Integrated STEM Unit Planner

Grade 2 Science

Slow the Damage

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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

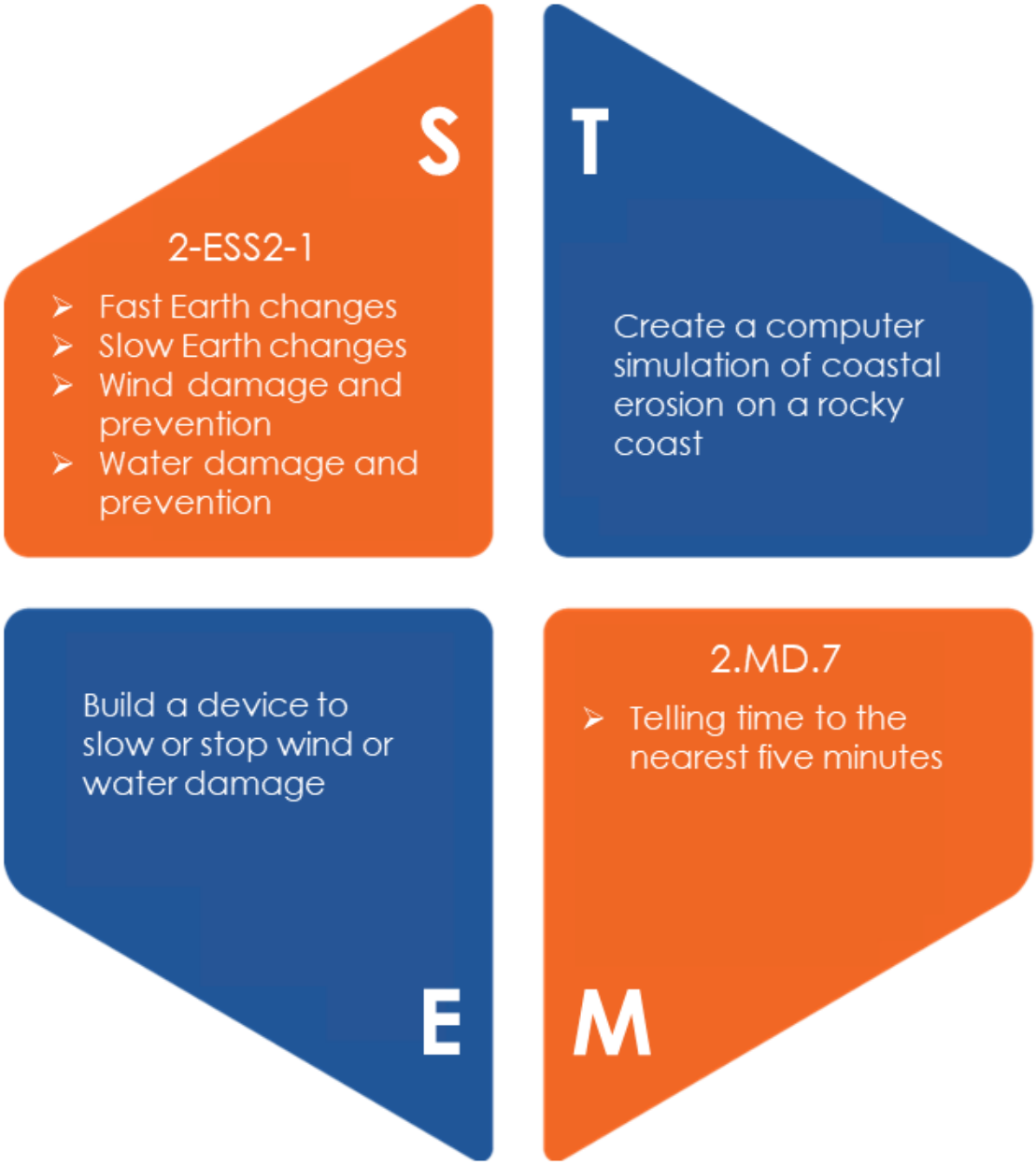
Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading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

2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water and different designs for using shrubs, grass, and trees to hold back the land.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing a time lapse of the Mud Creek Landslide from the United States Geological Survey[i] (https://on.doi.gov/3FsVJ0V). The purpose of the phenomenon is to engage students by having them think about what is happening during the disaster. Students will consider what they notice and what they wonder about what they are seeing.

Students will be introduced to the essential question: When wind and water damages land areas, what can that teach us about building structures or barriers that will slow the damage down or prevent it from happening again? It is important to have the students answer this question at the beginning and again throughout the unit to allow them to see how their thinking has changed and grown through the unit.

This will lead to the introduction of the design challenge: To build a device to slow or stop wind or water damage. Students will begin to ***ask*** questions like: What changes do landscapes go through? Does the land look the same all the time? What causes variations in the shape of the land? Does water affect how land looks? Does the wind effect it? Their ideas will be explored through lessons discussing fast earth changes, such as earthquakes or volcanic eruptions.

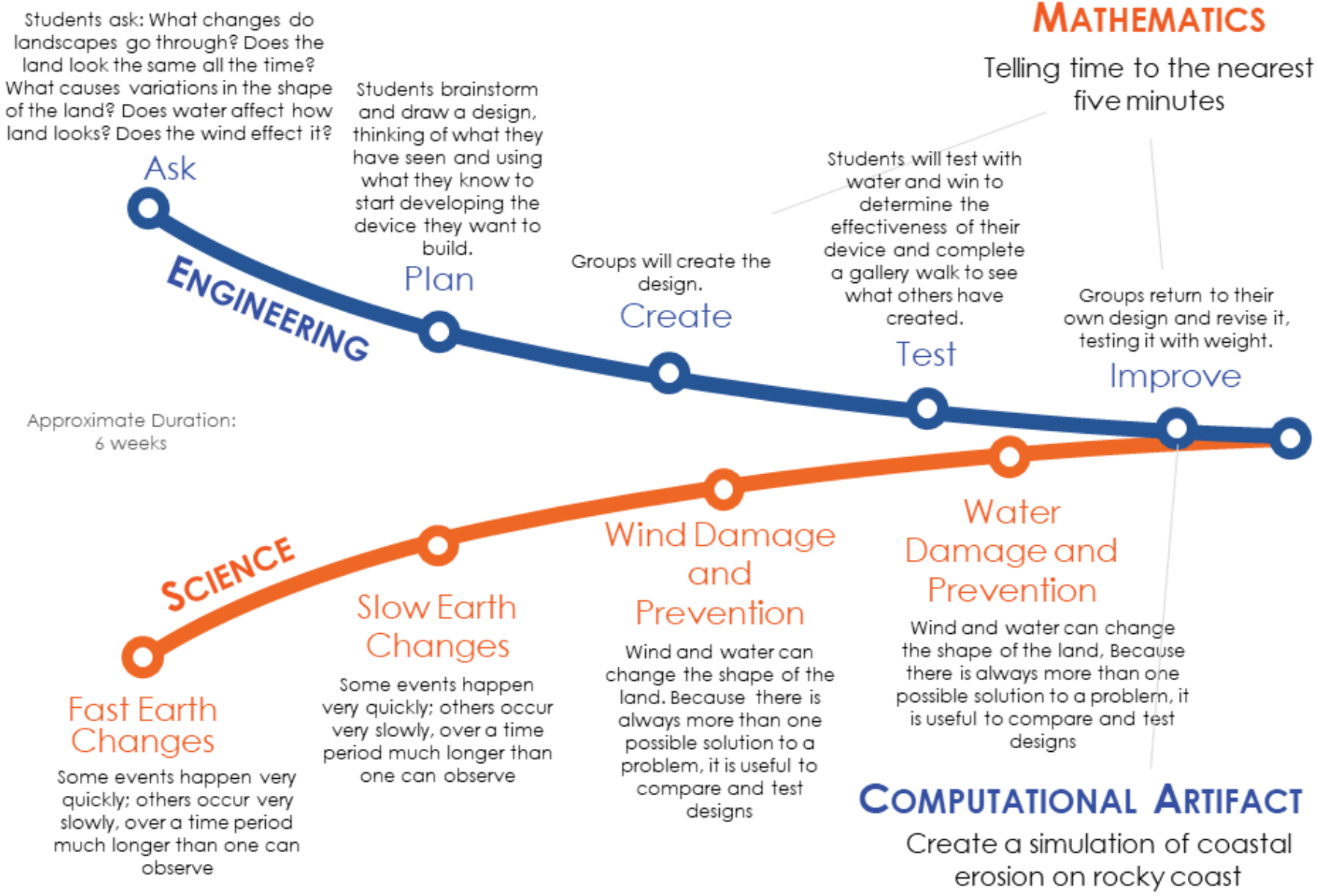
Sequence 2: Students will learn about slower earth changes, such as might occur with slow rock erosion due to wind and water. Students brainstorm and draw a design, thinking of what they have seen and using what they know to start developing the device they want to build. They will ***plan*** their model.

Sequence 3: Student work on the engineering task will be furthered as they learn about wind damage and strategies to prevent wind damage. Students will work in groups to ***create*** their device.

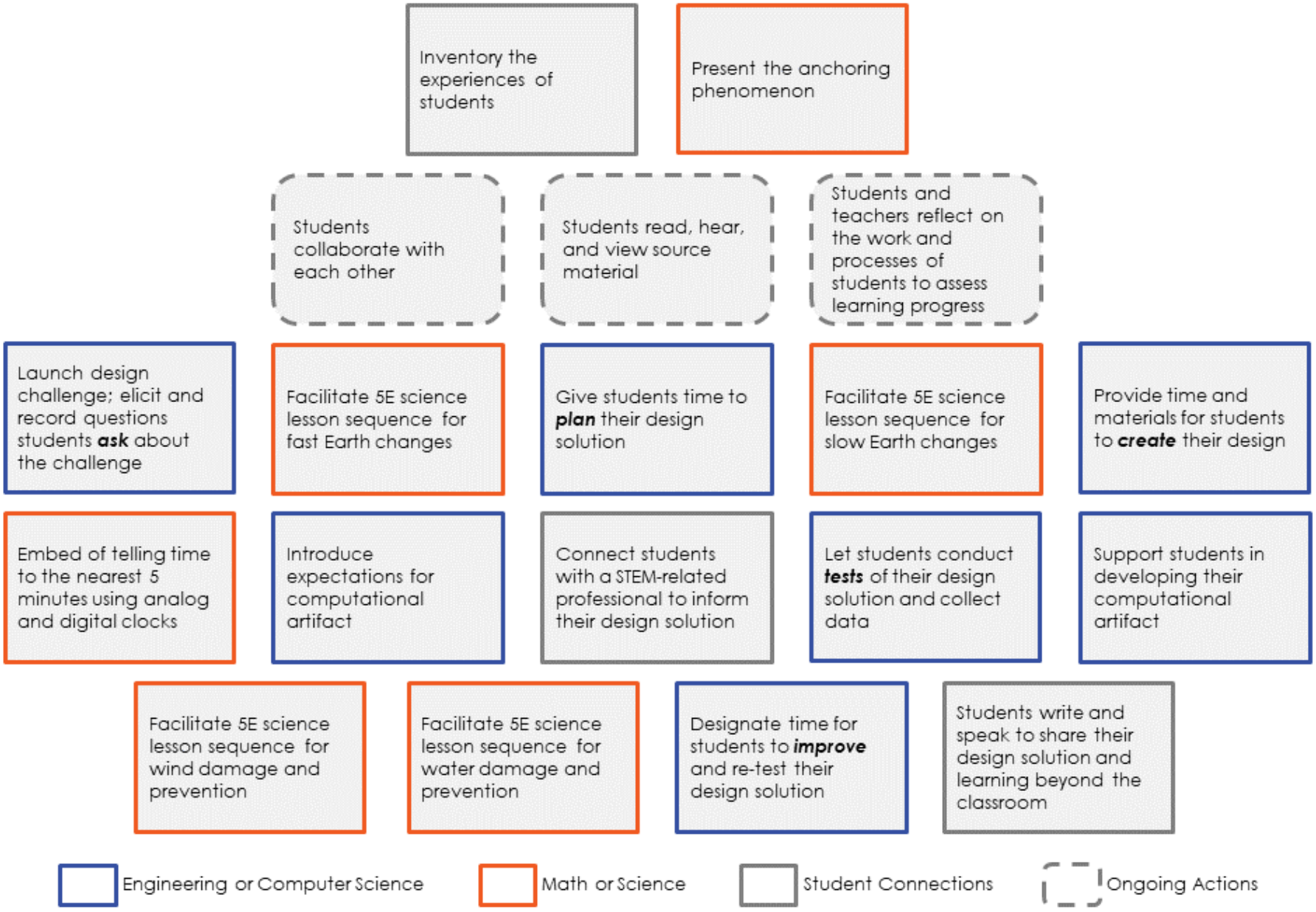
Sequence 4: Students explore how water can damage the Earth and what efforts can be made to prevent this damage. Students ***test*** the effectiveness of their design by first exposing their land portion to wind or water for five minutes. Students then rebuild the land area and add their protective device, then test the area again for five minutes. All students will complete a gallery walk and receive feedback from their peers on the effectiveness of their design.

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

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Build a device to slow or stop wind or water damage

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 changes do landscapes go through? Does the land look the same all the time? What causes variations in the shape of the land? Does water affect how land looks? Does the wind effect it?*	**K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. • A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) • Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)
Plan *Students brainstorm and draw a design, thinking of what they have seen and using what they know to start developing the device they want to build.*	**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 *Groups will create the design.*	
Test *Students will test with water and wind to determine the effectiveness of their device and complete a gallery walk to see what others have created.*	**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 *Groups return to their own design and revise it, testing it with weight.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create a computer simulation of coastal erosion on a rocky coast.

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)

- Simulation in Scratch of coastal erosion which should include a rocky coastline, rocks (sprites), rock movement (through the "glide" effect in blue and "ghost" effect in purple), and the sound of wind
- Digital images of the tested land area with and without the damage-reducing structure

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)

- Scratch

Standards

- **K-2.AP.12** Create programs with sequences of commands and simple loops to express ideas of address a problem.

Science

Focal Standard

2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* [Clarification Statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water and different designs for using shrubs, grass, and trees to hold back the land.]

Related Content Standards

2-ESS1-1 Use information from several sources to provide evidence that Earth events can occur quickly or slowly. [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly, and erosion of rocks, which occurs slowly.] [*Assessment Boundary: Assessment does not include quantitative measurements of timescales*.]

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

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing a time lapse of the Mud Creek Landslide from the United States Geological Survey (https://on.doi.gov/3FsVJ0V).

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
Fast Earth Changes (volcanic explosions, earthquakes)	• Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (ESS1.C)	6
Slow Earth Changes (rock erosion)	• Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (ESS1.C)	6

Key Concept	Key Learnings	# of Days
Wind Damage and Prevention	• Wind and water can change the shape of the land. (ESS2.A) • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (ETS1.C) (secondary to 2-ESS2-1)	8
Water Damage and Prevention	• Wind and water can change the shape of the land. (ESS2.A) • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (ETS1.C) (secondary to 2-ESS2-1)	8

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 run their tests for five minutes, using the clock as their guide.

Standards for Mathematical Content

2.MD.7 Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.

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.2.3 Describe the connection between a series of historical events, scientific ideas, or concepts, or steps in technical procedures in a text.

Writing Standard: Text Types and Purposes

W.2.2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.

Writing Standard: Research to Build and Present Knowledge

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).

Speaking and Listening Standard: Comprehension and Collaboration

SL.2.1 Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.

Language: Conventions of Standard English

L.2.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

- **L2.2c** Use an apostrophe to form contractions and frequently occurring possessives. (Plural nouns.)
- **L.2.2d** Generalize learned spelling patterns when writing words (e.g., cage/badge; boy/boil).

Unit Vocabulary

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

- **cause**: A cause is a reason for an action or condition. (Source: https://www.merriam-webster.com/dictionary/cause)
- **dike**: A dike is a mound of earth built to control water. (Source: https://www.merriam-webster.com/dictionary/dike). Dikes may be used to prevent flooding or to redirect water away from one location to another.
- **earthquake**: An earthquake is an intense shaking of Earth's surface. The shaking is caused by movements in Earth's outermost layer. (Sourced from NASA[1]: https://go.nasa.gov/38lTtUn)
- **effect**: An effect is an event, condition, or state of affairs that is produced by a cause. (Source: https://www.merriam-webster.com/dictionary/effect)
- **erosion**: Erosion is the gradual destruction of something by natural forces (such as water, wind, or ice). (Source: https://www.merriam-webster.com/dictionary/erosion)
- **event**: An event is something that happens, a special occasion or activity. (Adapted from: https://www.merriam-webster.com/dictionary/event)
- **flash flood**: A flash flood occurs when runoff from excessive rainfall causes a rapid rise in the water height (stage) of a stream or normally-dry channel. Flash floods are more common in areas with a dry climate and rocky terrain because lack of soil or vegetation allows torrential rains to flow overland rather than infiltrate into the ground. (Sourced from the USGS[2]: https://on.doi.gov/3anVW7f)
- **flood**: A flood occurs when a large amount of water covers an area of land that is usually dry. (Source: https://www.merriam-webster.com/dictionary/flood)
- **gradual**: Gradual means moving or changing in small amounts or happening in a slow way over a long period of time. (Source: https://www.merriam-webster.com/dictionary/gradual)
- **grass**: Grasses are plants that have narrow green leaves, that are eaten by cows, sheep, horses, etc., and that are commonly grown on lawns and in gardens. (Source: https://www.merriam-webster.com/dictionary/grass)

[1] NASA = National Aeronautics and Space Administration
[2] USGS = United States Geological Survey

- **processes**: Processes are a series of actions, motions, or operations leading to some result. (Source: https://www.merriam-webster.com/dictionary/processes)

- **rapid**: Rapid means happening in a short amount of time or happening quickly. (Source: https://www.merriam-webster.com/dictionary/rapid)

- **shrub**: A shrub is a woody plant that has several stems and is smaller than most trees. (Source: https://www.merriam-webster.com/dictionary/shrub)

- **slow**: Slow means not happening quickly. (Source: https://www.merriam-webster.com/dictionary/slow)

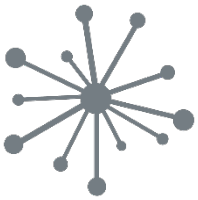
- **tree**: A tree is a long-lived woody plant that has a single usually tall main stem with few or no branches on its lower part. (Source: https://www.merriam-webster.com/dictionary/tree)

- **volcano**: A volcano is an opening in the earth's crust from which hot or melted rock and steam erupt. (Source: https://www.merriam-webster.com/dictionary/volcano)

- **weathering**: Weathering refers to the action of the weather conditions in altering the color, texture, composition, or form of exposed objects. (Source: https://www.merriam-webster.com/dictionary/weathering)

- **windbreak**: A windbreak is a shelter (such as a fence) from the wind. (Source: https://www.merriam-webster.com/dictionary/windbreak). Trees and shrubs can also serve as windbreaks.

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. Have you been in an earthquake or heard about one? What do you remember?
2. Talk about something you have seen break apart.
3. Have you seen the wind affect things outside? What was that like?
4. Have you seen water affect things outside? What was that like?

Aligned Learnings

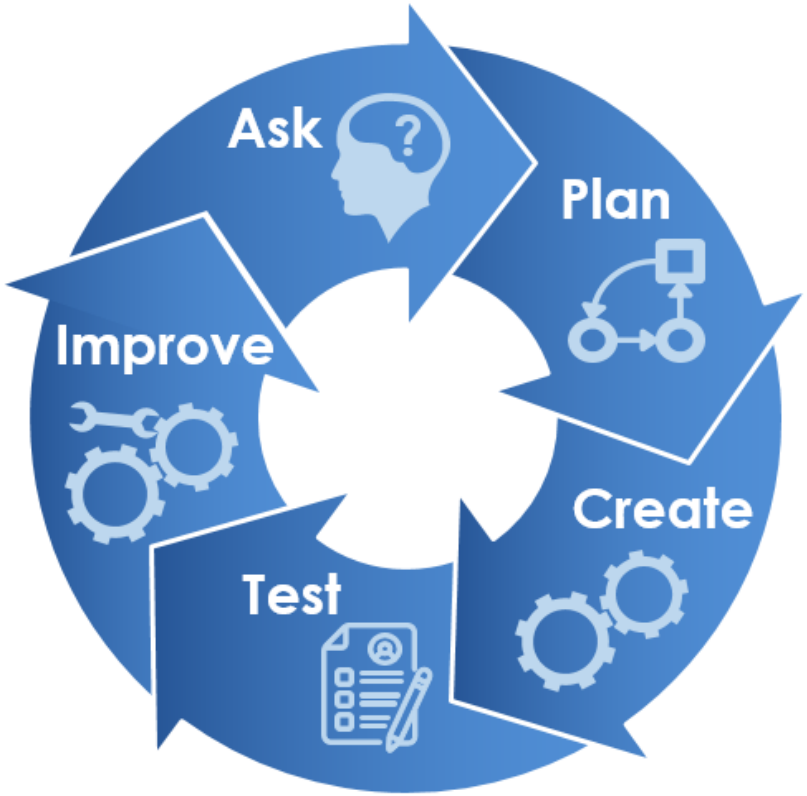
1. Responses to this item provide insight into students' experiences with an earthquake, a fast Earth change. 2-ESS1-1
2. Responses to this item provide insight into students' experiences with things breaking apart as in erosion. 2-ESS1-1
3. Responses to this item provide insight into students' experiences with wind damage. 2-ESS2-1
4. Responses to this item provide insight into students' experiences with water damage. 2-ESS2-1

Student Self-Assessment of Engineering

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

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

Plan:
Here are my design ideas for the project…



Test:
Here are the data I collected…

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

I am doing the work of a 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 create a simulation of coastal erosion on a rocky coast and photograph their testing. (K-2.AP.12)	
	Collaboration Students contribute and support others with honesty and kindness (SL.2.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.2.2, W.2.7). Students will share thoughts, read, and listen to learn from others. (SL.2.1)	
	Science Students will provide evidence that Earth events can occur quickly or slowly and will be able share solutions for slowing or preventing wind and water damage. (2-ESS2-1, 2-ESS1-1)	

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:

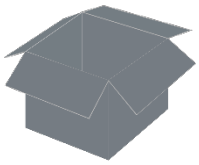
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Landscape Architect**(Engineering and Architecture or Building and Construction Trades)
- **Dermatologist** (Health Sciences and Medical Technology)
- **Outdoor Wear Clothing Designer** (Fashion and Interior Design)

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:

- **Landscape Architect**(Engineering and Architecture or Building and Construction Trades)
  - When you begin to design a landscape, what elements of the environment do you consider?
  - When you design the hardscape (structures in the yard), what kinds of things do you suggest to protect from the wind, sun, and/or water?
  - What structures or plants might you suggest to prevent erosion?
  - Sometimes people talk about plants and structures in a yard creating a micro-climate. What does that mean and how do you take advantage of that in your designs?
- **Dermatologist** (Health Sciences and Medical Technology)
  - What are some factors that create wear and tear on our skin?
  - What can you do to prevent skin damage?
  - Does it make a difference if you stay in the shade on a sunny day in terms of potential damage to your skin?
  - Does everyone need to wear sunscreen all the time and regardless of where they live?
- **Outdoor Wear Clothing Designer** (Fashion and Interior Design)
  - What kinds of special clothing do you design to protect people in very cold or very hot environments? Are the fabrics used different?
  - Suppose you want to create a waterproof raincoat. What kinds of material or coatings do you use to ensure that it works? How do you test it to make sure it works?
  - Do particular items of clothing, such as boots or pants, have to be designed differently depending upon the likely kind of activity of a typical buyer? Could you give an example of how clothes might be made differently?



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):

- ☐ Tub for sand (rough size: 14 x 10 x 3 inches) (available from previous unit)
- ☐ Tub for gravel (rough size: 14 x 10 x 3 inches) (available from previous unit)
- ☐ 2 lbs. of pea gravel (available from previous unit)
- ☐ 50 lb. bag of desert sand (available from previous unit)
- ☐ 1 pitcher (about 1 or 2 liters)

Consumable Equipment (classroom totals):

- ☐ 160 paper straws
- ☐ 256 toothpicks
- ☐ 1 roll of aluminum foil
- ☐ 320 cotton balls
- ☐ 320 (3 oz.) paper cups
- ☐ 30 square feet of mesh netting (fish tank covering mesh)
- ☐ water (from site)
- ☐ 8 rolls of paper towels (from site)

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 cup of sand
- ☐ 1 handful of pea gravel
- ☐ 5 paper straws
- ☐ 10 (3 oz.) paper cups
- ☐ 8 toothpicks
- ☐ about 1 square foot of aluminum foil
- ☐ 10 cotton balls
- ☐ about 1 square foot of mesh netting
- ☐ 1 roll of paper towels

Endnotes

[i] Unites States Geological Survey. (2019, July 18). *Mud Creek landslide changes March 2017 – June 2018.* *https://www.usgs.gov/media/images/mud-creek-landslide-changes-march-2017-june-2018*