Integrated STEM Unit Planner

Grade 2 Science

Design a Playground

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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

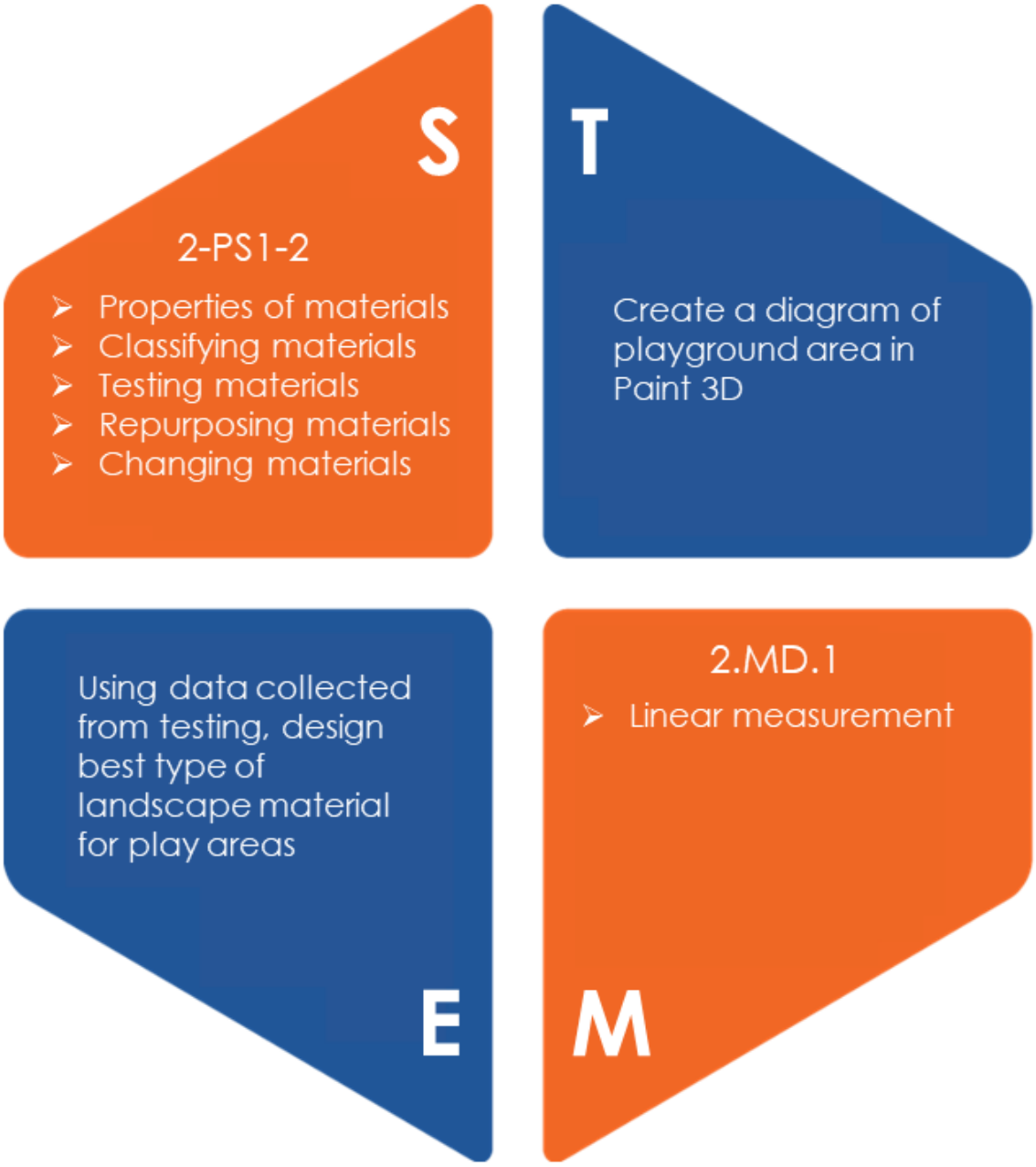
Community Training and Assistance Center (CTAC) is a national not-for-profit organization with a demonstrated record of success in the fields of education and community development. Tracy Unified School District, located in California's Central Valley, serves approximately 15,000 students. Fifty leading 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-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing a video of various playgrounds. The focus should be strictly on the groundcover or landscaping and not on the structures. During the entry event, teachers present the driving essential question: Why do people choose different landscape materials? Students will begin to think about the supporting questions: Why does it matter what is used to make an object? Can materials change shape? What kinds of materials exist? Why do people build with certain materials?

Students will learn about the properties of materials and strategies for classifying them based on those properties. These initial discussions lead to the design challenge which is to use data collecting from testing to design the best type of landscape materials for a play area. Students ***ask*** questions about the challenge including: What type of materials can be built on and are there differences depending on the type of land on which you are building? They will consider how weather might affect their materials and why certain ground materials are preferred.

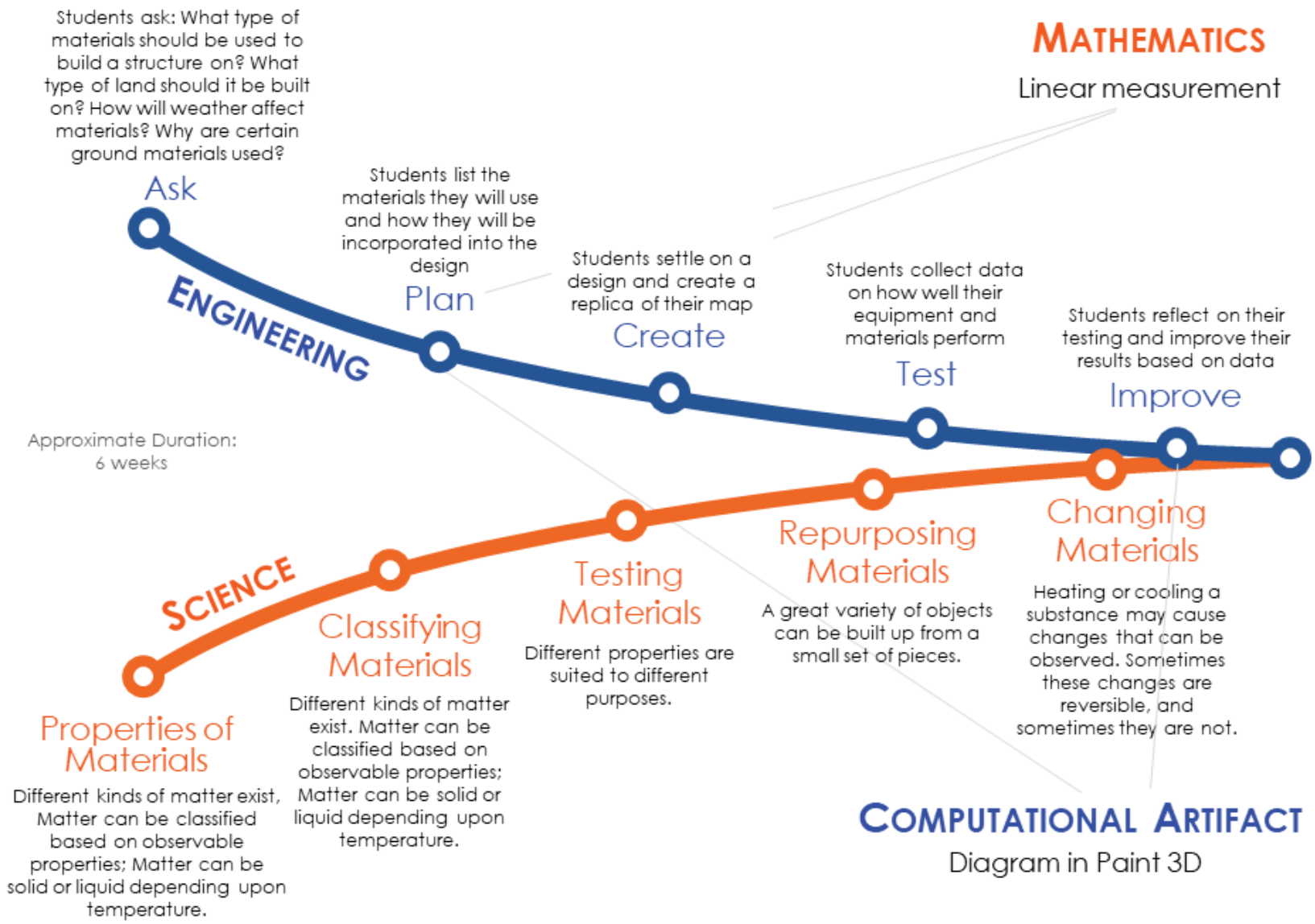
Sequence 2: Students learn more about testing materials and how the outcome might determine what works best in a particular location. At the same time, students begin to ***plan*** their landscape material by listing potential options.

Sequence 3: Students work on a design and ***create*** a map of their play area and how the groundcover would be used. They learn how materials originally designed for one purpose can be repurposed in new ways.

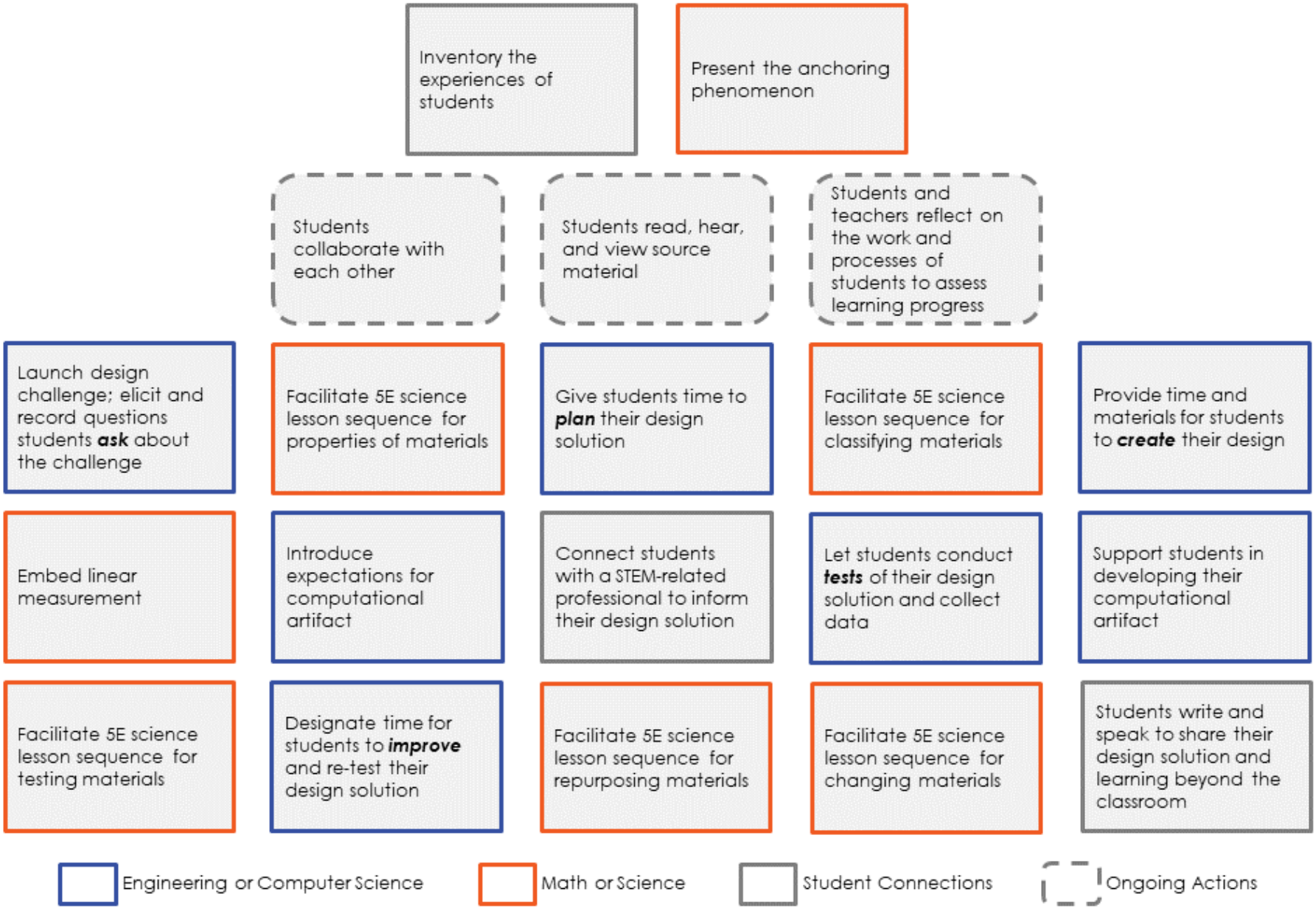
Sequence 4: Students ***test*** their design by collecting data on how well the equipment and materials perform. They will learn more about the impact of heating or cooling on materials and decide if that will impact their final selection.

Sequence 5: Students reflect on their data and what they have learned to revise the plan to ***improve*** their selections and then conduct follow-up tests. Students will complete a diagram of the playground on Microsoft Publisher® (or similar software) and create a Microsoft OneNote® (or similar software) report of the process and their findings.

Integrated Unit Storyline



Integrated Unit Wayfinder



STEM Dive

Engineering

Design Challenge: Using data collected from testing, design the best type of landscape materials for play areas.

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 materials should be used to build a structure on? What type of land should it be built on? How will weather affect materials? Why are certain ground materials used?*	**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 list the materials they will use and how they will be incorporated into the design*	**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 settle on a design and create a replica of their map*	
Test *Students collect data on how well their equipment and materials perform*	**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 reflect on their testing and improve their results based on data*	

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create a diagram of their playground area in Microsoft Paint 3D.

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)

- Diagram in Microsoft Paint 3D

Hardware

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

- Computer

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

Standards

- **K-2.NI.4** Model and describe how people connect to other people, places, information and ideas through a network.
- **K-2.DA.8** Collect and present data in various visual formats.
- **K-2.DA.9** Identify and describe patterns in data visualizations, such as charts or graphs, to make predictions.

Science

Focal Standard

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length*.]

Related Content Standards

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

2-PS1-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]

2-PS1-4 Construct an argument with evidence that some changes in matter, caused by mixing, heating, or cooling can be reversed and some cannot. [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing pictures of playgrounds from around the world (TCL Toys & Cardboard Crafts, 2013).[i] Students should be asked to focus on the materials on the ground and not on the equipment.

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
Properties of Materials	• Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	5
Classifying Materials	• Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)	5
Testing Materials	• Different properties are suited to different purposes.(2-PS1-2, 2-PS1-3))	5
Repurposing Materials	• A great variety of objects can be built up from a small set of pieces. (2-PS1-3)	5
Changing Materials	• Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	5

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 measure the edges of the model playground area.

Standards for Mathematical Content

2.MD.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

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 Idea and Details

RI.2.2 Identify the main topic of a multi-paragraph text as well as the focus of specific paragraphs within the text.

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

Reading Standard: Craft and Structure

RI.2.4 Determine the meaning of words and phrases in a text relevant to a grade 2 topic or subject area. (See grade 2 Language standards 4-6 for additional expectations.)

RI.2.6 Identify the main purpose of a text, including what the author wants to answer, explain, or describe.

Reading Standard: Integration of Knowledge and Ideas

RI.2.7 Explain how specific images (e.g., a diagram, showing how a machine works) contribute to and clarify text.

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic.

Writing Standard: Text Types and Purposes

W.2.1 Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., because, and, also) to connect opinion and reasons, 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: Vocabulary Acquisition and Use

L.2.4 Determine or clarify the meaning of unknown and multiple meaning words and phrases based on grade two reading and content, choosing flexibly from an array of strategies.

- **L.2.4.a** Use sentence-level context as a clue to the meaning of a word or phrase.

- **L.2.4.b** Determine the meaning of the new word formed when a known prefix is added to a known word (e.g., happy/unhappy, tell/retell).
- **L.2.4.c** Use a known root word as a clue to the meaning of an unknown word with the same root (e.g., addition, additional).
- **L.2.4.d** Use knowledge of the meaning of individual words to predict the meaning of compound words (e.g., birdhouse, lighthouse, housefly, bookshelf, notebook, bookmark).
- **L.2.4.e** Use glossaries and beginning dictionaries, both print and digital, to determine or clarify the meaning of words and phrases.

L.2.5 Demonstrate understanding of word relationships and nuances in word meanings.

- **L.2.5a** Identify real-life connections between words and their use (e.g., describe foods that are spicy or juicy).
- **L.2.5b** Distinguish shades of meaning between closely related verbs (e.g., toss, throw, hurl) and closely related adjectives (e.g., thin, slender, scrawny).

Unit Vocabulary

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

- **absorbency**: Absorbency is the quality of being able to take in something easily, especially liquid. (Source: https://www.oxfordlearnersdictionaries.com/us/definition/english/absorbency)
- **classify**: To classify means to arrange (people or things) into groups based on ways that they are alike. (Source: https://www.merriam-webster.com/dictionary/classify)
- **color**: Color is a quality such as red, blue, green, yellow, etc., that you see when you look at something. (Source: https://www.merriam-webster.com/dictionary/color)
- **cooling**: Cooling means to decrease in temperature.
- **disassemble**: To disassemble means to take apart. (Source: https://www.merriam-webster.com/dictionary/disassemble)
- **flexibility**: Flexibility is a quality of being able to be bent, or bending or being able to change easily. (Adapted from: https://www.merriam-webster.com/dictionary/flexibility)
- **hardness**: Hardness is the quality or state of being hard. (Source: https://www.merriam-webster.com/dictionary/hardness). Something that is hard may be difficult to scratch or break.
- **heating**: Heating is the process of making something warm.
- **liquid**: A liquid flows freely like water and is neither solid nor gaseous. (Adapted from: https://www.merriam-webster.com/dictionary/liquid)
- **material**: Material means relating to or made of matter. (Source: https://www.merriam-webster.com/dictionary/material)
- **matter**: Matter is the substance of which a physical object is composed. (Source: https://www.merriam-webster.com/dictionary/matter)
- **mixing**: Mixing means combining or blending into one mass. (Adapted from: https://www.merriam-webster.com/dictionary/mixing)
- **properties**: A property is a quality or trait belonging and especially peculiar to an individual or thing. (Source: https://www.merriam-webster.com/dictionary/property)

- **reconstruct**: To reconstruct is build or assemble something again. (Source: https://www.merriam-webster.com/dictionary/reconstruct)

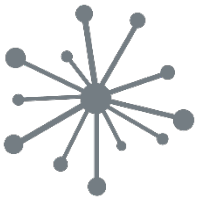
- **solid**: A solid is something (as a cube) that has length, width, and thickness or a substance that keeps its size and shape. (Source: https://www.merriam-webster.com/dictionary/solid)

- **strength**: Strength is the ability to resist being moved or broken by a force. (Source: https://www.merriam-webster.com/dictionary/strength)

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

- **texture**: Texture is the structure, feel, and appearance of something. (Source: https://www.merriam-webster.com/dictionary/texture)

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 do you like to do on a playground?
2. Tell me about a time you remember getting hurt. What happened?
3. Do you or anyone in your family make things? What do you make?
4. Who fixes things for you?

Aligned Learnings

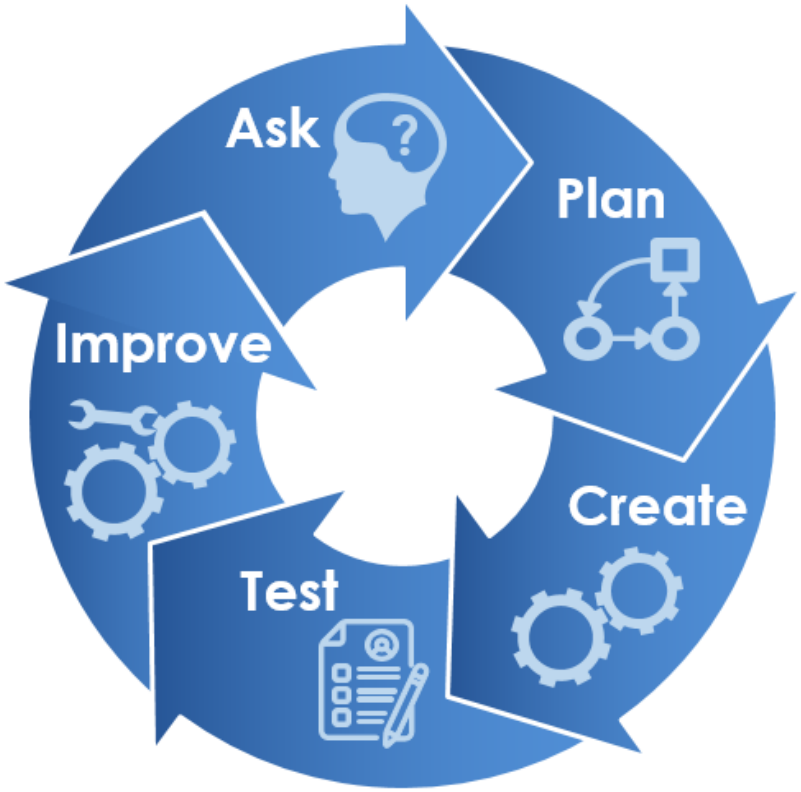
1. Responses to this item provide insight into students' playground experiences.
2. Responses to this item provide insight into students' experiences with injury. 2-PS1-1
3. Responses to this item provide insight into students' experiences with materials and their purpose. 2-PS1-2, 2-PS1-3
4. Responses to this item provide insight into students' experiences with reversible change. 2-PS1-4

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 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 diagram of their playground area in Paint 3D. (K-2.NI.4, K-2.DA.8, K-2.DA.9)	
	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.2.1, W.2.7). Students will share thoughts, read, and listen to learn from others. (SL.2.1)	
	Science Students will describe and classify kinds of materials by the properties. Students will test and choose the best material for the playground (2-PS1-1, 2-PS1-2, 2-PS1-3, 2-PS1-4)	

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:

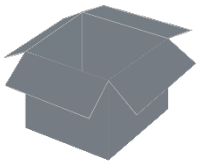
- Expose students to STEM as it applies in various careers
- Enrich student learning through collaborating with STEM professionals
- Help students see themselves doing the actual work of STEM

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

- **Landscaper** (Agriculture and Natural Resources)
- **Park Maintenance Worker** (Public Services)
- **Road Construction Supervisor or Worker** (Building and Construction Trades)

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:

- **Landscaper** (Agriculture and Natural Resources)
  - What kind of groundcover or mulch do you prefer and why?
  - Are there differences in how often the mulch has to be replaced depending on the materials that you use?
  - What purpose does a mulch serve in landscaping? What would happen if something was planted and no mulch was applied?
  - Do you plan your designs of plants and the ground covers differently when you are in areas that receive a lot of traffic from people?
  - Do you have any particular concerns for what to use as a groundcover when the area will be used by pets or children?
- **Park Maintenance Worker** (Public Services)
  - What kinds of different areas are in your park? How do they look different?
  - What do you do in order to keep the park clean and safe?
  - Do any areas of the park have more visitors? Do you see a change in the appearance of the area when there are fewer visitors?
  - Are there any materials that you use in the park that are particularly strong or tend not to get damaged or worn over time?
- **Road Construction Supervisor or Worker** (Building and Construction Trades)
  - What kinds of materials go into the construction of a road? Do you use different materials in different locations? Why?
  - What kind of trucks or other equipment do you use to make a road?
  - If you are in a new area and making a road for the first time, what steps do you follow? Is that different if you were putting new pavement over an existing road?



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):

- ☐ temperature gun
- ☐ heat source (blow dryer, lamp with bulb, or reptile lamp UVA UVB))

Consumable Equipment (classroom totals):

- ☐ 1 25 lb. bag of sand (unmoldable) (about 4 cups per group)
- ☐ 2 gallons or 8 quarts of tan bark/mulch (about 4 cups per group)
- ☐ 1 75-ft. roll of Aluminum foil (4 square feet per group)
- ☐ 32 pink erasers (4 per group)
- ☐ 2 lbs. of pea gravel (about 1 handful per student)
- ☐ 8 packing boxes (13X10X2)

Consumable Materials to collect from site (classroom totals):

- ☐ Soil (from site)
- ☐ Unifix cubes (at site to test plastic for landing, slide or swings)

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 unmoldable sand (in a bag)
- ☐ 1 cup of tanbark (in a bag)
- ☐ 1 handful of pea gravel
- ☐ 1 square foot of aluminum foil
- ☐ 1 pink eraser
- ☐ 1 half-sheet of foam

Endnotes

[i] TCL Toys & Cardboard Crafts. (2013, August 23). *15 amazing playground around the world for children.* YouTube. https://www.youtube.com/watch?v=AoFgIszhxHM