Integrated STEM Unit Planner

Pre-Kindergarten and Transitional Kindergarten Science Design a Sun-Blocking Item

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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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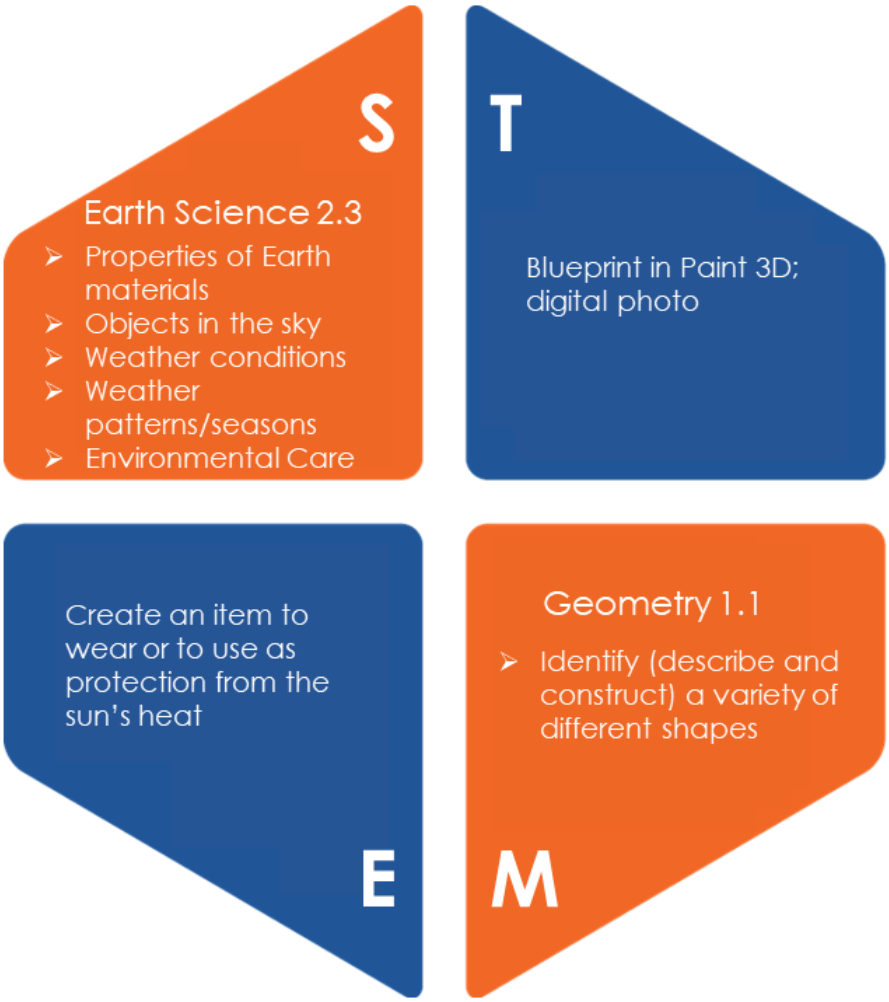
Contents

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*
2.3 Begin to notice the effects of weather and seasonal changes on their own lives and on plants and animals.	**2.3 Demonstrate an increased ability to notice and describe the effects of weather and seasonal changes on their own lives and on plants and animals.**

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing images of weather changes in the environment. Videos are readily available through YouTube and other media. Still images may also be used from local sources. Some video options include:

> A year in a life of a rural area (Faux, 2009)[i] (https://www.youtube.com/watch?v=2mIJK9u8qzo)
>
> Seasons in a forest (Motionkicker, 2013)[ii] (https://www.youtube.com/watch?v=jfa29pq6NFs)

Students will begin to think about the impact weather and seasonal changes have on their own lives and on plants and animals. After students view images or video, teachers facilitate students' thinking through an inquiry anchor chart (I notice, I think, I wonder). Teachers will introduce the driving essential question: How do weather and seasonal changes affect us in our environment? Teachers may wish to introduce readings of children experiencing seasonal changes, such as A Book of Seasons (Provensen & Provensen, 1976)[iii] or show a short video of a teacher reading this book, found here. (Linville, 2016)[iv]

Teachers will introduce the design challenge: to create an item to wear or use that will protect them from the sun's heat. Students will begin to ***ask*** questions like: What happens when the weather changes? How does that affect you and other living things? How could you keep yourself safe when it is very sunny? Students will begin to learn about earth materials as they notice the weather around them.

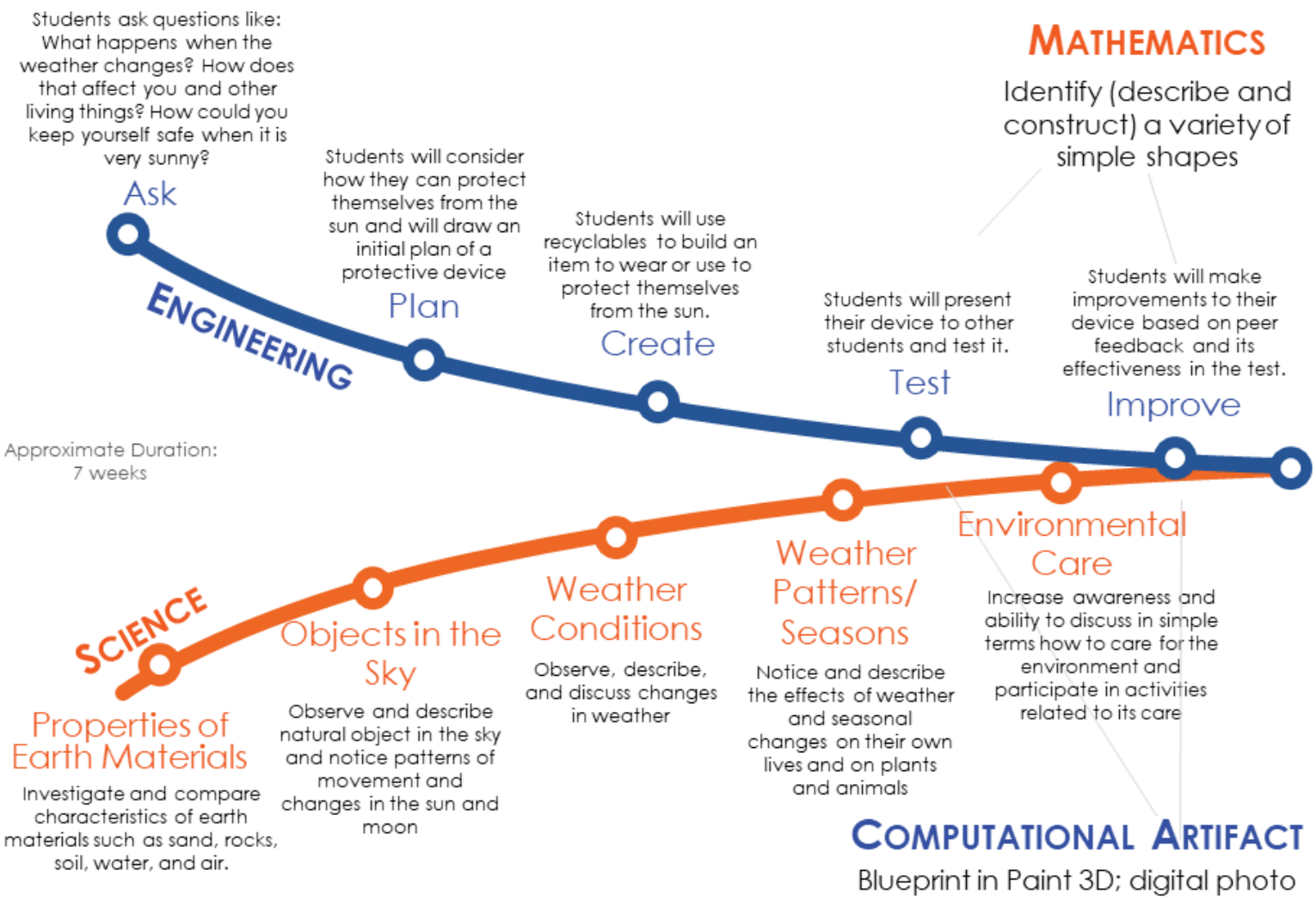
Sequence 2: Students will learn about the sun, moon and other objects in the sky and how they change over time. They will ***plan*** their protective device by drawing an initial plan.

Sequence 3: Students will learn more about the weather and how weather conditions can impact how humans as well as plants and other animals live and survive. Students will consider the materials available and being to ***create*** their device.

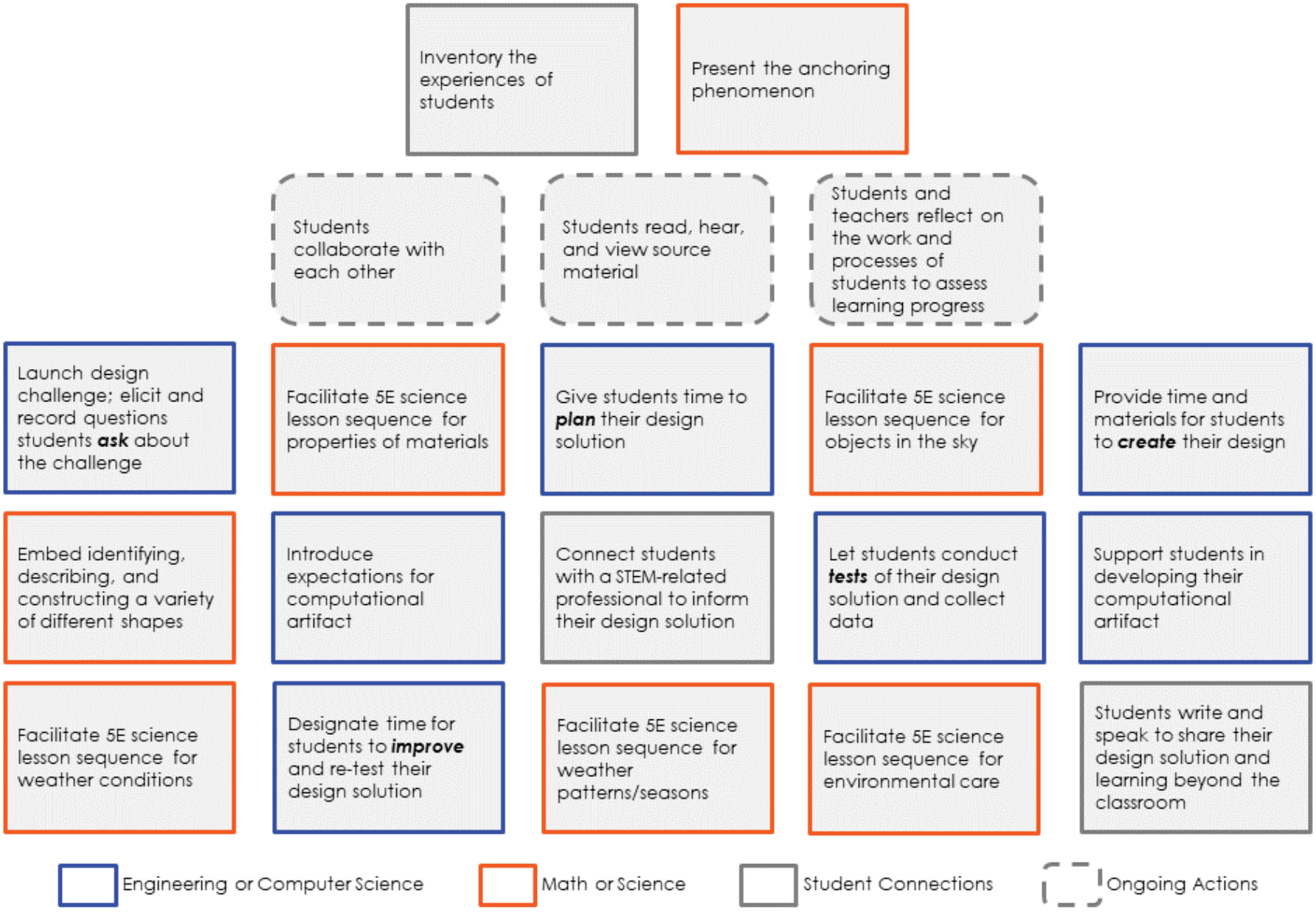
Sequence 4: Students will continue to learn about weather, noticing patterns of weather as well as seasonal changes. Students will present their protective device and ***test*** the effectiveness of the design, gathering information from peers about the design.

Sequence 5: Students will continue to learn about their environment and possible ways that they can care for the world around them. Based on what they learned from others, they will revise the plan to ***improve*** their model.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Create an item to wear or to use as protection from the sun's heat

Type of Engineering: Materials Engineer

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *What happens when the weather changes? How does that affect you and other living things? How could you keep yourself safe when it is very sunny?*	**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 will consider how they can protect themselves from the sun and will draw an initial plan of a protective device.*	**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 will use recyclables to build an item to wear or use to protect themselves from the sun.*	
Test *Students will present their device to other students and test it.*	**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 make improvements to their device based on peer feedback and its effectiveness in the test*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

1. Students will make a blueprint of their item in Microsoft Paint 3D.
2. Students will take a digital photo of their item.

Computational Artifact

Definition: Anything created by a human using a computational thinking process and a computing device. A computational artifact can be, but is not limited to, a program, image, audio, video, presentation, or web page file. (Source: College Board, 2016)

- Digital photo
- Microsoft Paint 3D publication

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
- Camera software

Standards

- **K-2.DA.7** Store, copy, search, retrieve, modify, and delete information using a computing device, and define the information stored as data.
- **K-2.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*
2.3 Begin to notice the effects of weather and seasonal changes on their own lives and on plants and animals.	**2.3 Demonstrate an increased ability to notice and describe the effects of weather and seasonal changes on their own lives and on plants and animals.**

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.
1.3 Begin to identify and use, with adult support, some observation and measurement tools.	1.3 Identify and use a greater variety of observation and measurement tools. May spontaneously use an appropriate tool, though may still need adult support.
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.
1.5 Make predictions and check them, with adult support, through concrete experiences.	1.5 Demonstrates an increased ability to make predictions and check them (e.g., may make more complex predictions, offer ways to test predictions, and discuss why predictions were correct or incorrect).
1.6 Make inferences and form generalizations based on evidence.	1.6 Demonstrate an increased ability to make inferences and form generalizations based on evidence.

2.0 Documentation and Communication	
2.1 Record observations or findings in various ways, with adult assistance, including pictures, words (dictated to adults), charts, journals, models, and photos.	2.1 Record information more regularly and in greater detail in various ways, with adult assistance, including pictures, words (dictated to adults), charts, journals, models, photos, or by tallying and graphing information.
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.
Physical Sciences	
1.0 Properties and Characteristics of Nonliving Objects and Materials	
1.1 Observe, investigate, and identify the characteristics and physical properties of objects and of solid and nonsolid materials (size, weight, shape, color, texture, and sound).	1.1 Demonstrate increased ability to observe, investigate, and describe in greater detail the characteristics and physical properties of objects and of solid and nonsolid materials (size, weight, shape, color, texture, and sound).
2.0 Changes in Nonliving Objects and Materials	
2.1 Demonstrate awareness that objects and materials can change; explore and describe changes in objects and materials (rearrangement of parts; change in color, shape, texture, temperature)	2.1 Demonstrate an increased awareness that objects and materials can change in various ways. Explore and describe in greater detail changes in objects and materials (rearrangement of parts; change in color, shape, texture, form, and temperature)
2.2 Observe and describe the motion of objects (in terms of speed, direction, the ways things move), and explore the effect of own actions (e.g., pushing pulling, rolling, dropping) on making objects move	2.2 Demonstrate an increased ability to observe and describe in greater detail the motion of objects (in terms of speed, direction, the ways things move), and to explore the effect of own actions on the motion of objects, including changes in speed and direction.
Earth Sciences	
1.0 Properties and Characteristics of Earth Materials and Objects	
1.1 Investigate characteristics (size, weight, shape, color, texture) of earth materials such as sand, rocks, soil, water, and air.	1.1 Demonstrate increased ability to investigate and compare characteristics (size, weight, shape, color, texture) of earth materials such as sand, rocks, soil, water, and air.

2.0 Changes in the Earth	
2.1 Observe and describe natural objects in the sky (sun, moon, stars, clouds) and how they appear to move and change.	2.1 Demonstrate an increased ability to observe and describe natural objects in the sky and to notice patterns of movement and apparent changes in the sun and the moon.
2.2 Notice and describe changes in weather.	2.2 Demonstrate an increased ability to observe, describe, and discuss changes in weather.
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.

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing images of weather changes in the environment. Videos are readily available through YouTube and other media. Some options include:

A year in a life of a rural area (https://www.youtube.com/watch?v=2mlJK9u8qzo)

Seasons in a forest (https://www.youtube.com/watch?v=jfa29pq6NFs)

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
Properties of Earth Materials	• Demonstrate increased ability to investigate and compare characteristics (size, weight, shape, color, texture) of earth materials such as sand, rocks, soil, water, and air. (Earth Sciences 1.1)	10
Objects in the Sky	• Demonstrate an increased ability to observe and describe natural objects in the sky and to notice patterns of movement and apparent changes in the sun and the moon. (Earth Sciences 2.1)	10

[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.

Key Concept	Key Learnings [1]	# of Days
Weather Conditions	• Demonstrate an increased ability to observe, describe, and discuss changes in weather. (Earth Sciences 2.2)	10
Weather Patterns/ Seasons	• Begin to notice the effects of weather and seasonal changes on their own lives and on plants and animals. (Earth Sciences 2.3)	10
Environmental Care	• 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

Foundations in Mathematics

Description of Student Engagement

Students will examine their weather protective devices and identify shapes that are included in the design.

Standards for Mathematical Content

Geometry	
1.0 Children begin to identify and use common shapes in their everyday environment.	**1.0 Children identify and use a variety of shapes in their everyday environment.**
At around 48 months of age	*At around 60 months of age*
1.1 Identify simple two-dimensional shapes, such as a circle and square.	1.1 Identify, describe, and construct a variety of different shapes, including variations of a circle, triangle, rectangle, square, and other shapes

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.
2.0 Vocabulary	
2.2 Understand and use accepted words for categories of objects encountered and used frequently in everyday life	2.2 Understand and use accepted words for categories of objects encountered in everyday life.
2.3 Understand and use simple words that describe the relations between the objects.	2.3 Understand and use both simple and complex words that describe the relations between objects.
Reading	
3.0 Alphabetics and Word/Print Recognition	
3.1 Recognize the first letter of own name.	3.1 Recognize own name or other common words in print.
4.0 Comprehension and Analysis of Age-Appropriate Text	
4.2 Demonstrate knowledge from informational text through labeling, describing, playing, or creating artwork.	4.2 Use information from informational text in a variety of ways, including describing, relating, categorizing, or comparing and contrasting.
Writing	
1.0 Writing Strategies	
1.2 Write using scribbles that are different from pictures.	1.2 Write letters or letter-like shapes to represent words or ideas.

Unit Vocabulary

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

- **cloudy**: 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) Students will recognize the sky as cloudy when they cannot see the blue sky but instead they see the clouds.

- **earth materials**: Earth materials are the inanimate or nonliving elements of our environment.
    - **sand**: Sand is loose material in grains produced by the natural breaking up of rocks. (Source: https://www.merriam-webster.com/dictionary/sand)
    - **rocks**: Rocks are solid mineral deposits or a mass of stone. (Source: https://www.merriam-webster.com/dictionary/rocks)
    - **soil**: Soil is the loose surface material of the earth in which plants grow. (Source: https://www.merriam-webster.com/dictionary/soil)

- **foggy**: 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) Students will describe the sky as foggy when they see a mist at ground level that makes it hard to see any distance.

- **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[3]: https://bit.ly/3zb0VCn)

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

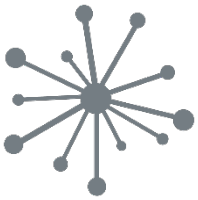
- **overcast**: The sky is overcast when it is covered with clouds. (Source: https://www.merriam-webster.com/dictionary/overcast)

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

[2] NWS = National Weather Service
[3] NOAA = National Oceanic and Atmospheric Administration

- **seasons**: Seasons are the four periods into which the year is typically divided based on the calendar year and typical weather expected.
    - **winter**: Winter is the season between autumn and spring (as from December to March in the northern half of the earth). (Source: https://www.merriam-webster.com/dictionary/winter)
    - **spring**: Spring is the season between winter and summer including in the northern hemisphere usually the months of March, April, and May. (Source: https://www.merriam-webster.com/dictionary/spring)
    - **summer**: Summer is the season between spring and autumn which is in the northern hemisphere usually the months of June, July, and August. (Source: https://www.merriam-webster.com/dictionary/summer)
    - **fall**: Fall or autumn is the season between summer and winter, usually the months of September, October and November in the northern hemisphere. (Adapted from: https://www.merriam-webster.com/dictionary/autumn)
- **snowy**: 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)
- **storm**: A storm is an occurrence of bad weather in which there is a lot of rain, snow, etc., and often strong winds. (Source: https://www.merriam-webster.com/dictionary/storm)
- **sunburn**: Sunburn means to burn or discolor by exposure to the sun. (Source: https://www.merriam-webster.com/dictionary/sunburn)
- **sunny**: A day is described as sunny when there are few or no clouds in the sky.
- **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)
- **windy**: A day is described as windy when air movement is heavy enough to be noticed. There are no specific definitions of the speed of the wind that would qualify as "windy".

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 things have you seen and felt outside? What did those things look and feel like?

2. What kinds of things have you seen up in the sky at night? In the daytime? What did you notice?

3. What kinds of weather changes have you seen outside? What do you remember about it? (Additional Prompts: Sunny weather that changed? Cloudy weather that changed? Rainy weather that changed? Windy weather that changed?)

4. What are some of the ways in our earlier unit that we cared for the Earth (or environment?

Aligned Learnings

1. Responses to these items provide insight into students' experiences with earth materials. Earth Sciences 1.1

2. Responses to these items provide insight into students' experiences with objects in the sky. Earth Sciences 2.1

3. Responses to these items provide insight into students' experiences with weather conditions and changes. Earth Sciences 2.2, 2.3

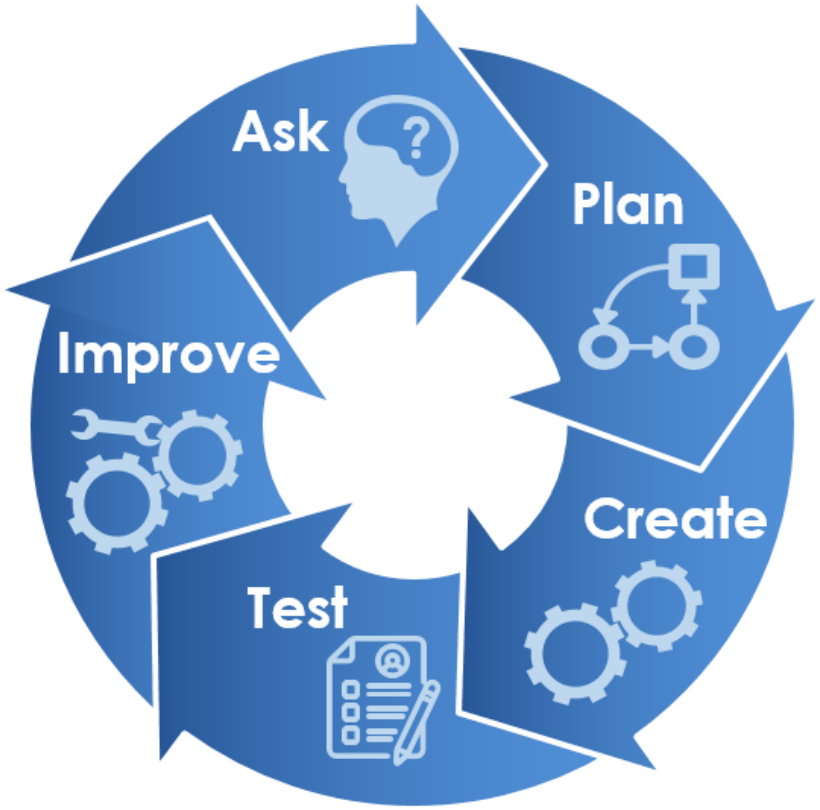
4. Responses to these items provide insight into students' experiences with the environmental care. Earth Sciences 2.4

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 a materials 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 digital photo and Paint 3D sketch of their device and create a video-recording of their wind test (K-2.DA.7, K-2.DA.8, K-2.DA.9)	
	Collaboration Students contribute and support others with honesty and kindness (Listening and Speaking 1.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (Listening and Speaking 2.3, Writing 1.2). Students will share thoughts, read, and listen to learn from others. (Listening and Speaking 1.1)	
	Science Students will talk about weather changes and how changes in the weather affect humans, animals, and plants. (Earth Sciences 2.3)	

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:

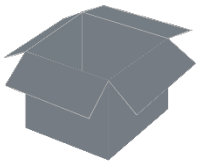
- **Window or Window Shade Manufacturer** (Manufacturing and Product Development)
- **Emergency Medical Technician** (Health Science and Medical Technology)
- **Athletic Trainer** (Hospitality, Tourism, and Recreation)

The interactive experience will ideally be co-constructed by the teacher and professional. In coordinating with the professional, a few questions appear below that can be used to guide the planning and live interaction with students:

- **Window or Window Shade Manufacturer** (Manufacturing and Product Development)
  - How much heat or cold is able to get through a window? How do you measure that?
  - What can you do to make a window or shade keep the outside weather outside?
  - Are there differences in the ability of a window or shade to protect from the sun? What about the window or shade makes it more protective?
  - What can you do on the inside of a house to protect it from the heat of the sun aside from putting in good windows or shades?

- **Emergency Medical Technician** (Health Science and Medical Technology)
  - What happens to people when they get over-heated by the sun? What can you do to help people feel better?
  - What can you do to protect yourself against getting over-heated?
  - Are some people more likely to have problems with getting over-heated? What is it about them that makes them more at risk?
  - What are some signs everyone should know that might be a warning they are getting over-heated?

- **Athletic Trainer** (Hospitality, Tourism, and Recreation)
  - How do you prepare athletes for an upcoming sporting event? Is the preparation different if they will be active in a very hot setting?
  - How do you monitor athletes during a sporting event to make sure they are not over-heated? If it seems like they are over-heated, what do you do?
  - Are there items of clothing or actions that you can take during sporting events to help athletes keep cool?
  - Are some kinds of athletes more likely to get over-heated than others? Does it have to do with the sports they play, such as speed of action, amount of running, etc.?



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.

Consumable Equipment:

- ☐ 8 rolls of blue painter's tape (1 per group)
- ☐ 130 sheets of newsprint
- ☐ 160 sheets of cardstock
- ☐ 200 brad fasteners
- ☐ 200 pipe cleaners
- ☐ 200 rubber bands
- ☐ 1 roll of aluminum foil
- ☐ 1 yard of material per group for making protective clothing (consider sheet plastic, painter's drop cloth, fabric, tablecloths)

Consumable Equipment(from home or site as available):

- ☐ recyclable materials

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:

- ☐ 1 roll of painter's tape
- ☐ 4 sheets of newsprint
- ☐ 5 sheets of cardstock
- ☐ 6 brad fasteners
- ☐ 6 pipe cleaners
- ☐ 5 rubber bands
- ☐ 3 feet of aluminum foil
- ☐ 1 yard of material
- ☐ recyclable materials from home

Endnotes

[i] Faux, S. (2009, July 9). *Fantastic time lapse – One year in nature*. YouTube. https://www.youtube.com/watch?v=2mIJK9u8qzo

[ii] Motionkicker (2013, February 21). *A forest year.* YouTube. https://www.youtube.com/watch?v=jfa29pq6NFs

[iii] Provensen, A., & Provensen, M. (1976). *A book of seasons.* Random House.

[iv] Linville, S. (2016, January 13). *A book of seasons: A children's book.* YouTube. https://www.youtube.com/watch?v=V0YCtW4eQiw