Integrated STEM Unit Planner

Grade 1 Science

Build a Time-Telling Tool

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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

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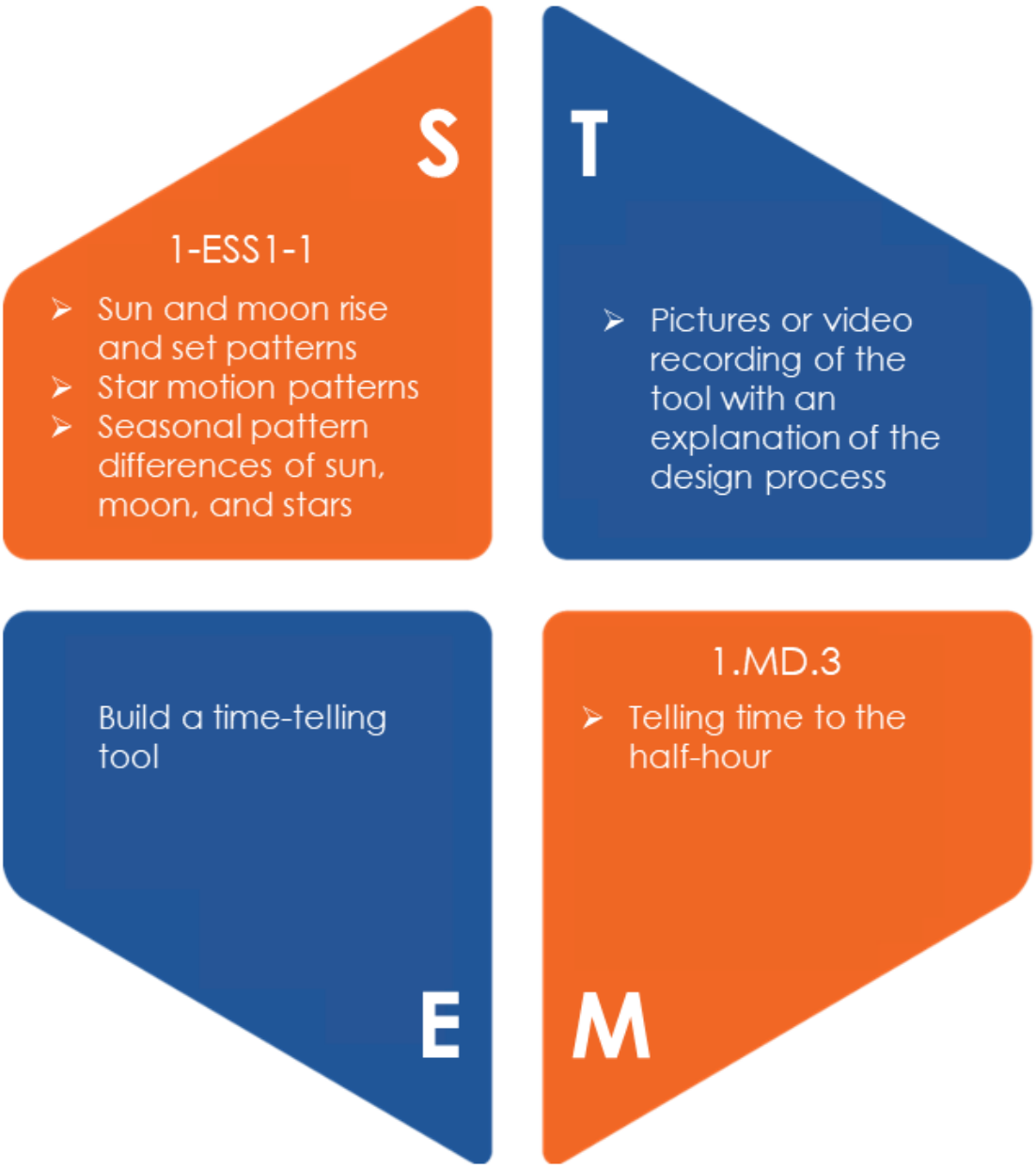
Big Picture

Unit Emblem



Focal Standard

1-ESS1-1 Use observations of the Sun, Moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [*Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.*]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing a short video of the path of the sun over the course of the year (Amateur Astronomers Association of New York, 2018)[i] (https://bit.ly/3FIlNEk). Teachers conduct a science talk in which pairs of students share what they notice and wonder about the video before continuing with a full class discussion. Teachers record students' responses on a Notice and Wonder Chart.

During the entry event, teachers introduce the driving essential question: How do objects in the sky seem to move over time? This connects to the supporting questions about the sun movement, shadow changes over the day, changes in the appearance of the moon, and the impact of the sun's movement on the amount of light on Earth.

This will lead to the introduction of the design challenge: To build a tool that can tell time based on predictable patterns of the sun in the sky. Students will begin to ***ask*** questions like: What would be the best location for getting the best results from my time-telling tool? How many days should we test the tool? How many times should we test per day?

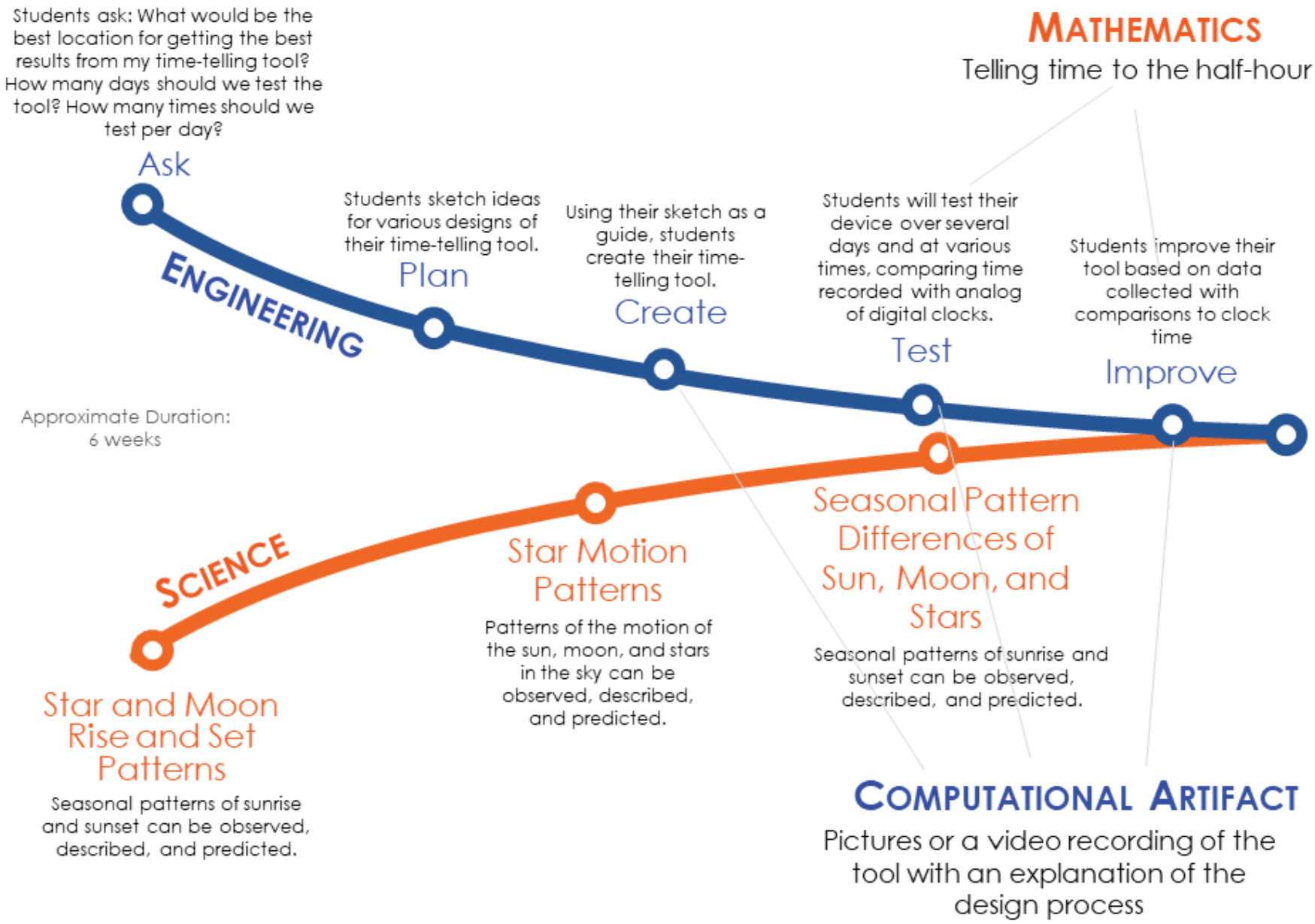
Sequence 2: Students will learn more about the sun and moon rise and set patterns and how this might impact their time-telling tool. Students will sketch out ideas for their tool and ***plan*** their model.

Sequence 3: Students will consider the materials available and being to ***create*** their time-telling tool. Students will learn about star motion patterns depending up the seasons.

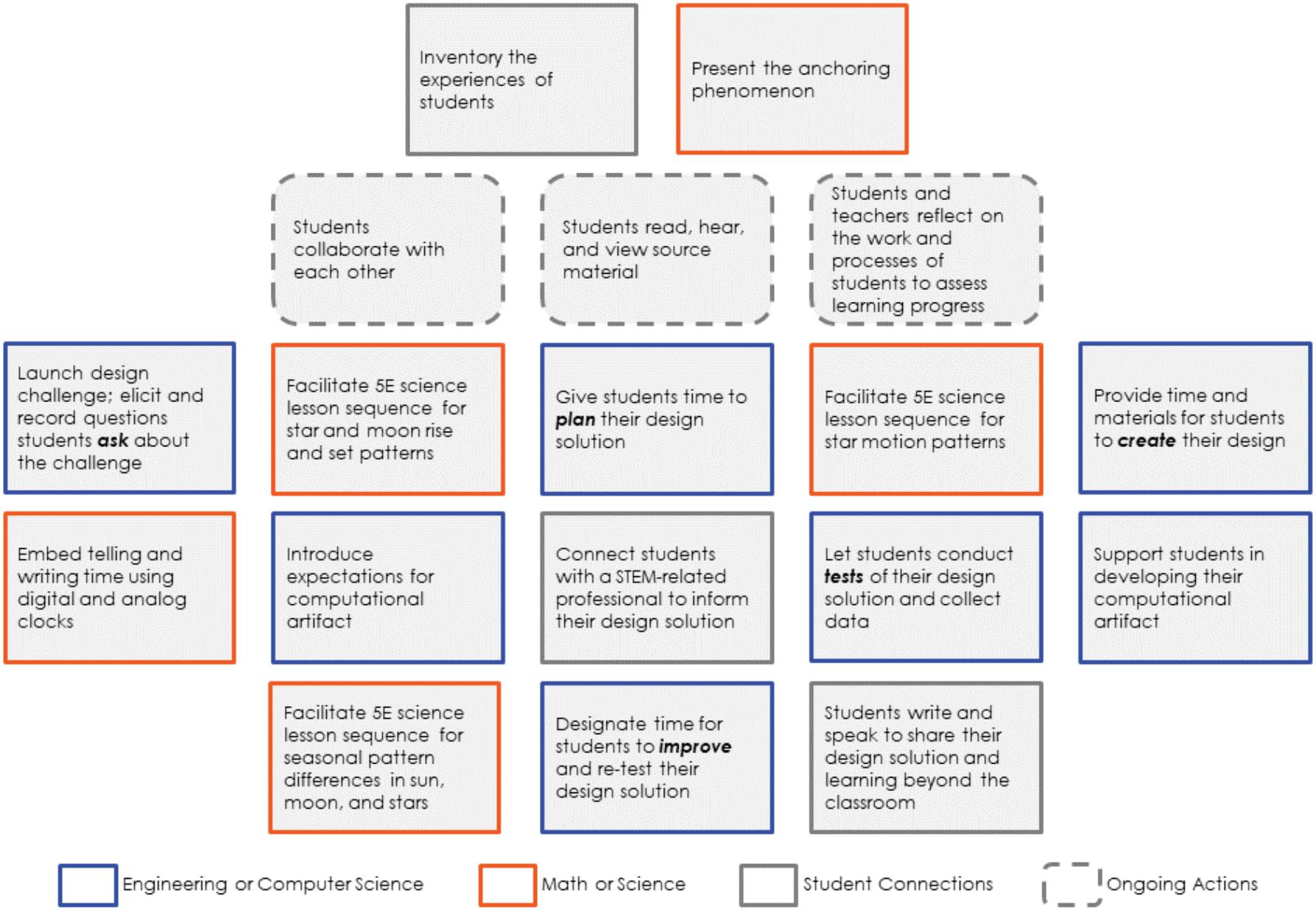
Sequence 4: Students will learn more about seasonal patterns of movement in the sun, moon and stars. Students will ***test*** the effectiveness of their design by conducting multiple tests of their device at different times of the day over different days and will compare the time reported to the time on an analog or digital clock.

Sequence 5: Students will reflect on how accurate their time-telling device was in their tests and will revise the plan to ***improve*** their model.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Build a time-telling tool.

Type of Engineering: Mechanical Engineer

The Engineering Design Process (EDP) and Engineering Standards

EDP Step	Standard and Grade Band End Points from the *Framework*
Ask *What would be the best location for getting the best results from my time-telling tool? How many days should we test the tool? How many times should we test per day?*	**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 sketch ideas for various designs of their time-telling tool.*	**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 *Using their sketch as a guide, students create their time-telling tool.*	
Test *Students will test their device over several days and at various times, comparing time recorded with analog of digital clocks.*	**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 improve their tool based on data collected with comparisons to clock time.*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students take pictures of the design process as they create their time-telling tool and create a video presentation of their experience.

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 images or video recording of time-telling tool with explanation of process

Hardware

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

- Computer with camera and/or video recorder

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

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

- Picture and/or video recording software

Standards

- **K-2.DA.8** Collect and present data in various visual formats.
- **K-2.DA.9** Identify and describe patterns in data visualizations, such as charts or graphs, to make predictions.
- **K-2.AP.10** Model Daily Processes by creating and following algorithms to complete tasks.
- **K-2.AP.11** Model the way programs store data.

Science

Focal Standard

1-ESS1-1 Use observations of the Sun, Moon, and stars to describe patterns that can be predicted. [Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [*Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.*]

Related Content Standards

1-ESS1-2 Make observations at different times of year to relate the amount of daylight to the time of year. [Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [*Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.*]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by watching a short video demonstrating the movement of the sun across the sky over a year's time (https://bit.ly/3FIlNEk).

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
Sun and Moon Rise and Set Patterns	• Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2, ESS1.B)	10
Star Motion Patterns	• Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1, ESS1.A)	10
Seasonal Pattern Differences of Sun, Moon, and Stars	• Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2, ESS1.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

Students will tell time and relate time of day to patterns of sunrise and sunset. They will compare the time on their time-telling device to time according to the clock.

Standards for Mathematical Content

1.MD.3 Tell and write time in hours and half-hours using analog and digital clocks.

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: Craft and Structure

RI.1.4 Ask and answer questions to help determine or clarify the meaning of words and phrases in a text.

RI.1.5 Know and use various text features to locate key facts or information in a text.

Writing Standard: Text Types and Purposes

W.1.1 Write opinion pieces in which they introduce the topic or name the book they are writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure.

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.

Writing Standard: Production and Distribution of Writing

W.1.5 With guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed.

Speaking and Listening Standard: Comprehension and Collaboration

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.

- **SL.1.1.a** Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time) about the topics and texts under discussion.
- **SL.1.1.b** Build upon others' talk in conversations by responding to the comments of others through multiple exchanges.
- **SL.1.1.c** Ask questions to clear up any confusion about the topics and texts under discussion.

Language: Conventions of Standard English

L.1.2 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

- **L.1.2.c** Use commas in dates and to separate single words in a series.
- **L.1.2.d** Use conventional spelling for words with common spelling patterns and for frequently occurring irregular words.
- **L.1.2.e** Spell untaught words phonetically, drawing on phonemic awareness and spelling conventions.

Unit Vocabulary

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

- **cloud**: A cloud is a visible mass of tiny bits of water or ice hanging in the air usually high above the earth. (Source: https://www.merriam-webster.com/dictionary/cloud)
- **dawn**: Dawn is the time when the sun comes up in the morning. (Source: https://www.merriam-webster.com/dictionary/dawn)
- **daylight**: Daylight is the light of the sun and sky during the day or the natural light of day. (Source: https://www.merriam-webster.com/dictionary/daylight)
- **dusk**: Dusk is the time when day changes into night and the sky begins to get darker. (Source: https://www.merriam-webster.com/dictionary/dusk)
- **full hour**: On a clock, a full hour occurs when the clock indicates a whole number for the hour and no minutes after that hour.
- **half hour**: On a clock, the half hour is 30 minutes after the full hour.
- **moon**: The moon is the large round object that circles the Earth and that shines at night by reflecting light from the sun. (Source: https://www.merriam-webster.com/dictionary/moon)
- **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)
- **planet**: A planet is any large heavenly body that orbits a star (as the sun). (Source: https://www.merriam-webster.com/dictionary/planet)
- **point of reference**: Point of reference can refer to your point of view: What direction are you looking? It can also mean something that you use as a basis for comparison. For example, is Light A brighter than Light B? You are using one of the lights and making a judgment about brighter or dimmer.
- **season**: A season is one of the four quarters into which a year is commonly divided. (Source: https://www.merriam-webster.com/dictionary/season)
- **shadow**: A shadow is the dark figure cast on a surface by a body that is between the surface and the light. (Source: https://www.merriam-webster.com/dictionary/shadow)

- **star**: A star is any of the heavenly bodies except planets which are visible at night and look like fixed points of light. (Source: https://www.merriam-webster.com/dictionary/star)

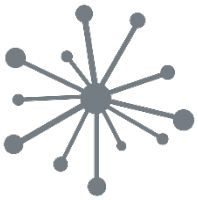
- **sun**: A sun is the heavenly body in our solar system whose light makes our day and around which the planets revolve. (Source: https://www.merriam-webster.com/dictionary/sun)

- **sundial**: A sundial is a device that shows the time of day by the position of the shadow cast onto a marked plate by an object with a straight edge. (Source: https://www.merriam-webster.com/dictionary/sundial

- **sunrise**: Sunrise is the time when the sun appears above the horizon in the morning : dawn or daybreak. (Source: https://www.merriam-webster.com/dictionary/sunrise)

- **sunset**: Sunset is the time when the sun goes below the horizon in the evening. (Source: https://www.merriam-webster.com/dictionary/sunset)

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 objects in the sky have you seen in the daytime? What are they like? (Remember not to look directly at the sun.)

2. What objects in the sky have you seen at night? What are they like?

3. Have you ever seen things move in the sky? What was the movement/motion like?

Aligned Learnings

1. Responses to this item provide insight into students' experiences with daytime objects in the sky. 1-ESS1-1

2. Responses to this item provide insight into students' experiences with nighttime objects in the sky. 1-ESS1-1

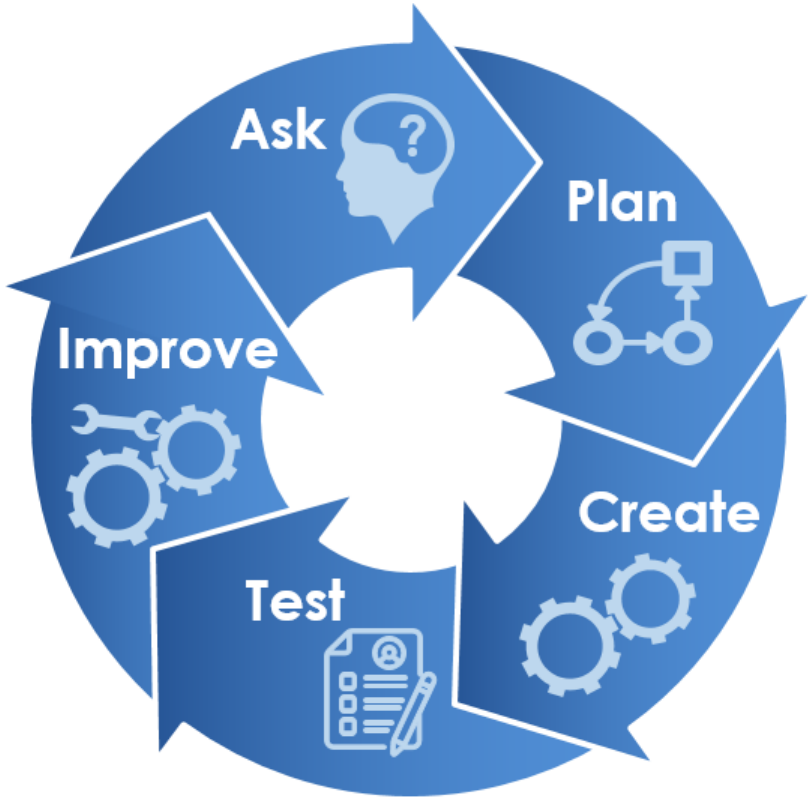
3. Responses to this item provide insight into students' experiences with the motion of objects in the sky. 1-ESS1-1

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 mechanical 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 take pictures of their device or create a video presentation of tool and include an explanation of the design process. (K-2.DA.8, K-2.DA.9, K-2.AP.10, K-2.AP.11)	
	Collaboration Students contribute and support others with honesty and kindness (SL.1.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.1.1, W.1.2). Students will share thoughts, read, and listen to learn from others. (SL.1.1)	
	Science Students will be able to analyze a pattern of moon, sun, and star movement and predict what will happen next. (1-ESS1-1, 1-ESS1-2)	

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:

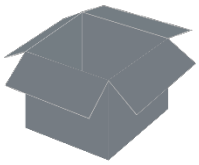
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Astronomer** (Agriculture and Natural Resources)
- **Solar Panel Installer** (Building and Construction Trades)
- **Utility Company Engineer or Manager** (Energy, Environment, and Utilities)

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:

- **Astronomer** (Agriculture and Natural Resources)
  - Are you studying planets, stars, the moon, or the sun?
  - How do the visible stars and planets change over the course of a year?
  - What is the most exciting thing that you have observed?
  - Do you have to do your work at night when it is dark or are there other kinds of things you can observe during the day?
- **Solar Panel Installer** (Building and Construction Trades)
  - How do you decide where to place solar panels?
  - What influences how many panels you would install?
  - Is it possible to use solar panels on a house that is shaded by trees?
  - Do you ever have to reposition solar panels because trees around the house grew, another building was constructed nearby, or for some other reason not related to damage?
- **Utility Company Engineer or Manager** (Energy, Environment, and Utilities)
  - What season of the year do you see the greatest demand for electricity?
  - Can you see usage increase and/or decrease depending upon the temperature?
  - Are there ever occasions where your ability to generate electricity cannot meet the demand level?
  - Are there specific actions you recommend homeowners do in order to lower their utility costs?



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:

- ☐ 64 pieces of sidewalk chalk
- ☐ 100 paper plates
- ☐ 160 craft sticks
- ☐ 200 pipe cleaners
- ☐ 200 (3 oz.) paper cups
- ☐ 32 rolls of clear tape
- ☐ 18 cans of modeling clay or Playdoh

Consumable Equipment (from home or site as available):

- ☐ construction paper
- ☐ colored pencils, crayons, markers
- ☐ unsharpened pencils

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):

- ☐ 2 pieces of sidewalk chalk
- ☐ 3 paper plates
- ☐ 5 craft sticks
- ☐ 6 pipe cleaners
- ☐ 5 (3 oz.) paper cups
- ☐ 1 roll of clear tape
- ☐ 1 container of modeling clay or Playdoh

Endnotes

[i] Amateur Astronomers Association of New York. (2018, June 29). *Sun's path through the months of 2018.* YouTube. https://www.youtube.com/watch?v=adJPV-sz5AI