radio talk about how hot or windy it is outside? What did they show or say about the weather?)

3. Can you think of a time you saw the weather outside get really bad? What was that like?

4. What kinds of things have you felt get warmed up by the sun?
   (Additional Prompts: Have you felt things outside that got warmed up by the sun like big rocks, dirt, the sidewalk, the side of a building, or things like that?)

Aligned Learnings

1. Responses to this item provide insight into students' experiences with weather conditions. K-ESS2-1

2. Responses to this item provide insight into students' experiences with weather forecasting. K-ESS3-2

3. Responses to this item provide insight into students' experiences with severe weather. K-ESS3-2

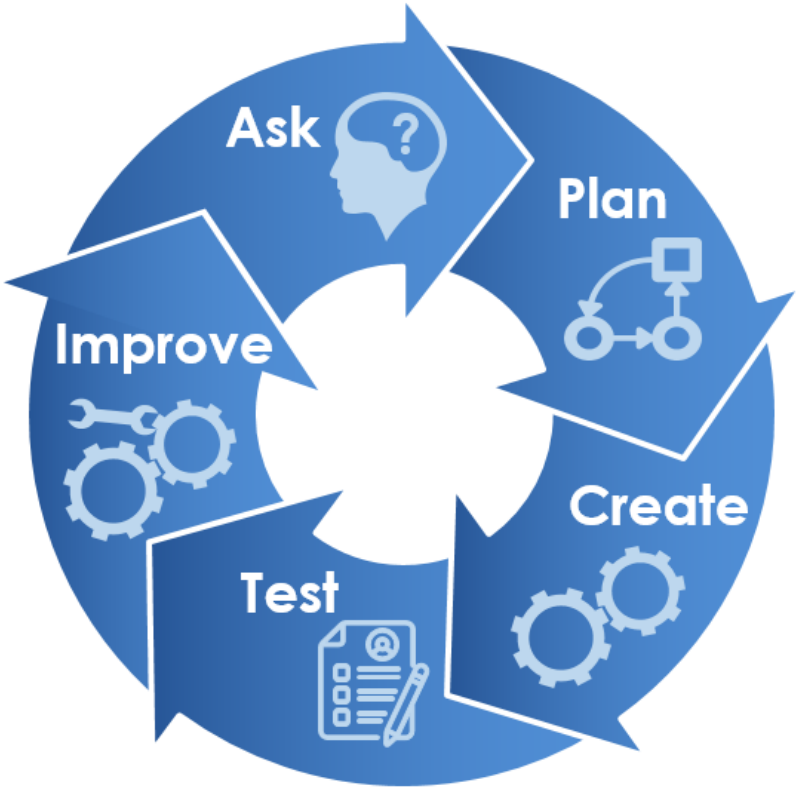
4. Responses to this item provide insight into students' experiences with the warming effects of the sun. K-PS3-1, K-PS3-2

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 civil 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 program a KIBO to move into the structure they build. (K-2.DA.7, K-2.DA.8, K-2.DA.9)	
	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.3). Students will share thoughts, read, and listen to learn from others. (SL.K.1)	
	Science Students learn about weather, forecasting and the impact of sunlight on animals. (K-ESS3-2, K-ESS2-1, K-PS3-1, K-PS3-2)	

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:

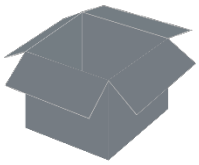
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Meteorologist** (Energy, Environment and Utilities)
- **Air Traffic Controller** (Transportation)
- **Public Safety Officer** (someone from Emergency Planning Center) (Public Services)

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:

- **Meteorologist** (Energy, Environment and Utilities)
  - How did you become interested in the weather?
  - What kinds of severe weather happen here? How often does it happen?
  - What is the most important warning about weather that you have had to tell people about?
  - Why do you think weather is important to humans' and animals' lives?
- **Air Traffic Controller** (Transportation)
  - Would you please explain what you do in your job?
  - How does the weather impact how you can do your job?
  - What are some weather challenges that can impact whether planes can land or take off?
  - How often does the airport have to close down because of weather? What is usually the weather problem that causes the closure?
  - Where do you get your information about incoming weather?
- **Public Safety Officer** (someone from Emergency Planning Center) (Public Services)
  - How does weather play a role in being prepared for an emergency?
  - How would you be alerted if severe weather is coming? What happens when you get such a warning?
  - Suppose a plane is coming in and there is a thunderstorm that is really bad. What do you do?
  - Have you worked in other places? Were there different weather problems there?



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:

- ☐ 8 digital thermometers to measure ambient temperature (not human temperature)
- ☐ 400 (1 inch) wooden blocks from Pushes and Pulls unit

Consumable Equipment:

- ☐ 1920 UV beads
- ☐ 320 white pipe cleaners
- ☐ 1 roll of aluminum foil
- ☐ 96 (3 oz.) paper cups
- ☐ 1060 craft sticks
- ☐ 160 sheets of cardstock

Consumable Equipment (from home or site as available):

- ☐ construction paper

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):

- ☐ 60 UV beads
- ☐ 10 white pipe cleaner
- ☐ 2 square feet of aluminum foil
- ☐ 3 (3 oz.) paper cups
- ☐ 30 craft sticks
- ☐ 5 sheets of cardstock

Endnotes

[i] Wargo Nature Center. (n.d.). *Animal homes week.* https://www.anokacounty.us/DocumentCenter/View/24910/Animal-Homes-Week

[ii] National Park Service. (2015, February 24). *Mammals of the Sonoran Desert.* *https://www.nps.gov/cagr/learn/kidsyouth/mammals.htm*