Integrated STEM Unit Planner

Grade 3 Science

Weather a Windstorm

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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.

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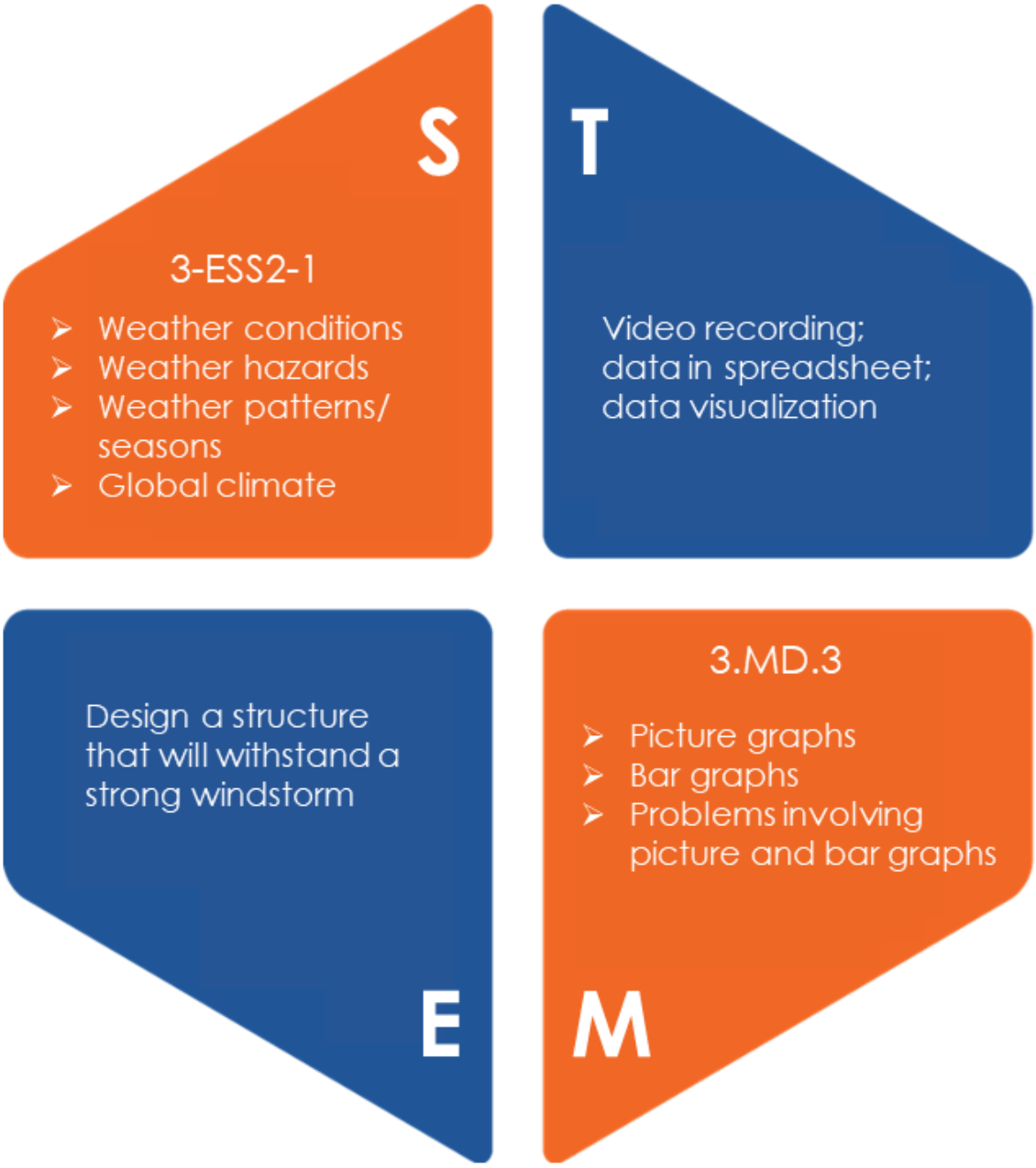
Big Picture

Unit Emblem



Focal Standard

3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data at this grade level could include average temperature, precipitation, and wind direction] [*Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change*.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing a video of and ice storm in the summer. After students view the video clip, teachers facilitate students' thinking through an inquiry anchor chart (notice, think, wonder), which teachers will revisit throughout the unit. During the entry event, teachers will present the driving essential question, "How does weather impact our community?" which connects all learning experiences to the learning targets.

Teachers also introduce the engineering design challenge, which is to design a structure that will withstand a strong windstorm. Students ***ask*** questions about the challenge including: What type of structure will be the most resistant to the winds? What materials will we need?

Students will begin to collect data regarding daily weather including temperature, wind direction, wind speed and precipitation. They will learn to represent data in tables and graphs to describe weather conditions.

Sequence 2: Students learn about weather hazards, including the potential for wind damage and hail storms. Using this knowledge, students will begin to ***plan*** their structure individually. They will then meet with their team to identify the most effective model and sketch out their design.

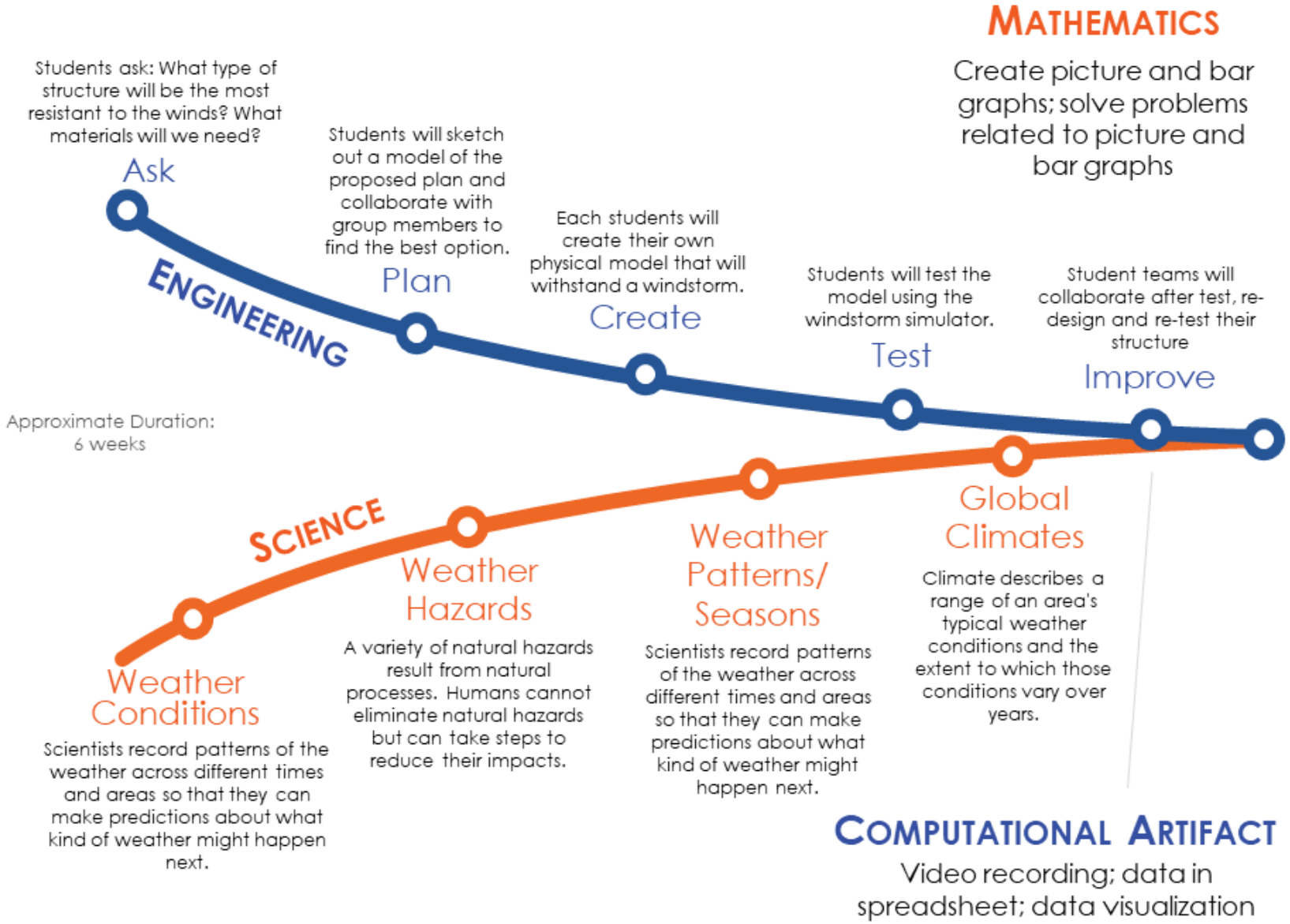
Sequence 3: Based on the selected design, each student will ***create*** their own model using available materials. The model will be informed by further study of changing weather patterns and the season.

Sequence 4: Students then begin to ***test*** their prototype, using the wind simulation device. They will collect data about what failed and collaborate with peers to determine next steps.

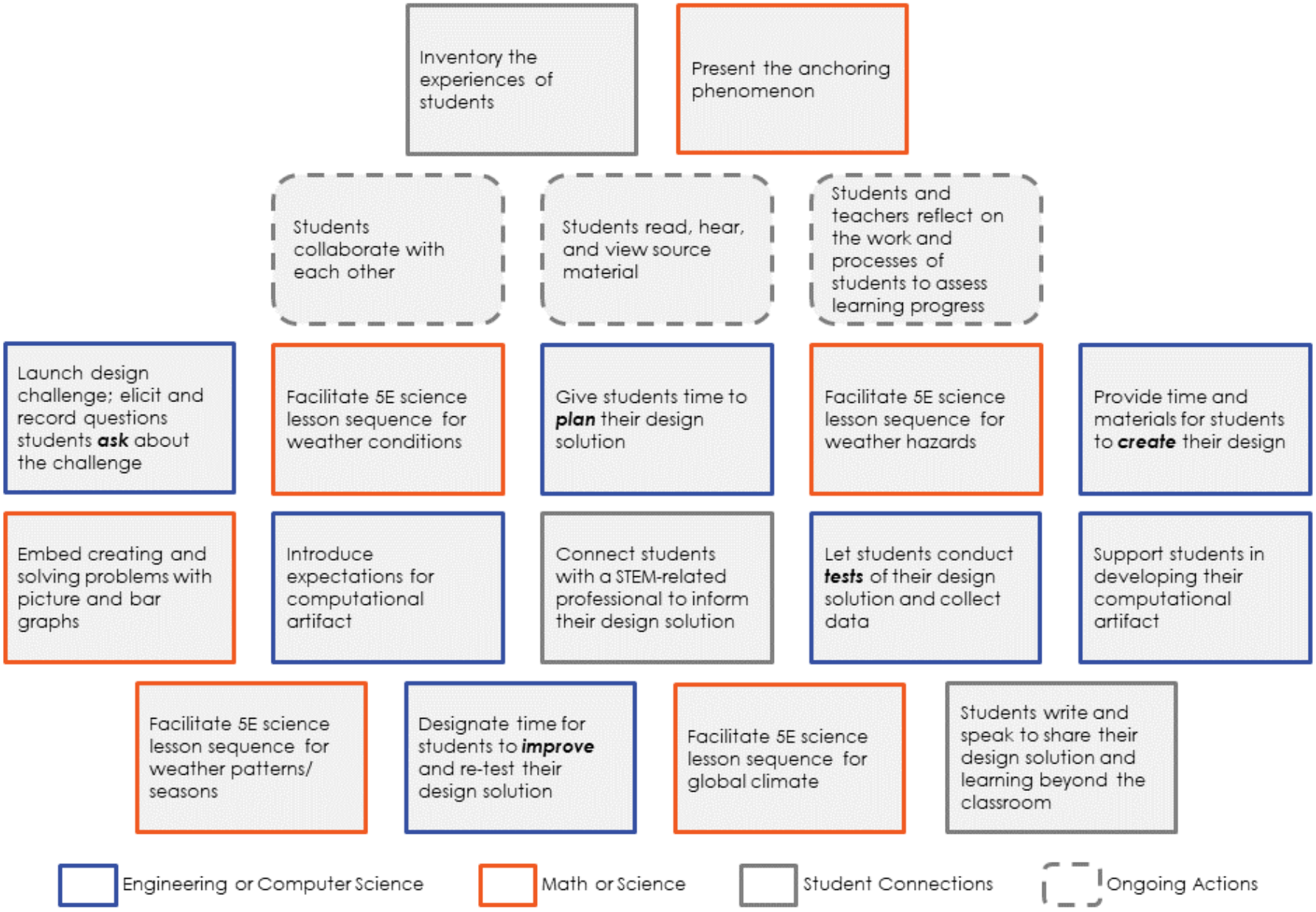
Sequence 5: Students reflect on their data and revise the plan to ***improve*** their model and then conduct follow-up tests on their improved structures. Students investigate world climates and how their design might work in some locations, but not in others.

Students will complete entering their weather data in a spreadsheet and produce graphs that demonstrate the pattern seen over time. Students will also complete a video describing the design process for their structure.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create a structure that will withstand a strong windstorm.

Type of Engineering: Civil Engineering

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *What type of structure will be the most resistant to the winds? What materials will we need?*	**3-5-ETS1-1.** Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)
Plan *Students will sketch out a model of the proposed plan and collaborate with group members to find the best option.*	**3-5-ETS1-2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
Create *Each students will create their own physical model that will withstand a windstorm*	
Test *Students will test the model using the windstorm simulator.*	**3-5-ETS1-3.** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)
Improve *Student teams will collaborate after test, re-design and re-test their structure*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create a video of their design being tested and enter weather data into a spreadsheet to create a data visualization.

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 the design being tested
- Spreadsheet of weather data
- Data display of weather data

Hardware

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

- Computer
- Video recording device

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

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

- Spreadsheet software such as Microsoft Excel or go to https://nces.ed.gov/nceskids/createagraph/Default.aspx (the National Center for Statistics[i]) to enter data into bar graph.

Standards

- **3-5.DA.8** Organize and present collected data visually to highlight relationships and support a claim.
- **3-5.DA.9** Use data to highlight and/or propose relationships, predict outcomes, or communicate ideas.

Science

Focal Standard

3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data at this grade level could include average temperature, precipitation, and wind direction] [*Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]*

Related Content Standards

3-ESS2-2 Obtain and combine information to describe climates in different regions of the world.

3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. [Clarification Statement: Examples of design solutions to weather related hazards could include barriers to prevent flooding, wind-resistant roofs, and lightning rods.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing a video of an ice storm in the summer. (Mason-Burt, 2020[ii]). (See also Mystery Science video on a summer ice storm.)

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
Weather Conditions	• Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)	7
Weather Hazards	• A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1)	7

Key Concept	Key Learnings	# of Days
Weather Patterns/ Seasons	• Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)	7
Global Climates	• Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)	7

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 create picture and bar graphs from the data they collect on local weather conditions and solve problems related to the picture and bar graphs.

Standards for Mathematical Content

3.MD.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.

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.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Reading Standard: Integration of Knowledge and Ideas

RI.3.7 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).

Speaking and Listening Standard: Comprehension and Collaboration

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

- **SL.3.1.a** Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- **SL.3.1.b** Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
- **SL.3.1.c** Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- **SL.3.1.d** Explain their own ideas and understanding in light of the discussion.

Speaking and Listening Standard: Presentation and Knowledge of Ideas

SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

Language: Conventions of Standard English

L.3.2.a. Capitalize appropriate words in titles.

Language: Vocabulary Acquisition and Use

L.3.5.a Distinguish the literal and nonliteral meanings of words and phrases in context (e.g., take steps).

Unit Vocabulary

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

- **Celsius**: Celsius is relating to or having a thermometer scale on which the interval between the freezing point and the boiling point of water is divided into 100 degrees with 0 representing the freezing point and 100 the boiling point. (Source: https://www.merriam-webster.com/dictionary/Celsius)

- **climate**: Climate in a narrow sense is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean [average] and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is 3 decades, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. (Sourced from the EPA[1] : https://bit.ly/3jX4li6)

- **cloud**: Clouds are formed when air contains as much water vapor (gas) as it can hold. This is called the saturation point. (Sourced from NWS[2]: https://bit.ly/3AedLB1)

- **coast**: The coast is the land near a shore. (Source: https://www.merriam-webster.com/dictionary/coast)

- **degrees**: Degrees are units for measuring temperature. (Source: https://www.merriam-webster.com/dictionary/degrees)

- **desert**: A desert is a dry land with few plants and little rainfall. (Source: https://www.merriam-webster.com/dictionary/desert)

- **drought**: Drought is a deficiency [lack] in precipitation over an extended period. Sourced from NWS: https://www.weather.gov/safety/drought)

- **Fahrenheit**: Fahrenheit is relating to or having a temperature scale on which the boiling point of water is at 212 degrees above the zero of the scale and the freezing point is at 32 degrees above zero. (Source: https://www.merriam-webster.com/dictionary/Fahrenheit)

- **flood**: Flooding is an overflowing of water onto land that is normally dry. Floods can happen during heavy rains, when ocean waves come on shore, when snow melts quickly, or when dams or levees break. (Sourced from NOAA[3]: https://bit.ly/3tG2jM4)

[1] EPA = Environmental Protection Agency
[2] NWS = National Weather Service
[3] NOAA = National Oceanic and Atmospheric Administration

- **fog**: There is no difference between fog and clouds other than altitude. Fog is defined as a visible moisture that begins at a height lower than 50 feet. If the visible moisture begins at or above 50 feet, it is called a cloud. (Sourced from NWS: https://bit.ly/3AedLB1)

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

- **freezing rain**: Freezing rain occurs when snowflakes descend into a warmer layer of air and melt completely. When these liquid water drops fall through another thin layer of freezing air just above the surface, they don't have enough time to refreeze before reaching the ground. Because they are "supercooled," they instantly refreeze upon contact with anything that that is at or below 0 degrees C, creating a glaze of ice on the ground, trees, power lines, or other objects. (Sourced from NOAA: https://bit.ly/3CbOoQV)

- **hail**: Hail is a form of precipitation consisting of solid ice that forms inside thunderstorm updrafts. Hail can damage aircraft, homes and cars, and can be deadly to livestock and people.(Sourced from NOAA: https://bit.ly/3zb0VCn)

- **hazards**: A hazard is a source of danger. (Source: https://www.merriam-webster.com/dictionary/hazard) Hazards can be natural, such as weather-related dangers, or man-made, such as pollution, putting damaging waste into the environment.

- **hurricane**: A hurricane is a type of storm called a tropical cyclone, which forms over tropical or subtropical waters. When a storm's maximum sustained winds reach 74 mph or higher, it is called a hurricane. (Sourced from NOAA: https://bit.ly/3tGostG)

- **lake**: A lake is a large inland body of standing water. (Source: https://www.merriam-webster.com/dictionary/lake)

- **mountain**: A mountain is a raised area of land higher than a hill. (Source: https://www.merriam-webster.com/dictionary/mountain)

- **ocean**: The ocean is the whole body of salt water that covers nearly three fourths of the earth. (Source: https://www.merriam-webster.com/dictionary/ocean)

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

- **rain**: Rain is water that falls in drops from clouds in the sky. (Source: https://www.merriam-webster.com/dictionary/rain)

- **season**: A season is one of the four quarters into which a year is commonly divided. (Source: https://www.merriam-webster.com/dictionary/season)

- **sleet**: Sleet occurs when snowflakes only partially melt when they fall through a shallow layer of warm air. These slushy drops refreeze as they next fall through a deep layer of freezing air above the surface, and eventually reach the ground as frozen rain drops that bounce on impact. (Sourced from NOAA: https://bit.ly/3CbOoQV)

- **snow**: Most precipitation that forms in wintertime clouds starts out as snow because the top layer of the storm is usually cold enough to create snowflakes. Snowflakes are just collections of ice crystals that cling to each other as they fall toward the ground. Precipitation continues to fall as snow when the temperature remains at or below 0 degrees Celsius from the cloud base to the ground. (Sourced from NOAA: https://bit.ly/3CbOoQV)

- **stream**: A stream is a natural flow of water that is smaller than a river. (Source: https://www.merriam-webster.com/dictionary/stream)

- **temperature**: Temperature is the degree [amount] of hotness or coldness as measured on a scale. (Source: https://www.merriam-webster.com/dictionary/temperature)

- **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)

- **tornado**: A tornado is a narrow, violently rotating column of air that extends from a thunderstorm to the ground. Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust and debris. (Sourced from NOAA: https://bit.ly/2Xm5P1W)

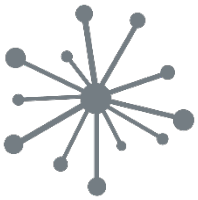
- **valley**: A valley is an area of lowland between ranges of hills or mountains. (Source: https://www.merriam-webster.com/dictionary/valley)

- **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)

- **weather vane**: A weather vane is a movable device usually attached to a roof to show which way the wind is blowing. (Source: https://www.merriam-webster.com/dictionary/weather%20vane)

- **wind**: Wind is the horizontal movement of air, transporting [heat] energy transferred from the earth's surface. (Adapted from NWS: https://bit.ly/3AedLB1)

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. What kinds of weather data have you collected?
    - ☐ Temperature
    - ☐ Amount of sunlight or clouds
    - ☐ Wind speed
    - ☐ Wind direction
    - ☐ Other types
    - ☐ None

2. What is your favorite time of year to be outside in our community? Why?

3. Name a place outside of our community that you want to visit someday. Why?

4. Think of a book you have read or a show you have seen lately. Describe the setting, which might include the
    - ☐ City
    - ☐ State
    - ☐ Country
    - ☐ Weather

5. What natural hazard (natural event that causes damage) do you fear the most? Why?

Aligned Learnings

1. Responses to this item provide insight into students' experience with data collection of weather conditions. 3-ESS2-1

2. Responses to this item provide insight into students' experiences with local weather conditions. 3-ESS2-1

3. Responses to this item provide insight into students' interests and possible experiences with global climates. 3-ESS2-2

4. Responses to this item provide insight into students' experiences with weather patterns in different places. 3-ESS2-2

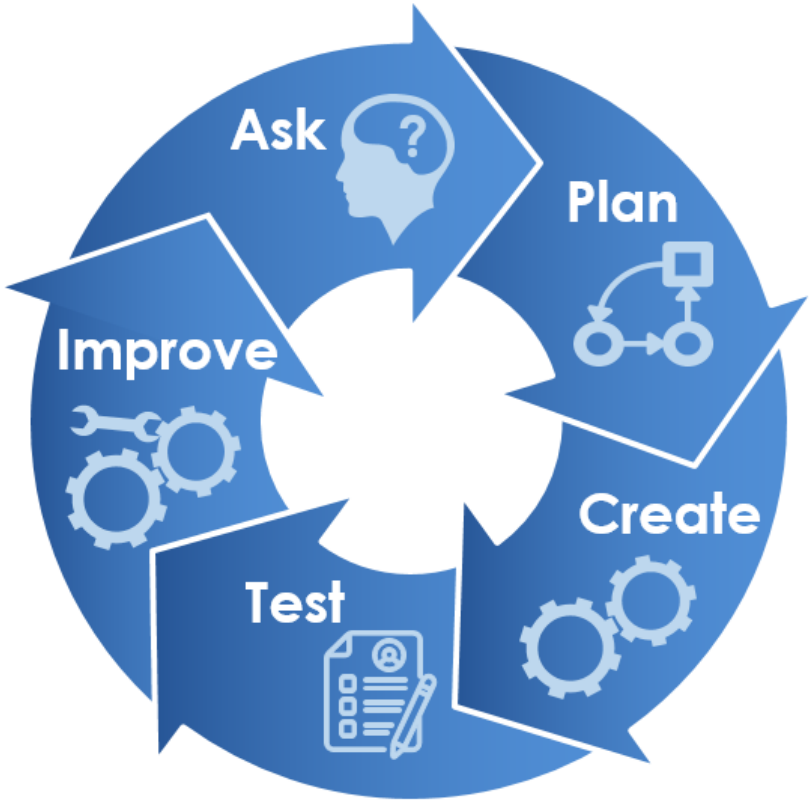
5. Responses to this item provides insight into students' experiences or knowledge of natural hazards. 3-ESS3-1

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 an 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. (3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3)	
	Computer Science Students create a video of their design, enter weather data into a spreadsheet, and create a data visualization. (3-5.DA.8, 3-5.DA.9)	
	Collaboration Students give and receive input with kindness and honesty. (SL.5.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.3.2). I can share thoughts, read, and listen to learn from others. (SL.3.4)	
	Science Students are able to represent and interpret data both in weather and climate region graphs. (3-ESS2-1, 3-ESS2-2, 3-ESS3-1)	

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:

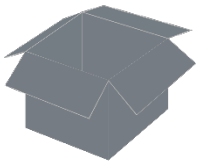
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Meteorologist** (Public Services)
- **Building Inspector** (Building and Construction Trades)
- **Farm Manager or Gardener** (Agriculture and Natural Resources)

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** (Public Services)
  - What weather events require you to do the most research and lead to the highest level of communication with the public?
  - What is the biggest weather hazard that is likely to occur in our area?
  - How did you get interested in this area?
  - What does a typical day on the job look like?
  - What is one problem you are currently facing in your day-to-day work?
- **Building Inspector** (Building and Construction Trades)
  - In our area, how does weather or Earth effects (like earthquakes) impact how structures are built?
  - What would you look for to ensure that a building could withstand high winds?
  - What kinds of factors do you routinely check to ensure that a building is "up to code" and normal wear and tear is being handled appropriately?
  - What is the most serious structural problem you have seen that may have been caused by the weather?
- **Farm Manager or Gardener** (Agriculture and Natural Resources)
  - How does day-to-day weather impact the work that you are able to do on your job?
  - What is the biggest weather hazard that you are concerned about with your work?
  - Have you seen evidence of climate change in terms of animals and plant survival in our area?
  - What is one problem you face in your day-to-day work?



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):

- ☐ 1 hairdryer

Consumable Equipment (classroom totals):

- ☐ 320 index cards
- ☐ 32 rolls of clear tape
- ☐ 1 roll of aluminum foil
- ☐ 230 pipe cleaners
- ☐ 160 rubber bands
- ☐ 500 craft sticks
- ☐ 160 paper straws
- ☐ 100 (3 oz.) paper cups
- ☐ 160 sheets of construction paper (from site)
- ☐ 160 sheets of copy paper (from site)
- ☐ cardboard (from site or home as available)

From Students' Homes (as available):

- ☐ 2 toilet paper tubes per students
- ☐ 2 paper towel tubes per student
- ☐ 2 water bottles per student
- ☐ cardboard

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 index cards
- ☐ 1 roll of clear tape
- ☐ 1 12x12 piece of aluminum foil
- ☐ 6-7 pipe cleaners
- ☐ 5 rubber bands
- ☐ 10-15 craft sticks
- ☐ 5 paper straws
- ☐ 3-4 paper cups
- ☐ 5 sheets of construction paper
- ☐ Cardboard (from home or site as available)

Endnotes

[i] National Center for Educational Statistics. (n.d.). *Kid's Zone: Create a graph.* https://nces.ed.gov/nceskids/createagraph/Default.aspx

[ii] Mason-Burt, E. (2020, September 16). *Summer ice storm in Guadalajara.* YouTube. https://www.youtube.com/watch?v=l8F1Ep5lQRY