Integrated STEM Unit Planner

Grade 3 Science
Protect the Plant

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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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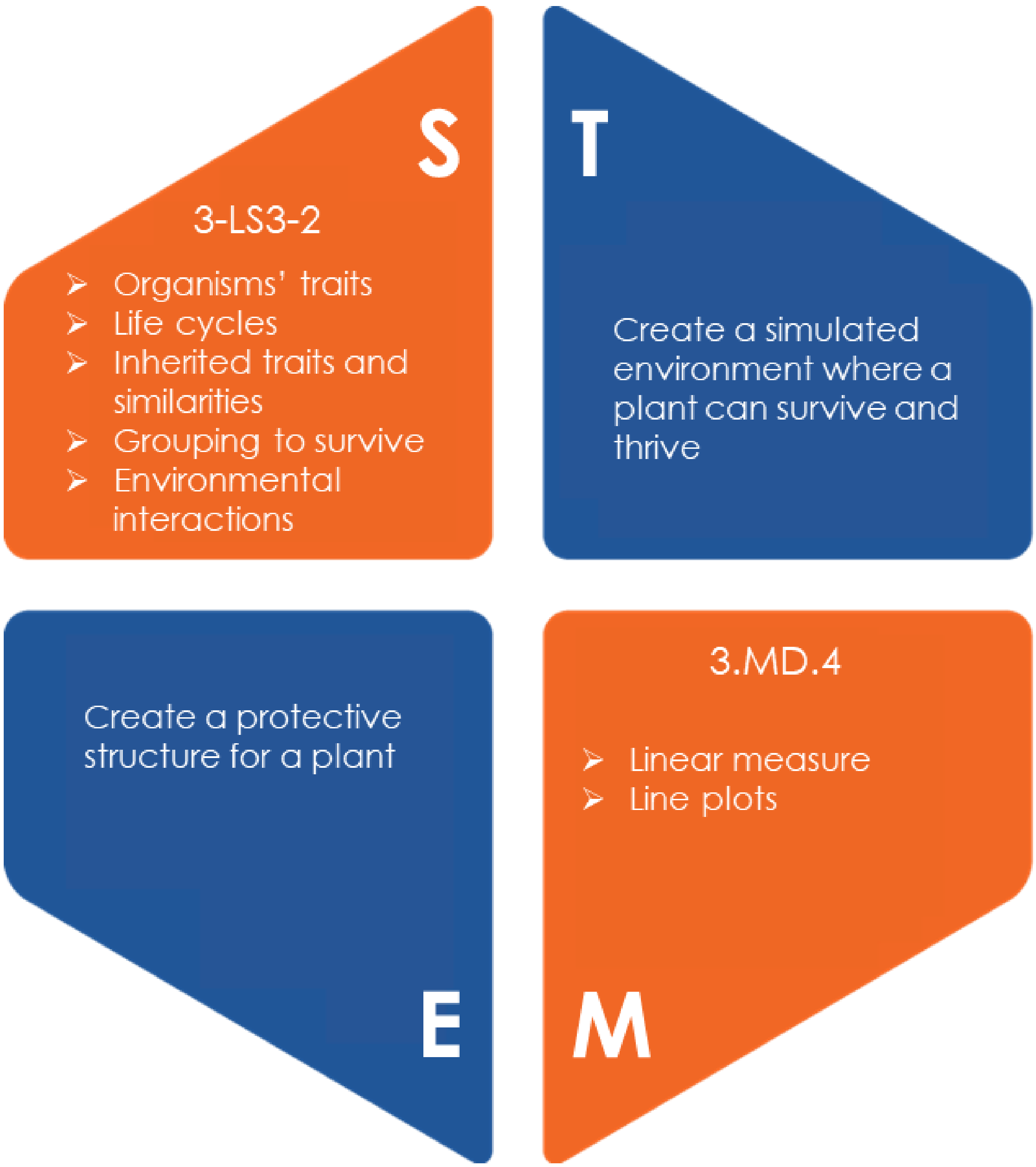
Contents

Big Picture

Unit Emblem



Focal Standard

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

Overview

Sequence 1: Teachers engage students with an anchoring phenomenon by showing the video of the life cycle of a lima bean plant (https://www.youtube.com/watch?v=9wlisi6ENq8). (Amazing Time Lapse Videos, 2016)[i]. Following the entry event, teachers present the driving essential question: How do living things change and grow? This question connects the concepts of all the supporting questions: What stages of life to all organisms share? How are offspring similar to and different from their parents? And, why might a species become endangered?

This will lead to a discussion of the design challenge which is to help the local food bank develop a new way of growing radishes which have been subject to being eaten by wildlife, trampled and damaged by frost and drought. The task is to create a protective designed environment (greenhouse) which will help radishes survive throughout their life cycle while still allowing pollinators in to pollinate the plants. Students begin to ***ask*** questions about the challenge including: What is the organism we will be researching? What do we need to create? And, what materials are available for use?

At the same time, students will be learning about how animals develop and grow throughout their life cycle and the impact of traits on that development.

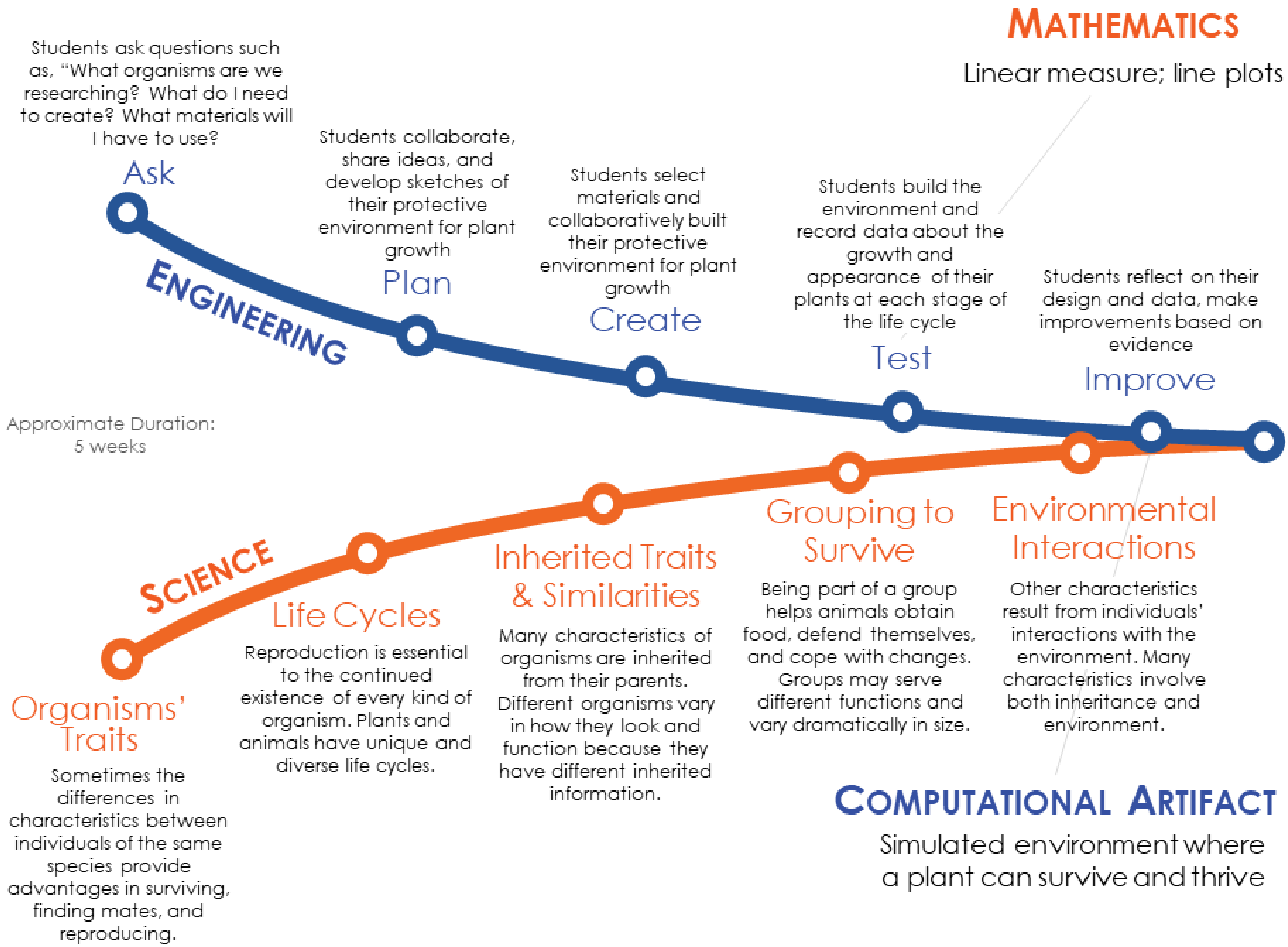
Sequence 2: As students begin to ***plan*** their greenhouse, they will collaborate with others to share ideas and develop initial sketches. They will learn about the variability of traits seen in plants and animals and how that impacts their survivability.

Sequence 3: Students will collaborate to ***create*** their protective environment models, using the available materials. They will learn about how their plants will be impacted by inheritance and the environment.

Sequence 4: Students then begin to ***test*** their prototype, collecting data to determine how effective their model is at protecting plants. They will explore grouping as a survival technique.

Sequence 5: Students reflect on their data and revise the plan to ***improve*** their model and then conduct follow-up tests on their improved environments. Students will complete a simulation online with environmental conditions for the plant to survive and thrive.

Integrated Unit Storyline



Integrated Unit Wayfinder

Inventory the experiences of students	Present the anchoring phenomenon

Students collaborate with each other	Students read, hear, and view source material	Students and teachers reflect on the work and processes of students to assess learning progress

Launch design challenge; elicit and record questions students ***ask*** about the challenge	Facilitate 5E science lesson sequence for organisms' traits	Give students time to ***plan*** their design solution	Facilitate 5E science lesson sequence for life cycles	Provide time and materials for students to ***create*** their design
Embed graphic representation of data	Introduce expectations for computational artifact	Connect students with a STEM-related professional to inform their design solution	Let students conduct ***tests*** of their design solution and collect data	Support students in developing their computational artifact
Facilitate 5E science lesson sequence for inherited traits and similarities	Designate time for students to ***improve*** and re-test their design solution	Facilitate 5E science lesson sequence for grouping to survive	Facilitate 5E science lesson sequence for environmental interactions	Students write and speak to share their design solution and learning beyond the classroom

Engineering or Computer Science | Math or Science | Student Connections | Ongoing Actions

STEM Dive

Engineering

Design Challenge: Create a protective structure for one of the plants you are growing

Type of Engineering: Environmental Engineering

The Engineering Design Process (EDP) and Engineering Standards

<table>
<tr><th>EDP Step</th><th>Standard and Grade Band End Points from the Framework</th></tr>
<tr><td>Ask
What organisms are we researching? What do I need to create? What materials will I have to use?</td><td>3-5-ETS1-1. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.
• Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)</td></tr>
<tr><td>Plan
Students collaborate, share ideas, and develop sketches of their protective environment for plant growth</td><td rowspan="2">3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)</td></tr>
<tr><td>Create
Students select materials and collaboratively built their protective environment for plant growth</td></tr>
<tr><td>Test
Students build the environment and record data about the growth and appearance of their plants at each stage of the life cycle</td><td rowspan="2">3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
• Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)
• Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)</td></tr>
<tr><td>Improve
Students reflect on their design and data, make improvements based on evidence</td></tr>
</table>

Computer Science (Technology)

Computer Science Integrations

Description of Student Engagement

Students create a model simulation of the environment in which the pollinator will survive and thrive.

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 an environment where a plant can survive and thrive

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)

- Scratch

Standards

- **3-5.DA.8** Organize and present collected data visually to highlight relationships and support a claim.

Science

Focal Standard

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment. [Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.]

Related Content Standards

3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles, but all have in common birth, growth, reproduction, and death. [Clarification Statement: Changes organisms go through during their life form a pattern.] [*Assessment Boundary: Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.*]

3-LS2-1. Construct an argument that some animals form groups that help members survive.

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents or among siblings. Emphasis is on organisms other than humans.] [*Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples*.]

3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. [Clarification Statement: Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators and animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.]

Anchoring Phenomenon

Teachers engage students with an anchoring phenomenon by showing the video of the life cycle of a lima bean plant (https://www.youtube.com/watch?v=9wlisi6ENq8)

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
Organisms' Traits	• Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)	5
Life Cycles	• Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)	5
Inherited Traits and Similarities	• Many characteristics of organisms are inherited from their parents. (3-LS3-1) • Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)	5
Grouping to Survive	• Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size (3-LS2-1)	5
Environmental Interactions	• Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2) • The environment also affects the traits that an organism develops. (3-LS3-2)	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 mathematical 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 height of their plants and graph the data using line plots.

Standards for Mathematical Content

3.MD.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.

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: Integration of Knowledge and Ideas

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

RI.3.8 Describe the logical connections between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).

Reading Standard: Craft and Structure

RI.3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.

Writing Standard: Production and Distribution of Writing

W.3.4 With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.

Writing Standard: Research to Build and Present Knowledge

W3.8 Recall information from experiences to gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Speaking and Listening Standard: Comprehension and Collaboration

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

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

Speaking and Listening Standard: Presentation and Knowledge of Ideas

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

Unit Vocabulary

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

- **birth**: Birth is the coming of a new individual from the body of its parent. (Source: https://www.merriam-webster.com/dictionary/birth)
- **chrysalis**: A chrysalis is a moth or butterfly pupa that is enclosed in a hardened protective case. (Source: https://www.merriam-webster.com/dictionary/chrysalis)
- **cocoon**: A cocoon is the silky covering which a moth caterpillar makes around itself and in which it is protected while changing into a moth. (Source: https://www.merriam-webster.com/dictionary/cocoon)
- **death**: Death is the end or ending of life. (Source: https://www.merriam-webster.com/dictionary/death)
- **endangered**: An endangered species is a type of animal or plant that has become very rare and that could die out completely. (Source: https://www.merriam-webster.com/dictionary/endangered)
- **growth**: Growth is a stage or condition in increasing, developing, or maturing. (Source: https://www.merriam-webster.com/dictionary/growth)
- **life cycle**: A life cycle is a series of stages through which something (such as an individual, culture, or manufactured product) passes during its lifetime. (Source: https://www.merriam-webster.com/dictionary/life%20cycle)
- **offspring**: Offspring are the young of a person, animal, or plant. (Source: https://www.merriam-webster.com/dictionary/offspring)
- **organism**: An organism is a living thing made up of one or more cells and able to carry on the activities of life (as using energy, growing, or reproducing). (Source: https://www.merriam-webster.com/dictionary/organism)
- **parents**: A parent is an animal or plant that produces a young animal or plant. (Source: https://www.merriam-webster.com/dictionary/parents)
- **reproduction**: Reproduction is the process by which living things produce offspring. (Source: https://www.merriam-webster.com/dictionary/reproduction)
- **trait**: A trait is a quality that makes one person, animal, or thing different from another. (Source: https://www.merriam-webster.com/dictionary/traits). They can be inherited or related to environmental influences.

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 living things are inside or near where you live?
2. Are there things you want that only one person can have?
3. How do you make decisions about sharing or turns in your family?

Aligned Learnings

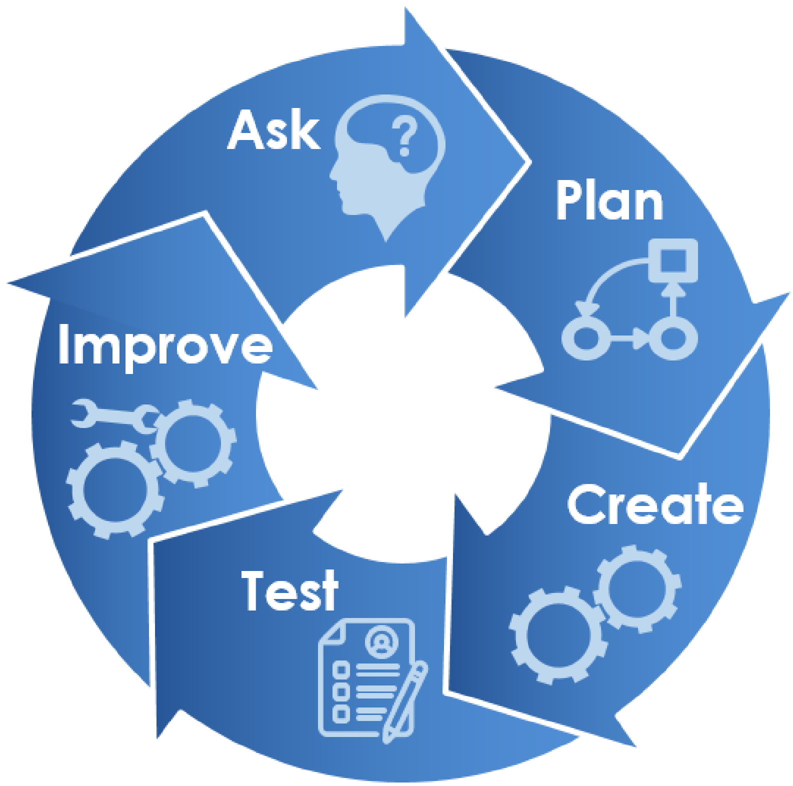
1. Responses to this item provide insight into students' experiences with living things. 3-LS1-1
2. Responses to this item provide insight into students' experiences with competition. 3-LS4-2
3. Responses to this item provide insight into students' experiences with cooperation. 3-LS2-1

Student Self-Assessment of Engineering

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

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

Plan:
Here are my design ideas for the project…



Test:
Here are the data I collected…

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

I am doing the work of an environmental engineer.

One-Point Design Challenge Rubric

Criteria serve as a primary reference point throughout the engineering design process. Teachers use the criteria **to communicate expectations** and **to guide students**. With teacher guidance, students use the criteria to inform and reflect on their work.

Approaches Expectations *Notes on how to improve the project*	**Meets Expectations** *Criteria indicating success*	**Exceeds Expectations** *Notes on how project goes beyond expectations*
	Engineering Students participate in the 5-part engineering design process, use data, and make thoughtful improvements to their design. (3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3)	
	Computer Science Students create a simulation in Scratch of an environment where a plant can survive and thrive (3-5.DA.8)	
	Collaboration Students give and receive input with kindness and honesty. (SL.3.1)	
	Communication Students speak and write about their ideas clearly using accurate vocabulary (W.3.4, W.3.8). I can share thoughts, read, and listen to learn from others. (SL.3.4)	
	Science Students describe the life cycle of organisms, inheritance of traits, variety in trait expression, and interaction of traits with the environment. (3-LS3-2, 3-LS1-1, 3-LS2-1, 3-LS3-1, 3-LS4-2)	

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:

- **Architect** (Engineering and Architecture)
- **Park Ranger** (Hospitality, Tourism and Recreation)
- **Farmer or Plant Store Manager** (Agriculture and Natural Resources)

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

- **Architect** (Engineering and Architecture)
    - Are there special differences in how you think about building a greenhouse as compared to a house or some other building?
    - How does the type of building material impact the design? For example, if you were told a building had to be glass, how does that limit or expand what you can do? (Other considerations might include brick vs. wood vs. stucco houses)
    - What kinds of tools does an architect use?
    - What is one problem you are currently facing in your day-to-day work?
- **Park Ranger** (Hospitality, Tourism and Recreation)
    - What kind of ecosystems are present in the park where you work?
    - Are there any portions of the ecosystem that are currently in danger? If so, what is causing that danger?
    - What rules does the park have in place to protect the land, plants, and animals?
    - What does a typical day on the job look like?
    - What is one problem you are currently facing in your day-to-day work?
- **Farmer or Plant Store Manager (Agriculture and Natural Resources)**
    - What are the most common plants that you grow? How long does it take for them to reach maturity?
    - What actions do you take daily to protect plants that you grow?
    - What are key tools and knowledge required for your job?
    - Has there been a change in the number of pollinators around here? How is it different? Why do you think it has changed?

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 (classroom totals):

- ☐ 124 radish seeds
- ☐ 200 seeds of Wisconsin Fast Plant seeds (alfalfa seeds also work)
- ☐ 64 soil pellets
- ☐ 32 square feet of foil
- ☐ 64 (6 oz.) paper cups for hot liquids
- ☐ 320 sheet pale cardstock
- ☐ 32 rolls of tape
- ☐ 64 seed bags

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):

- ☐ 4 radish seeds in a seed bag
- ☐ 4 Wisconsin Fast Plant seeds or alfalfa seeds in a seed bag
- ☐ 3 soil pellets
- ☐ 2 cups (6 oz. size)
- ☐ 10 sheets of pale cardstock
- ☐ 1 roll of clear tape

Endnotes

[i] Amazing Time Lapse Videos. (2016, June 2). *Growing lima beans time lapse*. YouTube. https://www.youtube.com/watch?v=9wlisi6ENq8