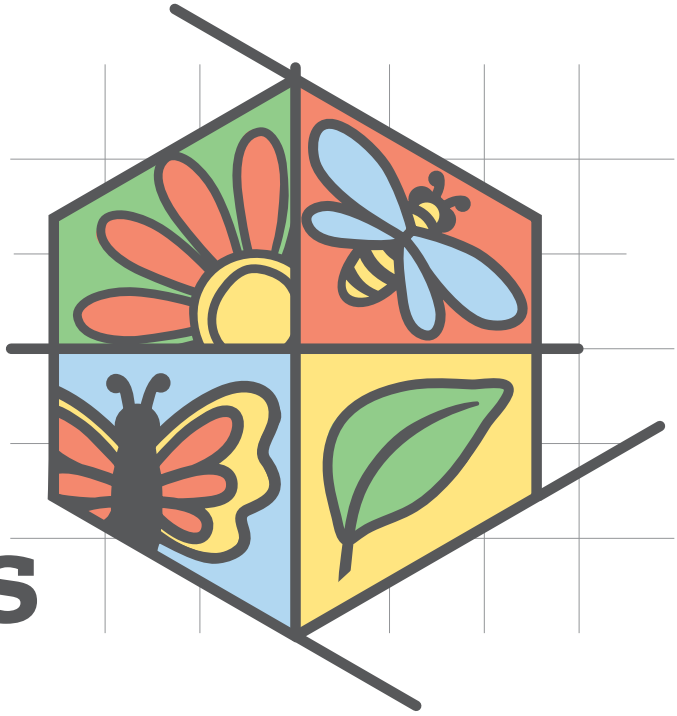
Why Won't Our Blueberries Grow?



2nd Grade Life Science Storyline to support the Insects kit

STEM

6.25.19

ABOUT THIS UNIT

We are pleased to present this NGSS Storyline Unit to help support educators in our region as we shift towards providing students with NGSS-aligned, phenomenon-based and project-based learning experiences. Our vision is to provide students with high-quality and equitable learning experiences that empower them to develop fluency in STEM and literacy. This unit strives to engage students in the phenomenon of a lack of fruiting experienced by a farmer's plants due to the lack of pollinators. Students face this real problem, investigating what exactly a plant needs in order to thrive and the importance of the symbiotic relationship that pollinators and fruiting plants have.

This unit also contains links to online resources created by other organizations which may use a different license. Please make sure that you understand the terms of use of third-party resources before reusing them. Prior to publishing this unit of study, we have reviewed the content of this unit to ensure that all materials are in accordance with creative commons regulations. If you notice that a part of this unit infringes another's copyright, please contact us.

A digital copy of this document is available on the STEM Materials Center website at:
https://www.stemmaterials.org/blueberries

ATTRIBUTION

This unit is a result of a collaborative effort between Educational Service District 112 and educators and specialists from other school districts and agencies.

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STEM
Science
Technology
Engineering
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supporting Next Generation Science Standards

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OSPI

CLIME TIME
CLIMATE SCIENCE LEARNING

UNIT OVERVIEW

Embark on a journey with your students to answer the driving question: ***How can we design a solution to help Shanelle's blueberries grow?*** This NGSS-aligned integrated storyline unit strives to help students explore the 2nd grade NGSS standards bundle Interdependent Relationships in Ecosystems (2-LS2-1, 2-LS2-2, 2-LS-4-1) and K-2 Engineering Design (K-2-ETS1-1). Students investigate why the blueberry plants on Shanelle's farm are not producing fruit and create a model of what a blueberry plant needs in order to thrive. By studying what plants need, and the unique relationship between pollinators and flowering plants, students determine why the plants are not fruiting. The unit culminates with students creating a tool to help Shanelle pollinate her blueberry flowers so that they produce fruit.

Please note that the sequence of FOSS activities in this storyline unit differs from the way that the FOSS teacher guide presents these investigations. For alignment with NGSS and to create an integrated STEM-based learning experience for your students, it is recommended that you use this storyline unit instead of closely following the sequence of the FOSS guide. The outline below can help in your planning. Please note that each session is intended to take a class period of 30-45 minutes.

For your convenience, all resources have been uploaded to this Google drive folder, Why won't our blueberries grow? (Insects Kit NGSS Storyline) , http://bit.ly/whynoblueberries for easy access. Since curriculum revision during the school year will be limited, any additional resources and changes will be reflected in the live documents on the Google drive. You may also make comments for suggested revisions on these documents. In order to modify the Google resources to make changes, click "file" and "make a copy." This will create a copy in your drive that you can edit to fit your needs.

LESSON 1: Why Won't Our Blueberries Grow? *pg. 8*

This lesson will serve as an entry point into the unit by exposing students to the problem of low crop yield due to lack of pollinators. Students will start by engaging with the phenomenon of absent fruiting of a blueberry plant. The phenomenon will be presented to students by using the example of a farmer who is growing blueberry plants that are not fruiting. This lesson will simply engage students in this problem by presenting it to students through the lens of a real farmer.

Session	Materials Needed		Page
1. Why won't Shanelle's blueberries grow?	• KLEWS chart • Chart paper	• Intro slides presentation	**9**
2. Introducing the driving question	• KLEWS chart	• Intro slides presentation	**10**
3+ Critter investigations	• Materials for FOSS Investigation 3: Milkweed Bugs • Materials for FOSS Investigation 5: Butterflies	• Materials for FOSS Investigation 4: Silkworms • The Life Cycle of a Milkweed Bug • The Lifecycle of a Butterfly	**11**

UNIT OVERVIEW (cont.)

LESSON 2: What Do Plants Need? *pg. 16*

In this lesson, students will be planning and conducting an investigation to determine what exactly plants need in order to grow. The lesson will start by connecting to the storyline so that students have a context and relevance for their investigation. Then, students will design an investigation and a method to collect observations that answer the question, what do plants need in order to grow? In the primary grades, planning and carrying out the investigation is a process that will be done collaboratively, in this case, collectively as a class. Students will collect data and create an argument as a class to support their claim. Then students will reconnect with the storyline and see how the farmer is meeting the needs of her plants.

Session	Materials Needed		Page
1. So, what do the blueberries need?	• Plant predictions template	• KLEWS chart	**17**
2. Planning our investigation	• Teacher slides	• Chart paper, markers	**19**
3. Conducting the investigation FOSS Investigation 1 (NEW PLANTS): Brassica Seeds	• Materials for Investigation 1 Part 2: Planting Brassica	• Observation Template • Prediction template	**20**
Ongoing observation sessions	• Class observation chart (on chart paper)	• Observation Template	**21**
4-5. Analyzing data and constructing an argument	• Student data charts (templates) • Class data chart	• KLEWS chart • Chart paper, markers	**26**
6. Connecting to the storyline: So what do blueberries need?	• Slides for connecting to storyline • Large sheets of paper or chart paper	• Markers, colored pencils • KLEWS Chart	**28**

UNIT OVERVIEW (cont.)

LESSON 3: Flowers and Fruits *pg. 30*

In this lesson, students will investigate the purpose of flowers and fruits. Students will study the process of a flower turning into a fruit and will generate observations and ask questions about what they observe in several time-lapse videos. Students will then begin to study the role of pollinators in helping a flower turn into a fruit and will use an expository text to further develop their understanding of the phenomenon.

Session	Materials Needed	Page
1. Flowers and fruits	• Slides presentation • KLEWS chart	**31**
2. How does a flower become a fruit?	• Slides presentation • *From Seed to Plant* by Gail Gibbons • Students' models of the blueberry plant • KLEWS chart • What does a blueberry plant need? assessment	**32**
3. Outdoor lesson comparing biodiversity on campus	• Science notebook or clipboards with paper to take notes/draw observations.	**34**

UNIT OVERVIEW (cont.)

LESSON 4: Pollinators! *pg. 38*

In this lesson, students will continue to investigate why Shanelle's blueberries won't grow by looking at the phenomenon of a lack of pollinators as a cause of the missing blueberries. Students will study their live critters, who are all pollinators and identify the different structures that allow these organisms to sustain themselves while pollinating flowers. Students will expand and elaborate their understanding of pollination by studying a variety of pollinators that have interesting structures to survive and to pollinate.

Session	Materials Needed		Page
1. Where have the bees gone?	• Slides presentation • *What if There Were No Bees?* by Suzanne Slade	• Honeybees by Readworks • KLEWS chart	**39**
2-4. Milkweed bugs and butterflies as pollinators	• Adult bugs in their habitat or in vials (if possible) • Hand lenses	• Milkweed Bug Observation Template • Butterflies Observation Template	**44**
5. Other important pollinators	• Slides presentation • *Sip, Pick, and Pack* by Polly Cheney	• Pollinators Research Log • KLEWS chart	**47**
6. FOSS Investigation 4: Silkworms and Nighttime pollinators (optional extension)	• Grown-up silk moths • Hand lenses • Silk moth habitats	• Pollinators Research Log • KLEWS chart	**50**
7. FieldSTEM: Searching for flowers, fruits and pollinators	• Clipboards with paper or science notebooks.		**51**

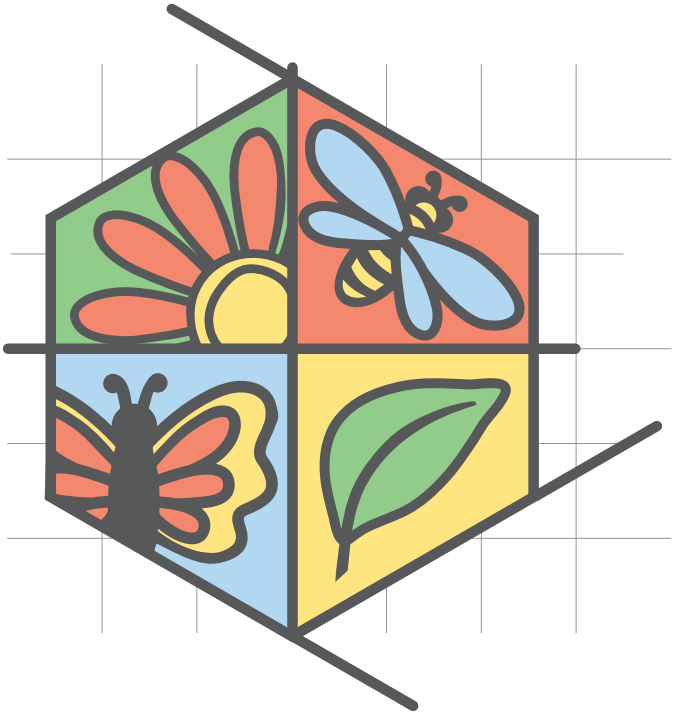
UNIT OVERVIEW (cont.)

LESSON 5: Designing a Tool to Help Shanelle *pg. 56*

Students will engage in the engineering design process to create a device that Shanelle can use to help pollinate her berry plants. Students will look back at the pollinators' structures they have studied and identified and will use these animals as inspiration to create an artificial pollinating device.

Session	Materials Needed		Page
1. Wondering about the problem	• Slides presentation • KLEWS chart	• Engineering design template	**65**
2. Imagining the solution	• Slides presentation • KLEWS chart	• Engineering design template	**66**
3. Planning the solution	• Markers, crayons, colored pencils • Chart paper • Engineering design template	• Access to these materials for building: pipe cleaners, felt, construction paper, straws, coffee stirrers (plastic), toothpicks, string, pompoms, cotton swabs, aluminum foil, beads, other recyclables	**67**
4. Creating the tool	• Engineering design template	• Building materials (see above)	**69**
5-6. Optimize and explain	• Thimble (model of blueberry flower) • White flour to represent "pollen" • Black construction paper with a flower	• Materials to make improvements • Measure and Test Your Tool Data Collection	**70**
7. Share!	• Slides presentation	• Student projects	**72**

LESSON 1: Why Won't Our Blueberries Grow?



STRATEGY: ENGAGE

This lesson will serve as an entry point into the unit by exposing students to the problem of low crop yield due to lack of pollinators. Students will start by engaging with the phenomenon of absent fruiting of a blueberry plant. The phenomenon will be presented to students by using the example of a farmer who is growing blueberry plants that are not fruiting. This lesson will simply engage students in this problem by presenting it to students through the lens of a real farmer.

SESSION 1:
Why won't Shanelle's blueberries grow?

Warm-up

Tell students that in this science unit, they will be helping a farmer solve a very important problem. Use this slides presentation to introduce students to Shanelle Donaldson, a farmer from Washington state who is having trouble getting her blueberry plants to produce blueberries.

Main activity

After you have introduced the problem of, "why won't the blueberries grow?" ask students to think about their *noticings*, *wonderings*, and *knowings*. A noticing is something that they notice about the problem that is presented to them (an observation). A wondering is a question that they have or something they wonder about related to the problem. A knowing is something that they already know that may help them to answer the question (this is some information or knowledge they walked into the room with before the lesson/unit even started). Take the time to have each student share something they notice, something they wonder, and something they know. Allowing for all students to share their thinking is time consuming but promotes equity of students' voices in the classroom.

Wrap-up

Create a KLEWS chart to help yourself and students track their learning throughout the unit. A KLEWS chart is a version of the KWL chart that is specifically geared towards supporting students with developing their scientific understanding through engagement with a phenomenon and an inquiry-based progression of learning. This video by 1st grade teacher Kathryn Yablonski is a helpful overview of the KLEWS chart.

Materials Needed

- Intro slides presentation
- KLEWS chart
- Chart paper

SESSION 2:
Introducing the driving question

Warm-up

Ask students about the problem that Shanelle is having with her blueberry plants not producing fruit. Have students recap the entry lesson and look back at the KLEWS chart.

Main activity

Present students with the driving question of the unit:
How can we design a solution to help Shanelle's blueberries grow?

Ask students to think about what other wonderings they have that will help them to solve this problem. What else do they wonder or need to know?

Career connections:

Introduce students to the job of an agriculturalist. The slides (10-16) can be helpful in facilitating a discussion with students. Tell students that in this unit, we will be trying to help Shanelle, who is an agriculturist, and in doing so, we will also be problem-solving like an agriculturist by trying to figure out why the blueberries won't grow!

Wrap-up

Ask students to think of anything they'd like to add to the KLEWS chart. The term "agriculturalist" can be added to the "S" or "science concpets/ideas" column of the KLEWS chart.

Materials Needed

Intro slides presentation
KLEWS chart

SESSION 3+:
Critter investigations! (PLANNING AHEAD)

FOSS Investigations Milkweed Bugs, Butterflies and Silkworms

Teacher set-up required!

In the context of this storyline, these three insects, who are all pollinators, will be studied so that students can investigate the structures that pollinators have that make them effective at spreading pollen around. All habitats can be set up at the same time and students will 1) make observations about the life cycle and changes in the insects and 2) make observations about insect structures once they are grown to adulthood.

It is suggested that you set up your critter habitats now and guide the students through observing their different life cycles. The critters will take over one month to fully mature, and we would like students to study the fully grown adult insects by Lesson 4: Pollinators (which will be approximately 4-5 weeks from now).

Career connections:

Introduce students to the job of an entomologist. An entomologist is a person who studies insects. Tell students that in this unit, we will be studying how different insects grow and use plants for food. We will also be studying the life cycles and behaviors of the three insects, which is something that an entomologist does. Add the term "entomologist" to the "S" column of the KLEWS chart, or create your own chart to highlight STEM careers that are featured in the unit.

Note: Although the focus of investigations in the FOSS teacher's guide is on the lifecycle of these insects, the NGSS standards for 2nd grade Life Science do not focus on life cycles. Therefore, resources and a suggested lesson sequence to help connect with the storyline and NGSS grade level standards are provided below. You may still want to use a template to have students draw the life cycle of a milkweed bug or arrange the steps in the lifecycle of a butterfly, since they will naturally be making observations about how they change over time after hatching.

Materials Needed

Materials for FOSS Investigation 3: Milkweed Bugs

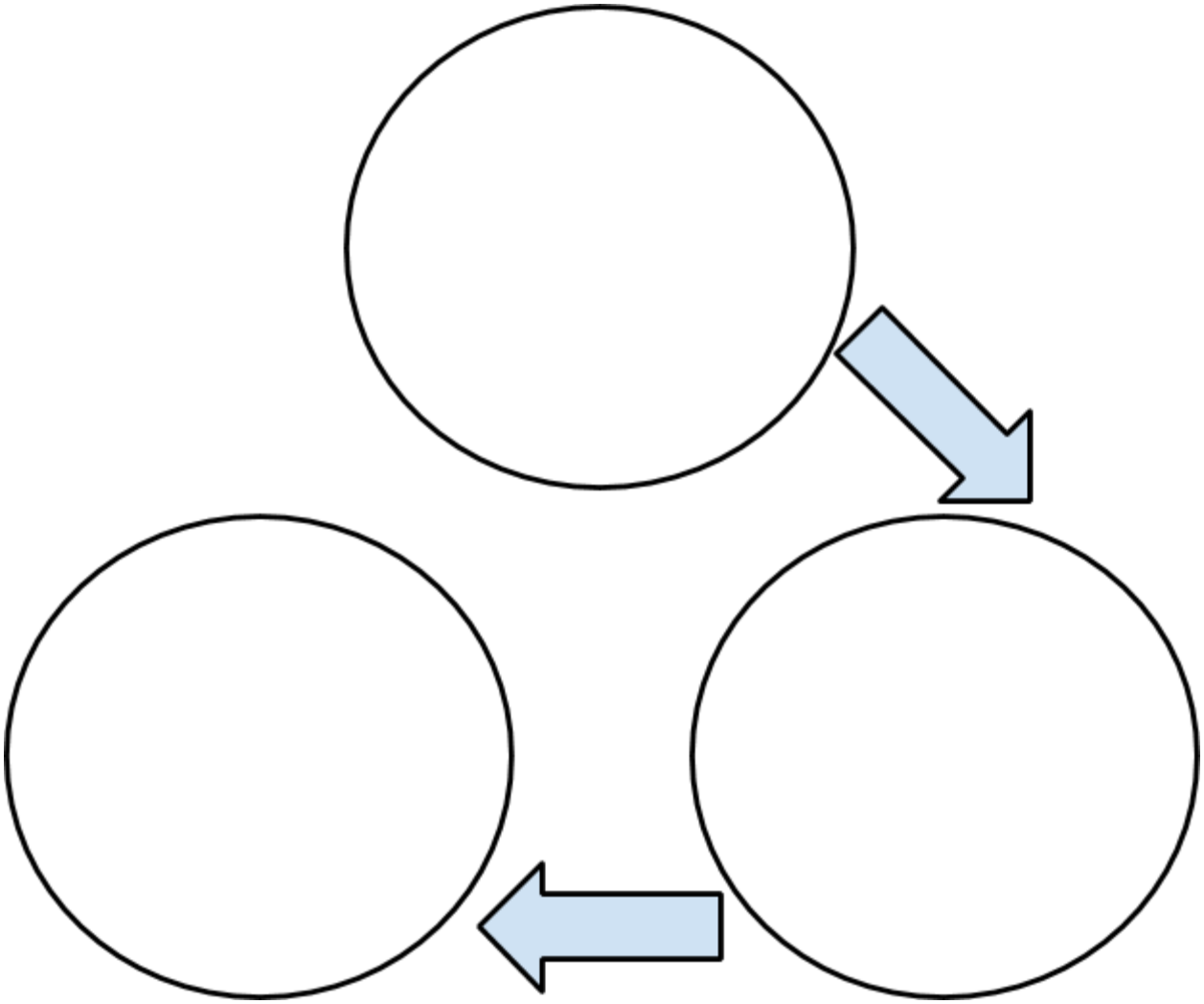
- 1 vial with cap
- Labels
- Hand lenses
- Milkweed bug eggs
- Small paintbrush
- Marking pen*
- White paper*
- Vial with milkweed bug nymphs
- Vial with cap
- 4 L zip bag
- Pushpin
- Cardboard piece
- Piece of netting
- Rubber bands
- Cotton ball
- Paper towel*
- Large paper clip
- 2-3 twigs (get from outside)
- Pointed dowel
- Hole punch
- Sunflower seeds, raw, shelled
- Scissors
- Water*
- Basin

Materials for FOSS Investigation 5: Butterflies

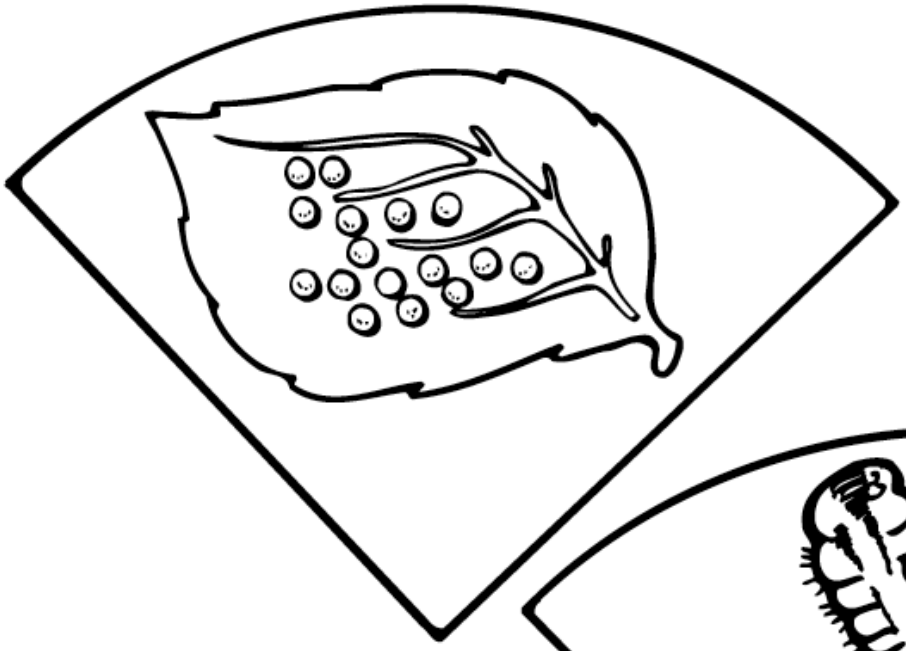
- Painted lady butterfly larvae
- Chart paper*
- Marking pen*
- Science notebooks for taking observations
- Butterfly cage
- Painted lady butterfly pupae
- Transparent tape*
- Adult butterflies in butterfly cage
- Vial with cap
- Vial holder
- Hole punch
- Sugar*
- Water*
- Measuring spoon*
- Red or orange construction paper*
- Paper towel*
- Scissors*

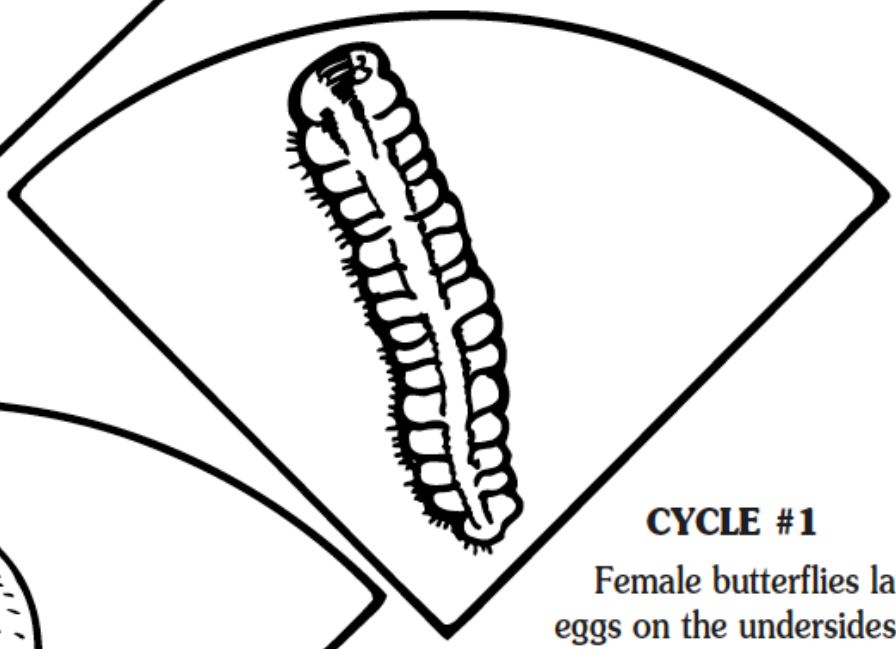
**not included in kit*

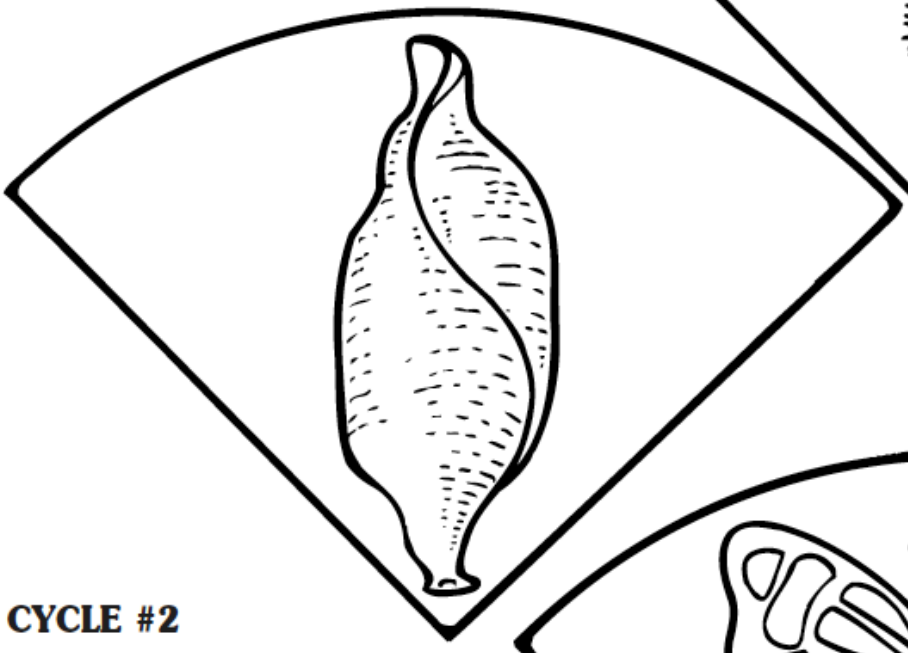
Milkweed Bugs Life Cycle

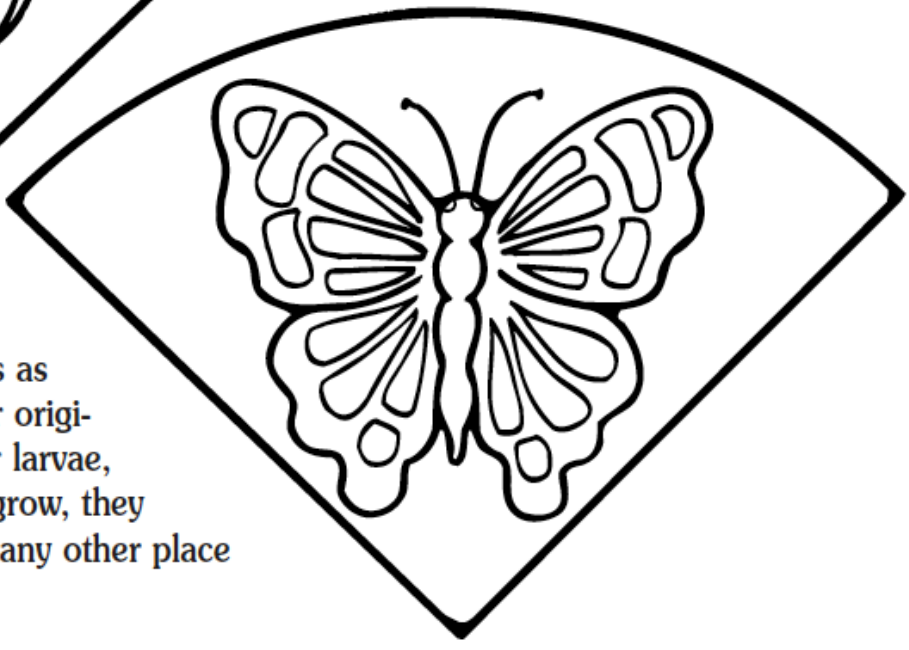


Butterfly Life Cycle









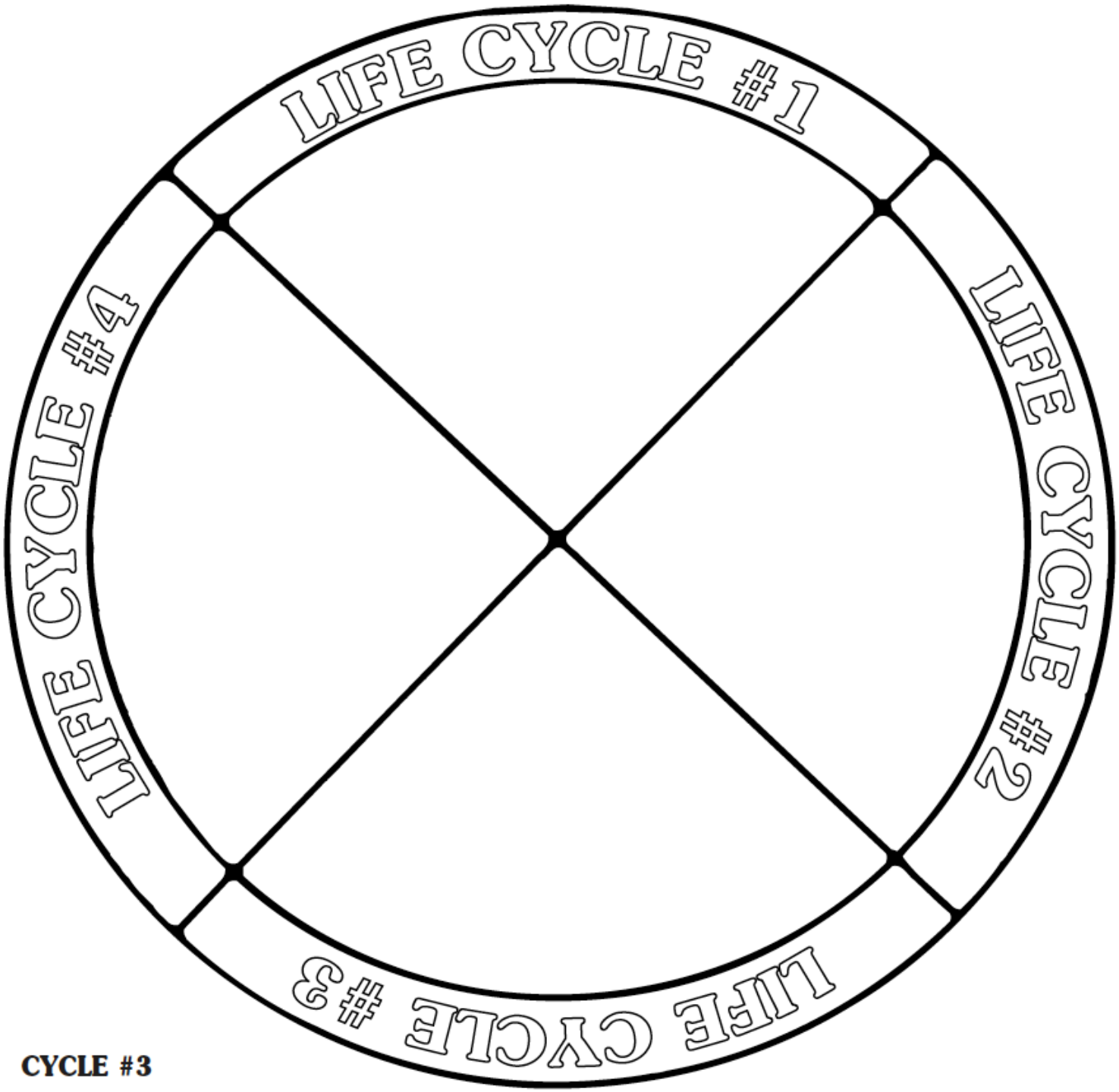
CYCLE #1

Female butterflies lay eggs on the undersides of leaves. These leaves are always the kind that the soon-to-be caterpillars like to eat.

CYCLE #2

The crawling caterpillars are the larvae of the butterfly. Caterpillars eat continuously. They shed their skin several times as they grow hundreds of times their original size. When the caterpillars, or larvae, have grown as large as they will grow, they attach themselves to a branch or any other place suitable for a long rest.

Have students cut apart the illustrations on the previous page and paste them onto the appropriate sections of the wheel below.



CYCLE #3

We call the insect in this cycle of life a "pupa." The pupa develops a covering over its body called a "chrysalis." Inside this case, during the long rest, the adult butterfly is forming. When the pupa has finished its transformation, a butterfly will emerge from the chrysalis.

CYCLE #4

The adult butterfly slowly comes out of its chrysalis. The wings of the butterfly quickly grow strong in the fresh air. In a few hours the butterfly can fly away to find the flowers from which it extracts its food.

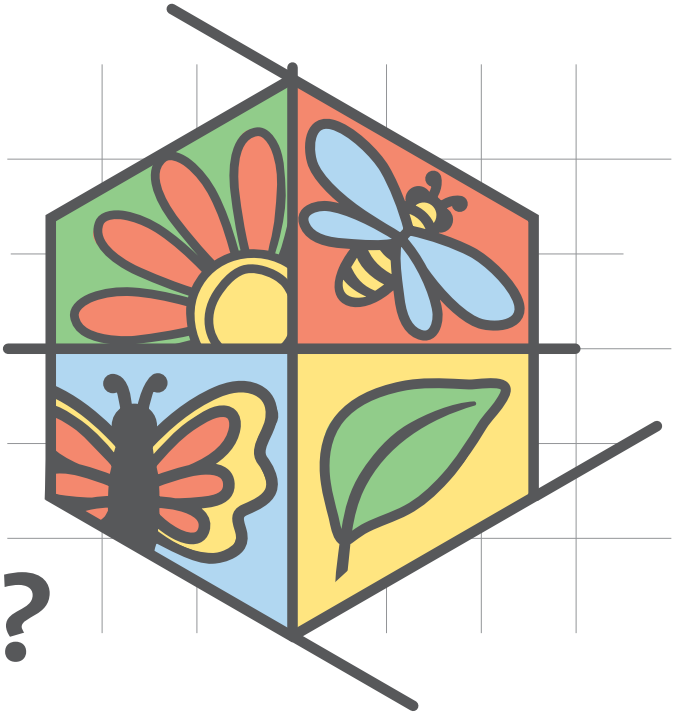
How Lesson 1 Supports Next Generation Science Standards

2. Interdependent Relationships in Ecosystems

Performance Expectation	**Connections to Classroom Activity,** *Students:*
2-LS2-1 Plan and Conduct an investigation to determine if plants need sunlight and water to grow.	• Begin to engage with the phenomenon of "why won't the blueberries grow?" which will launch them into an investigation of what plants need in order to grow. • Generate questions (wonderings) about why Shanelle's blueberries might not be growing.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems	• Ask questions to start the process of inquiring why Shanelle's blueberries are not growing.
DISCIPLINARY CORE IDEAS	
LS2.A Interdependent Relationships in Ecosystems. Plants depend on water and light to grow.	• Engage with a real-world problem in which plants are not growing as they should and generate questions and noticings about what these plants need in order to thrive.
CROSSCUTTING CONCEPTS	
Cause and Effect	• Engage with the phenomenon of the blueberries and generate ideas about what is causing the blueberries not to produce any fruit.

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

https://www.nextgenscience.org/topic-arrangement/2interdependent-relationships-ecosystems



LESSON 2: What Do Plants Need?

STRATEGY: EXPLORE

In this lesson, students will be planning and conducting an investigation to determine what exactly plants need in order to grow. The lesson will start by connecting to the storyline so that students have a context and relevance for their investigation. Then, students will design an investigation and a method to collect observations that answer the question, what do plants need in order to grow? In the primary grades, planning and carrying out the investigation is a process that will be done collaboratively, in this case, collectively as a class. Students will collect data and create an argument as a class to support their claim. Then students will reconnect with the storyline and see how the farmer is meeting the needs of her plants.

SESSION 1:
So, what do the blueberries need?

Warm-up

Ask students to think about what they already know about plants. What are some things that they know that plants need? Ask students to share their thoughts with a partner and then share with the class. Write down students' ideas in the "know" column of the KLEWS chart. Tell students that in this lesson, we will be answering that question: What do plants need in order to grow? Tell students that we have two different types of seeds (Brassica Seeds and Bean Seeds) that we will plant and we will study what these seeds need in order to grow into a healthy plant. Ask students, "how might our test help Shanelle on her farm? What are we trying to figure out?"

Materials Needed

Plant predictions template

KLEWS chart

Main activity

Ask students to think, how can we test to see if plants need water and light in order to grow? Allow students to share ideas. If they are struggling with coming up with ideas, further scaffold by using these prompting questions:

- Ask students, if we have two seeds and we want to see if seeds need water to grow, what can we do to one? What can we do to the other? How will we know if the seeds really need water? (Prompt students to explain that if we water one and don't water the other, we can see if they both grow to see if they really needed water).
- Ask students, how about light? How can we tell if the seeds/plants will need light to grow? Allow students to discuss until and continue to prompt until they decide that one seed will be placed in light and one in a dark closet.

Career connections:

Introduce students to the job of a botanist. Tell students that in this unit, we are trying to figure out why Shanelle's blueberry plants won't grow blueberries. "A botanist is a scientist who studies plants, including flowering plants, and plant-like things such as moss and seaweed. In this lesson, we will be studying brassica plants and will be trying to figure out what these plants need to grow. We will also try to figure out why Shanelle's plants aren't growing." Add the term "botanist" to the "S" column of the KLEWS chart, or create your own chart to highlight STEM careers that are featured in the unit.

Wrap-up

Have students make predictions about how the plants will look after 10 days using the following template. This can serve as a pre-assessment of their understanding of the phenomenon.

Plant Investigation Predictions

Draw a prediction of how you think your seed will look in 10 days:

Light and Water 	Light but **no** water 
Water but **no** light 	**No** water and **no** light

SESSION 2:
Planning our investigation

Teacher note: Planning an investigation is a Science and Engineering Practice that is an important part of the standards bundle being addressed in this unit. Even students in primary grades are expected to be a part of planning an investigation. Instead of giving directions on how to conduct the investigation or using the scientific method, collaboratively engage students in the process of thinking about their investigation and how they will collect data.

Materials Needed

- Teacher slides
- Chart paper
- Markers

Warm-up

Tell students that before we start our investigation, we have to think of what data we are going to collect and how we will use the data to answer the question: What do plants need in order to grow? This slides presentation can be used to work through this process of setting up the investigation with students.

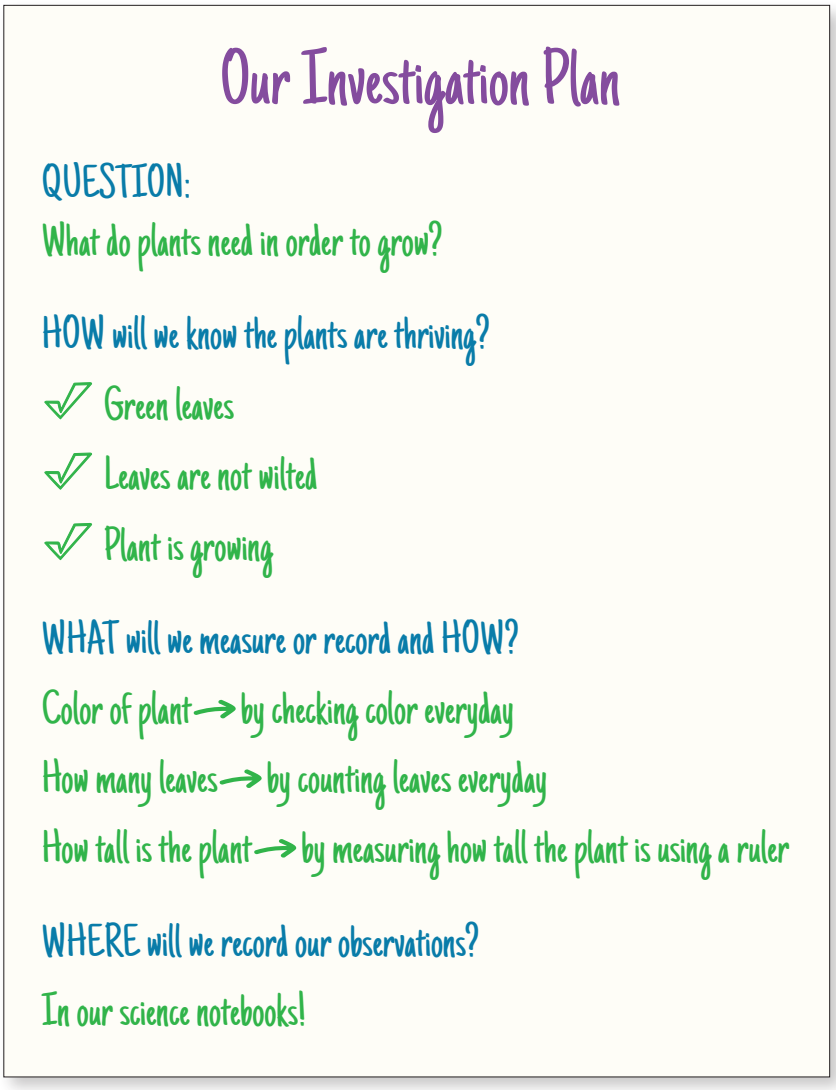
Main activity (15 min)

Work through different aspects of planning an investigation using the slides and pausing to record students' thoughts on a large piece of chart paper. You can create the following categories on a piece of chart paper:

- How will we know the plants are thriving?
- What will we measure or record and how?
- Where will we record our observations?

Wrap-up (5-10 min)

Check-in with the KLEWS chart and write down any ideas that have come up. Students may be prompted to add some "wonderings" or words such as "data" and "observations" in the "science vocabulary/concepts" column.



SESSION 3: Conducting the investigation: FOSS Investigation 1 (NEW PLANTS: Brassica Seeds)

Note: Skip part 1 of this investigation since you have already taken the time in the previous sessions to discuss how students will study the growth of these plants. Also, construct the lamp support structure in advance using directions on pages 14-15 of your FOSS teacher's guide and directions on pages 16-17 to prepare for the planting.

Warm-up

Introduce the brassica seeds and tell students that today we will be planting the brassica seeds and will be testing what these seeds need in order to grow into thriving plants. Have each team of students plant seeds in 4 different cups. Have students label their cups with their team name (let them be creative).

Main activity

Have students set up the materials for their investigation. Directions in FOSS guide page 18-19 can be used to guide students how to plant the seeds.

1. **Cup 1** will go in the growing light and will receive water. Ask students to decide how much water the seeds will be given and how often (FOSS recommends that you water the plants by pouring water in the tray and waiting until the water dries up before re-watering, you may want to follow this procedure.
2. **Cup 2** will go in the growing light but will not receive water.
3. **Cup 3** will go in a dark location (ask students to pick a location in the classroom where there will be no light) and will receive water (ask students how much water they will give—one vial every 2-3 days should suffice).
4. **Cup 4** will go in a dark place and will not receive water.

Have students take their initial observations in their template. Ask students how often they would like to take observations of their 4 test subjects and support students in following through with their investigation plan.

Wrap-up

After students have finished making observations in their templates, ask them to share ideas with their team. Which seeds will grow? Which ones do they predict will not grow? Why?

Materials Needed

Observation Templates

Materials for Investigation 1, Part 2: Planting Brassica

- Planter cup with holes
- Brassica seeds
- Label
- Paper towel*
- Plastic cups
- Container ½ L
- Vial
- Pencils
- Basins
- Planter tray
- Lamp with cool white bulbs
- Lamp frame (PVC pipe)
- Potting soil
- Liquid plant fertilizer
- Scissors*
- Permanent marker
- Water*
- Newspaper*
- Extension cord (optional)*

**not included in kit*

Ongoing Observation Sessions

Observe the brassica every day (or every other day) for several weeks. This template can be used or modified to help students take observations. This blank template can also be used if you would like students to focus on creating sketches instead of just collecting data. Prompt discussion that helps students analyze the data they are finding by using the following prompting questions:

- What changes are you noticing in your 4 test cups?
- What are some of the changes you observe?
- What are some of the differences you see between the different cups?

It may be helpful to create a collective log as a class so that students can see the results that other teams are having (are results similar or different?). It is also important to check-in with the KLEWS chart every few days and add to the "evidence" column. Students observations are technically evidence and can be used later to answer the driving question.

Materials Needed

Observation Templates

Class observation chart (on chart paper)

Name_____ My Plant Observations

Plant #	Date:	Date:	Date	Date
1	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
2	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
3	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
4	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____

Name_____ My Plant Observations

Plant #	Date:	Date:	Date	Date
1	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
2	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
3	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____
4	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____	How tall? _____ Color? _____ Number of leaves? ____

Name_____ My Plant Observations

Plant #	Date:	Date:	Date	Date
1				
2				
3				
4				

Name_____ My Plant Observations

Plant #	Date:	Date:	Date	Date
1				
2				
3				
4				

SESSIONS 4-5: Analyzing data and constructing an argument

Warm-up

With students, take a look at all the data that was collected during the past few weeks. Students can bring along their personal logs, can look at a class tracker (if there was one) and look at the KLEWS chart as well. Remind students what the question for this investigation was: ***What do plants need in order to grow?*** Tell students that we will be constructing an argument to answer the question. Ask students what an argument is (Students might mention that an argument is some kind of disagreement). Tell students that although we think of arguments as two people disagreeing, an argument is actually an explanation or solution to a question or a problem.

Materials Needed

- Student data charts
- Class data chart
- KLEWS chart
- Chart paper and markers

Main activity

Facilitate a discussion by asking some prompting questions such as:

- In which conditions did the plants grow the best? How do you know?
- In which conditions did the plants not grow so well? How do you know?

While students are answering some of these prompting questions, draw stars next to the pieces of evidence that support their answer. Ask students to turn to a partner and use this sentence frame to explain their answer: I think that plants grew well when _____ because _____. (Ex. I think that plants grew well in the light and with water because they had leaves and were green). Have students share their sentences with the whole group. Then, ask students if the class can reach a consensus: "Can we work together to agree on an answer our question?" Constructing an argument as a class:

1. On a large piece of chart paper write down the question that you are trying to answer: What do plants need in order to grow?
2. Underneath, write the word "claim." Ask students, have they ever heard of the word "claim?" What might that mean? Tell students that a claim is an answer to a question. We will be trying to write a claim to answer the question: What do plants need to grow?
3. Ask students if they can answer the question. Let students share answers with their partner and then have as many students as possible share their claims with the whole group.
4. Ask students if there is a way we can come to a consensus or agreement about an answer to the question.
5. After you have come up with a claim that nearly all students agree with, tell them, "in order for a claim to be a strong answer, we have to back it up with evidence! We collected weeks and weeks of evidence to answer our question. Which pieces of evidence support our claim and make it stronger? Have students take a marker, have each student walk up to (either the KLEWS chart or the class observations chart), and make a star next to a piece of evidence that they think backs up the class' claim.
6. Work with students to identify several pieces of evidence that you can add to the Argument chart.

SESSIONS 4-5: Analyzing data and constructing an argument (cont.)

Wrap-up

After the class has worked together to create an argument with a claim and supported by evidence, this is a solid piece that can be added to the "Learned" section of the KLEWS chart. This is something that students learned through investigation and analysis of data and it should be celebrated!

Our Argument

QUESTION:

What do plants need in order to grow?

CLAIM

Plants need water and light to grow.

EVIDENCE #1

The plants that didn't get water did not grow.

EVIDENCE #2

The plants that didn't get light grew a little and then died.

EVIDENCE #3

The plants that got water and light grew, were green, and had lots of leaves.

SESSION 6: Connecting to the storyline: So, what do blueberries need?

Warm-up

Use this slides presentation to reconnect students with the storyline. Recap the findings from the investigation. What did our investigation show us?

Main activity

Ask students to consider: Are Shanelle's plants getting what they need? Students will likely determine that Shanelle is an effective farmer and is giving the plants what they need.

Creating a model of a blueberry plant: Tell students that we will be creating a model of a blueberry plant that explains what a blueberry plant needs in order to grow and produce fruits. A model is a drawing or diagram that explains how something happens or works in nature.

1. Arrange students in groups of 2-3 and provide each group with a large piece of paper (or half a chart paper). Ask students to draw a blueberry plant.
2. Ask them to think about what we learned in our investigation, what are two things that the plant needs in order to grow? Ask students to add these to the model (water and sunlight).
3. Tell students that we will be returning to our models throughout the unit once we learn more about what exactly the plants need and why they are not making blueberries.

Wrap-up

Reconnect with the KLEWS chart and add to the column for "what we learned." Students can now make a connection and determine that the blueberry plants are not producing for a reason other than not getting enough sun and water. Ask students to ponder about some other reasons why Shanelle's blueberries might not be producing fruit. Have students share out their ideas.

Materials Needed

- Slides for connecting to storyline
- Large sheets of paper or chart paper
- Markers and colored pencils
- KLEWS chart

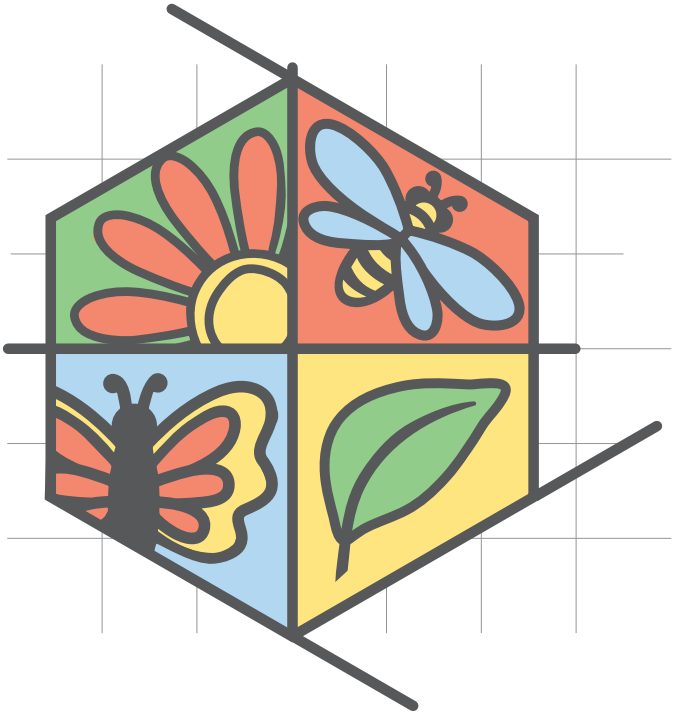
How Lesson 2 Supports Next Generation Science Standards

2. Interdependent Relationships in Ecosystems

Performance Expectation	Connections to Classroom Activity, *Students:*
2-LS2-1 Plan and Conduct an investigation to determine if plants need sunlight and water to grow.	• Create a plan to investigate the question: What do plants need in order to grow? • Determine how they will collect data, what kind of data they would like to collect, and what they will do with the data once it is collected. • Take observations over a span of several weeks of Brassica seeds and how the plants are growing differently in differing conditions (with light and water, with light and no water, with water and no light, and with no water and no light). • Students will analyze their data and use it to construct an argument based on evidence for what plants need to grow.
SCIENCE & ENGINEERING PRACTICES	
Planning and Carrying out Investigations Constructing an Argument from Evidence Analyzing and interpreting data Developing and Using Models Asking Questions and Defining Problems	• Plan how they will answer the question: what do plants need in order to grow? • Decide how they will investigate the question by determining what data they will collect, how they will collect it, and how they will interpret the data to answer the question. • Use observations to construct an argument based on evidence for what plants need to grow. • Create an initial model of a blueberry plant and what it needs in order to survive. • Ask questions about what other conditions aren't being met that are causing the plants to not produce blueberries.
DISCIPLINARY CORE IDEAS	
LS2.A Interdependent Relationships in Ecosystems. Plants depend on water and light to grow.	• Investigate what plants depend on in their ecosystem. • Investigate what plants need in order to thrive and grow.
CROSSCUTTING CONCEPTS	
Cause and Effect	• Determine what conditions cause a plant to thrive and which conditions cause a plant to not survive.

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

https://www.nextgenscience.org/topic-arrangement/2interdependent-relationships-ecosystems



LESSON 3: Flowers and Fruits

STRATEGY: EXPLAIN

In this lesson, students will investigate the purpose of flowers and fruits. Students will study the process of a flower turning into a fruit and will generate observations and ask questions about what they observe in several time-lapse videos. Students will then begin to study the role of pollinators in helping a flower turn into a fruit and will use an expository text to further develop their understanding of the phenomenon.

STEM

SESSION 1:
Flowers and fruits

Warm-up

Ask students to think about the driving question for the unit. Use this slides presentation to reconnect with the storyline. What is the big problem Shanelle has that is causing her trouble? Students will recap that the blueberry plant is growing, but it is not producing any fruits.

Materials Needed

- Slides presentation
- KLEWS chart

Main activity

Show students the time-lapse video of the strawberry plant fruiting from flowers. There are a plethora of important observations that students will be able to make about this video. On a piece of chart paper, write down students' observations after one viewing of the video. Then, show students the video one more time and ask them to share any additional noticings.

Some things that students may notice:

- the strawberry plant has flowers
- the flowers wilt
- only two fruits are formed even though there are many flowers
- the fruits start to rot because no one picks the strawberry

What are some things that students wonder after watching the video? Some things that students may wonder: why did only some flowers become fruits? Why do plants have flowers?

Wrap-up

Ask students if there are any observations they think should be added to the evidence column of the KLEWS chart. Do they have any new questions about the blueberries and why they aren't growing?

SESSION 2:
How does a flower become a fruit?

Warm-up

Tell students that we will be working on answering some of the questions and wonderings we have about how flowering plants make fruits. Ask students to look back at the KLEWS chart and see if there are unanswered questions about fruit that we still wonder about. Show students video on slide 6 of the slides presentation and ask them to share their questions. Students may have lots of questions (what are pollinators? Why does the fruit need to be pollinated? Does each flower become a cherry?)

Main Activity

Read *From Seed to Plant* by Gail Gibbons. Pause and have students reflect on the information presented in the book. What information did we learn that helped answer some of our questions? Revisit students' wonderings and see if any of students' questions were answered after reading the text. Be sure to pause and ask students what they notice about pollinators. What are pollinators? What do they do? What are some examples of animals that pollinate plants?

Working on the blueberry model: Have students revisit their model of the blueberry plant that they drew earlier in the unit. Use the images of the blueberry bushes in the slides presentation to encourage students to add flowers to the model. Ask students what other things they saw in the video or read in the book that are important for the blueberry plant (students may, or may not want to add pollinators at this point, and that is fine). You can also use this template as a formative assessment to see where students are in their understanding of what a plant needs in order to survive.

Wrap-up

Have students check in with the KLEWS chart. What might be an issue that is causing the blueberry plant not to be able to make blueberries? Ask students to share their ideas. Add to the "learned" and "evidence" column if there are things that students want to add based on their reading or watching the video. At this point, students may be sensing that the problem has something to do with the lack of pollinators. This concept will be further explored in the next lesson on pollinators.

Materials Needed

From Seed to Plant by Gail Gibbons

Slides presentation

KLEWS chart

Students' models of the blueberry plant

What does a blueberry plant need quick assessment

Name_____

Things that a blueberry plant needs!

1. _____
2. _____
3. _____
4. _____

Draw a blueberry plant and the things it needs in its environment.

SESSION 3: Outdoor lesson comparing biodiversity on campus

Warm-up

Ask students to think of places in their community, including at school, where they've seen flowers bloom. Think-pair-share, with teacher charting locations. Share with students that today's work will be focused on designing and leading a field investigation to collect and compare data on the plants, flowers and seeds in two places on our school campus. Share investigation question with students: Are there more plants, flowers, and/or seeds _____ or _____? The teacher can pick the two locations (the playfield, the school garden, the weeds near the parking lot, etc.), or lead the class to pick two with a vote or consensus. If students are picking, it might be useful to use language like "Our criterion for a good location is that it must be a place we've seen flowers before, and our constraints are that it must be safe to access and be on our school campus."

Materials Needed

- Plant Investigation recording sheet
- Field Investigation slides
- Two outdoor spaces to observe

Main activity

Distribute the Plant Investigation recording sheet, and read through it with students. When you get to 'procedure,' complete step one (guide students to fill out the top sections - name, date and time, weather conditions, and areas to be investigated). Read through the rest of the procedures, asking students to imagine themselves finding a spot outside and sitting down, away from their friends and other distractions, taking time to look just low to the ground and recording what they see, then when asked by the teacher looking at eye level, then when asked by the teacher looking up high. Ask, "Can anyone remind me of what we're going to be looking for?" Think-pair-share, leading students to the answer of the number of different plants/flowers/seeds in our chosen areas. Teacher shares, "Sometimes, when I'm looking at a bush or a plant, I can't tell if it's a bunch of different plants very close to each other, or one plant with many parts. Today, when we're observing in our areas, I want you to try to focus on looking for different TYPES of plants, flowers and seeds, not how many of each type you see. Let's practice." Show students the Field Investigation slides to model observing and recording data; consider noting that maybe a student saw a plant/seed/flower that you missed, and that's okay. Lead students to area 1, and ask students to find a 'sit spot' near some plants on their own and focus their attention on the ground in front of them. Tell students they have 30 seconds to observe the area on the ground in front of them, and record their findings. Repeat the process, prompting students to look at eye level in front of them, and again looking up. Move to area 2 and repeat the process. Then, move inside.

Sharing and discussing data: In groups of 3 or 4, ask students to share the results of their investigation. Then, as a class, discuss findings. Did you find more plants/seeds/flowers in area 1 or 2? Did you find more plants/seeds/flowers when you looked low, high or middle? Collect and chart class data on the question, "Which area did you find more plant diversity, or different number of plants, area 1 or 2?" Then, return to investigation question, "Are there more plants, flowers, and/or seeds _____ or _____?" Guide class to answer the question using the following "claim-evidence-reasoning" frame:

SESSION 3: Outdoor lesson comparing biodiversity on campus (cont.)

We found that area ___ has more plants/seeds/flowers than area ___. My evidence for that is _____ (example: 24 people in our class found more plant diversity in area one and 5 people in our class found more plant diversity in area two). Plant diversity can be measured by how many different plants are in one place, so I know area ___ has more plant diversity.

Wrap-up

Have students share their responses. Check-in with the KLEWS chart, students ideas can be added to the "evidence" or what we "learned columns." The word storm surge can also be added to the last column for "science concepts."

Plant Investigation Recording Sheet

Name: _____
Date and time : _____
Weather conditions: _____

Investigation question: Are there more plants, flowers, and/or seeds _____ or _____?

Procedure:

1. Write current date, time, and weather conditions at your school, then write down the name of the areas you will investigate.
2. Travel to first area and find a place to sit with this recording sheet and a pencil.
3. Follow teacher instructions for observing the plants, flowers and/or seeds. Record your observations in the boxes below.

	Area 1 - _____	Area 2 - _____
Looking low		
Looking at eye level		
Looking high		

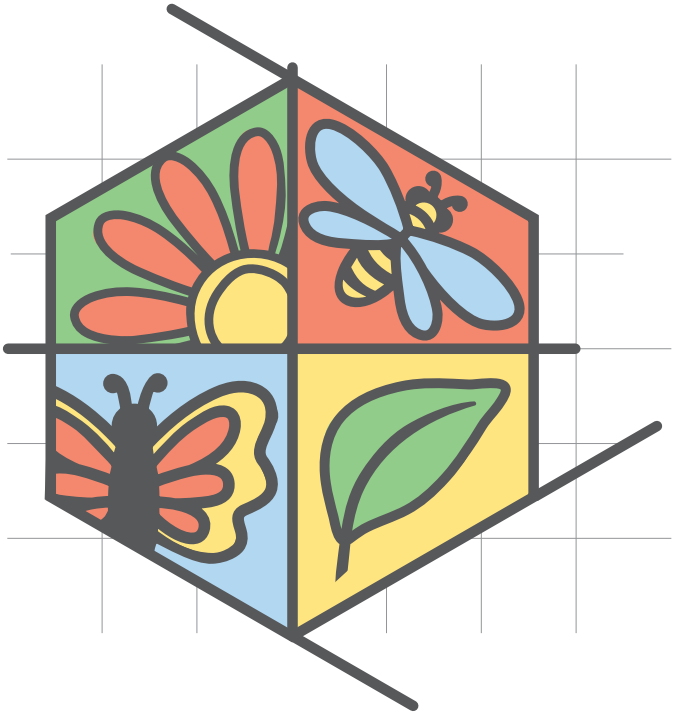
How Lesson 3 Supports Next Generation Science Standards

2. Interdependent Relationships in Ecosystems

Performance Expectation	**Connections to Classroom Activity,** *Students:*
2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. 2-LS-4-1: Make observations of plants and animals to compare the diversity of life in different habitats.	• Make observations of the process by which a plant produces flowers and how flowers turn into fruit when pollinated. • Make connections to the blueberry plant to understand why it may not be producing blueberries. • Observe and compare the diversity of plants, flowers, seeds and fruits in different parts of the school campus (ex. in parking lot, in the garden, or in the play yard).
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Obtaining, Evaluating, and Communicating information Developing and using models	• Obtain information through various media sources (videos of plants flowering and fruiting, and a text) to describe, ask questions about and communicate information about how why a plant needs flowers and how flowers become fruits. • Continue to add to the model of the blueberry plant by adding flowers (and possibly fruits and pollinators).
DISCIPLINARY CORE IDEAS	
LS2.A: Interdependent Relationships in Ecosystems ETS1.B Developing Possible Solutions LS4.D Biodiversity and Humans	• Continue to develop an understanding of how flowers are pollinated to produce fruit and seeds that are then dispersed. • Make field observations to determine how the diversity of life can be different based on the location (ex. in parking lot vs forest).
CROSSCUTTING CONCEPTS	
Structure and Function Cause and Effect	• Read texts, make observations of media, and collect field data to describe how the structure of flowers promotes the process of pollination. • Continue to investigate what is causing the blueberry plant to not flower.

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

https://www.nextgenscience.org/topic-arrangement/2interdependent-relationships-ecosystems



LESSON 4: Pollinators!

STRATEGY: ELABORATE

In this lesson, students will continue to investigate why Shanelle's blueberries won't grow by looking at the phenomenon of a lack of pollinators as a cause of the missing blueberries. Students will study their live critters, who are all pollinators and identify the different structures that allow these organisms to sustain themselves while pollinating flowers. Students will expand and elaborate their understanding of pollination by studying a variety of pollinators that have interesting structures to survive and to pollinate.

SESSION 1:
Where have the bees gone?

Warm-up

Present students with the information provided in this slides presentation where Shanelle talks about how the bees in the area have disappeared. Read *What if There Were No Bees?* by Suzanne Slade.

Main activity

Read the article Honeybees by Readworks together as a class (or using your preferred protocol). After students are done, ask them: why are bees important for plants? What does pollination mean? Allow students to share their ideas, then make the connection to the storyline by asking students: What might be happening to the blueberry plants? Are the bees important for the blueberry plants? Have students revisit their models of a blueberry plant. What should be added to the model? Remember, the model is showing what a blueberry plant needs in its environment.

Wrap-up

This may be a helpful moment to check in with the KLEWS chart and revisit the driving question: how can we design a solution to help Shanelle's blueberries grow? What are some ideas that students have about how they can help Shanelle? Are there more new things that they wonder? Is there information they learned from Shanelle or from the readings that can help as evidence to figure out how to help the plants?

Materials Needed

- Slides presentation
- KLEWS chart
- *What if There Were No Bees?* by Suzanne Slade
- Honeybees by Readworks

Honeybees

by ReadWorks

Have you ever seen a honeybee? If so, you may have kept your distance. Many people are scared of their stingers! But honeybees are not scary pests. In fact, they are actually very important insects.

If you've seen a honeybee, think about where you saw it. You may have seen it by some flowers. Honeybees go from flower to flower. They collect nectar and pollen from the flowers for food. They can use this to make honey to eat. This is the honey that people eat, too!

But honeybees aren't just important because of the honey they make. They're important because of how they help plants. When they go from flower to flower, they move the pollen from flower to flower, too. This is called pollination. This is what lets plants grow new seeds! And those new seeds can grow into new plants. So without honeybees, a lot of plants

couldn't exist. Apples, nuts, and berries are just some of the plants that need honeybees to help them make new seeds. About 100 important crops in the U.S.A. depend on bees!

Many people are worried because a lot of honeybees have been dying. Some people think the chemicals used on farms may be hurting them. Honeybees are also being hurt by diseases that we don't understand well yet. But people are working to find ways to save the bees. How would you like to help the bees?

Name: _____ Date: _____

1. What do honeybees make that people eat?

A. nectar

B. pollen

C. honey

2. The text describes how honeybees help plants by moving pollen from flower to flower. What does moving pollen do for plants?

A. It helps plants make honey.

B. It helps plants grow new seeds.

C. It helps plants stop chemicals.

3. Read these sentences from the text.

> They can use this to make honey to eat. This is the honey that people eat, too!
>
> But honeybees aren't just important because of the honey they make. They're important because of how they help plants.

What can you conclude from these sentences?

A. Honeybees are not very important.

B. Honeybees are important to plants, but not to people.

C. Honeybees are important to people and plants.

4. Read these sentences from the text.

> Apples, nuts, and berries are just some of the plants that need honeybees to help them make new seeds. About 100 important crops in the U.S.A. depend on bees!
>
> Many people are worried because a lot of honeybees have been dying.

Why might people be worried that there have been fewer honeybees?

A. because fewer honeybees means fewer apples, nuts, and berries

B. because fewer honeybees means more important crops in the U.S.A.

C. because fewer honeybees means more apples, nuts, and berries

5. What is the main idea of this text?

A. Honeybees collect nectar and pollen from flowers, and they can make honey that people eat.

B. Honeybees are important for people and plants, but many honeybees have been dying.

C. Honeybees have been dying because of some diseases and the chemicals used on farms.

SESSIONS 2-4:
Milkweed bugs and butterflies as pollinators

The following sessions are suggested after the insects have grown into adults.

Materials Needed

Adult bugs in their habitat or in vials (if possible)

Hand lenses

Milkweed bug observation template

Butterflies Observation template

FOSS Investigation 3: Milkweed Bugs

Warm-up

Show students the video of Milkweed bugs out in the garden using this slides presentation. It is important to see how these insects behave in a more natural environment vs the habitats that are created in class. Ask students to make observations about what they see.

Main activity

After showing students the videos in the slides presentation, ask students: What are the behaviors you are seeing? How might these behaviors help pollinate the plants? Or how might they help spread the seeds? If students listen carefully they will hear in the video that the milkweed bugs eat the seeds, but do not harm the rest of the plant.

Have students look carefully at the milkweed bugs in the classroom habitat to try and identify structures that the bugs have. What body parts might help in transferring pollen?

Wrap-up/assessment

Provide students with a template to draw their observations and write a sentence about how they think the milkweed bugs can pollinate plants.

FOSS Investigation 5: Butterflies

Warm-up

Show students the video of the butterflies pollinating plants using this slides presentation. It is important to see how these insects behave in a more natural environment vs the habitats that are created in class. Ask students to make observations about what they see.

Main activity

After showing students the videos in the slides presentation, ask students: What are the behaviors you are seeing? How might these behaviors help butterflies pollinate the plants? Or how might they help spread the seeds? Ask students, why are the butterflies moving from flower to flower?

Have students look carefully at the painted lady butterflies in the classroom habitat to try and identify structures that the bugs have. What body parts might help in transferring pollen? The diagram of the butterfly on the slides presentation can be used to help students identify the different structures and what they are used for.

Wrap-up/assessment

Provide students with a template to draw their observations and write a sentence about how they think the painted lady butterflies can pollinate plants.

Milkweed bugs as pollinators

Draw a picture showing how the milkweed bugs help to pollinate the milkweed flowers or spread their seeds.

Butterflies as pollinators

Draw a picture showing how the butterflies help to pollinate flowers.

SESSION 5:
Other important pollinators

Warm-up

Ask students about the driving question for the unit: how can we help Shanelle's blueberries to grow? Ask students what we have identified as a likely problem that is not allowing the blueberries to grow? Students should be able to talk about pollinators and remember that Shanelle is having issues with the amount of pollinators visiting her blueberry plants. Tell students that our plan is to design some kind of a device that will be able to help Shanelle with pollinating her plants. But before we do that, we will look at all the amazing insects and animals in nature that pollinate and learn from them!

Materials Needed

- Slides presentation
- *Sip, Pick, and Pack* by Polly Cheney
- Pollinators Research Log
- KLEWS chart

Main activity

Use this slides presentation and this research log template to guide students through a study of different pollinators and their structures.

1. Start by showing students the video of pollinators, ask students to share what pollinators they observed/recognized and what surprised them.
2. Read *Sip, Pick, and Pack* by Polly Cheney and ask students to share their thoughts, ideas, and questions about different pollinators that the book introduces.

Assessment

Go through slides and allow students to make observations about the structures that help different pollinators to pollinate plants. Ask students to draw a sketch of the animal and/or the structure that it uses to pollinate and to write a few words to describe their drawings.

Wrap-up

Connect with the storyline & KLEWS chart:

"What interesting structures or behaviors did we find that we can use as inspiration to create our device for Shanelle?" You may also want to give students time to revisit their blueberry plant models and make revisions. What type of help form pollinators do the blueberry plants need order to grow blueberries and why?

Pollinators Research

Name of Pollinator	Drawing of How it Pollinates	Words to describe drawing
Bees		
Butterflies		
Moths		

Name of Pollinator	Drawing of How it Pollinates	Words to describe drawing
Bats		

SESSION 6: FOSS Investigation 4: Silkworms and Nighttime Pollinators (OPTIONAL EXTENSION)

By this time in the unit, the silkworms should be reaching adulthood.

Warm-up

Use this slides presentation to show students the video of the Dragon Flower blooming. What do they notice about when this flower blooms? Since the flower blooms at night, who would pollinate it? Do we see lots of bees and butterflies flying around at night time?

Main activity

1. Show students the video of the moth pollinating a night time bloom. What does this animal look like? Students will notice that it is a moth and looks similar to the silk moths that the class has raised. Tell students that moths take over for the night shift of pollination once the day is over.
2. Show students the image and video of bats pollinating and have them make observations in their research logs.
3. Provide students with the opportunity to look closely at a silk moth (whether in its habitat or, if possible, put a silk moth in a vial or jar and have students gently pass around and observe through a hand lens.). What are some structures of this silk moth that may capture and transfer pollen?

Wrap-up

Reconnect with the KLEWS chart. What other pollinators did we learn about that have interesting structures for pollination? What have we learned that we can add to the KLEWS chart?

Materials Needed

- Grown-up silk moths
- Hand lenses
- Silk moth habitats
- Pollinators Research Log
- KLEWS chart

SESSION 7: FieldSTEM: Searching for flowers, fruits and pollinators

(Will yield varied success based on season/weather.)

Warm-up

Tell students that today we will be going outside to search for flowers, fruits and pollinators! The focus is for students to find a flower to draw, a fruit or seed to draw, and a pollinator to identify and draw. Depending on the weather, students will have more/less success, so plan accordingly. If occurring during the winter, you may have students look just for remnants of flowers/fruits.

Main activity

Have students explore and search. Ask students to spend time making a drawing of only one flower, fruit or seed, and pollinator. This template (or a blank sheet of paper) can be used to have students draw their observations.

Wrap-up

Have students come back inside and share their drawings. The following questions can be used to prompt student thinking:

- Where did you find the flowers?
- Were you able to find any fruits or seeds? Where were the fruits? Where were the seeds?
- How did you know that something was a fruit?
- How did you know that something was a seed?
- Did you find any pollinators? Why or why not?
- What pollinators did you find?
- Where did you find the pollinators?

Materials Needed

Clipboards with paper or science notebooks.

Optional Field Observation Template

Flowers, Fruits, and Pollinators
FieldSTEM Journal

A flower

Flowers, Fruits, and Pollinators
FieldSTEM Journal

A fruit or seed

Flowers, Fruits, and Pollinators
FieldSTEM Journal

A pollinator

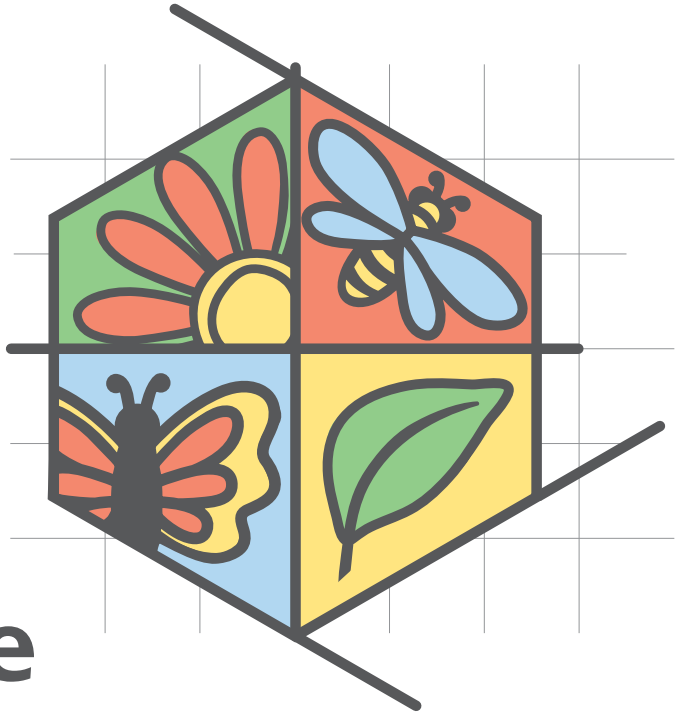
How Lesson 4 Supports Next Generation Science Standards

2. Interdependent Relationships in Ecosystems

Performance Expectation	Connections to Classroom Activity, *Students:*
2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	• Collect information and research about different pollinators and the structures that these different pollinators have to collect pollen and nectar while pollinating plants.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Analyzing and interpreting data Constructing Explanations Obtaining, Evaluating, and Communicating information	• Identify the problem of lack of pollinators and how this is preventing Shanelle's blueberries from flowering. • Use a variety of media to collect, evaluate and communicate information about different pollinators and how their structures aid in pollination.
DISCIPLINARY CORE IDEAS	
LS2.A: Interdependent Relationships in Ecosystems ETS1.B Developing Possible Solutions	• Study the importance of pollinators in helping flowering plants to produce fruit. • Log findings about different structures that pollinators have so that this information can help in creating a device in lesson 5.
CROSSCUTTING CONCEPTS	
Structure and Function Cause and Effect	• Make connections between the structures that animals have and how they affect that animal's ability to successfully pollinate plants. • Describe how the lack of pollinators (bees) may be causing Shanelle's blueberry problem.

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

https://www.nextgenscience.org/topic-arrangement/2interdependent-relationships-ecosystems



LESSON 5: Designing a Tool to Help Shanelle

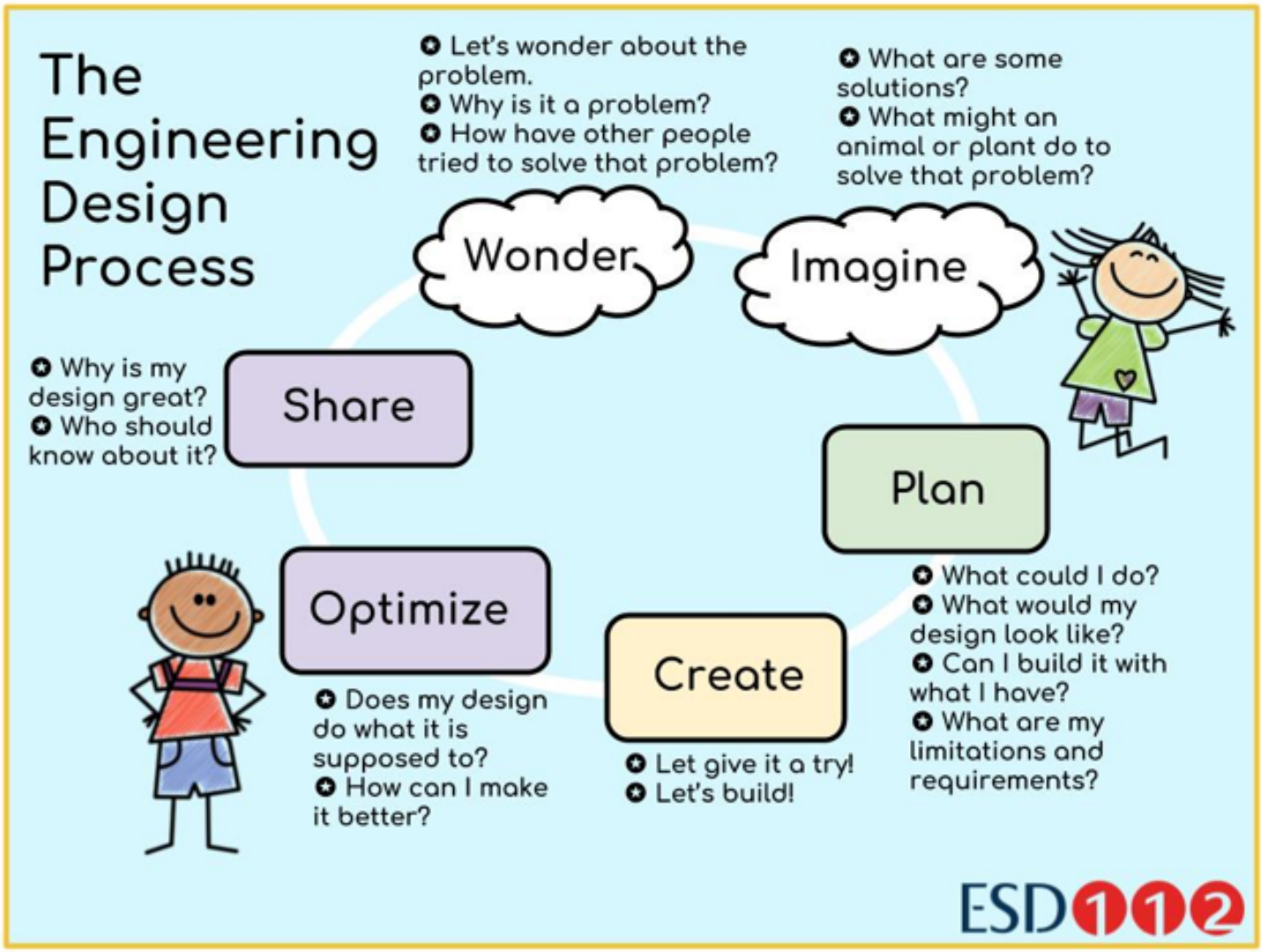
STRATEGY: EVALUATE

Students will engage in the engineering design process to create a device that Shanelle can use to help pollinate her berry plants. Students will look back at the pollinators' structures they have studied and identified and will use these animals as inspiration to create an artificial pollinating device.

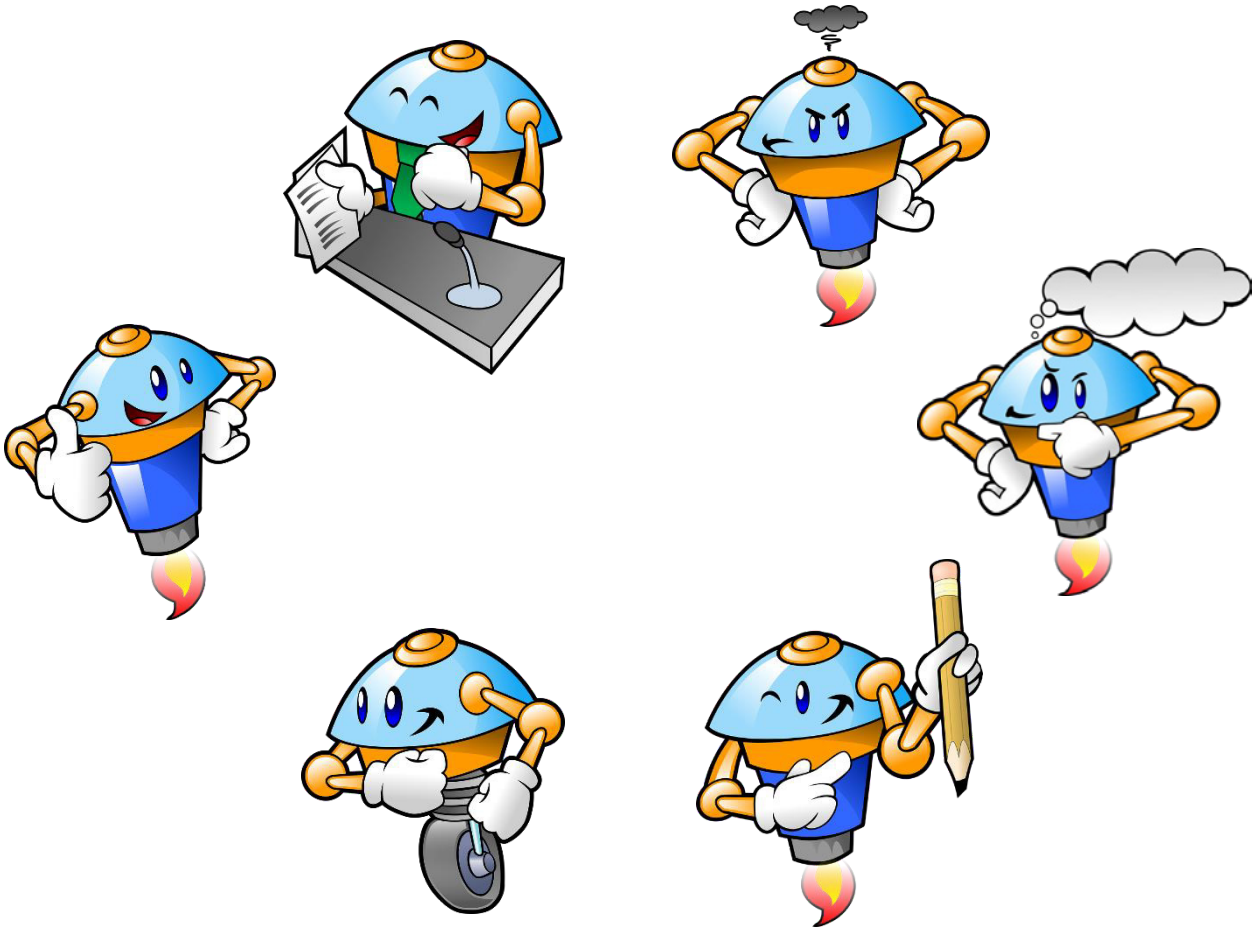
STEM

THE ENGINEERING DESIGN PROCESS:
Engineering design mini-project

The next several sessions will engage students in an age-appropriate engineering design project. This engineering design process has been articulated to help primary students understand different parts of the process. This Engineering Design Project Template can be used as a place for students to plan and log their ideas. An editable version can be found here.



Engineering Design Project



Name:_____

STEP 1: WONDER

What is the problem?

Use words or pictures to draw the problem you are trying to solve.

STEP 2: IMAGINE

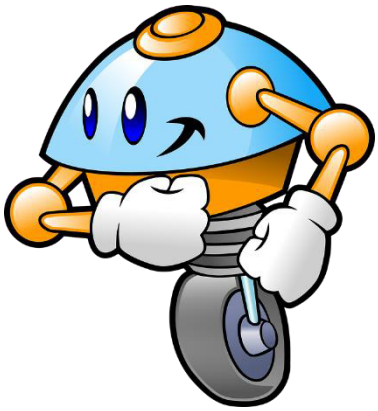
What are some solution ideas?

STEP 3: PLAN a prototype

Draw what your solution looks like. What materials will you use?

STEP 4: CREATE a prototype

Build!



STEP 5: OPTIMIZE your solution

Does your design work? How can you make it better?

STEP 6: Share

Share why your design is great! Who should know about it?

SESSION 1:
Wondering about the problem

Warm-up

Use this slides presentation to reintroduce the problem that Shanelle is facing with her blueberries.

Main activity

Ask students to revisit their blueberry models and identify what the blueberry plants need in order to thrive and produce fruit. Why do they think that Shanelle's plants aren't producing any blueberries? Why are fewer pollinators in the farm a problem?

Career connections:

Introduce students to the career of an engineer. An engineer is someone who uses science, math, technology, and creativity to design a solution to a real problem. In this unit, we are trying to design a solution to Shanelle's problem, because Shanelle's plants aren't producing any blueberries!

Wrap-up

Have students draw the problem on their design templates. Ask students to turn-and-talk with a partner. Why is it even a problem that the plants aren't producing blueberries? What's the cause of the problem? How do we know that? Have students share thoughts with the whole group.

Materials Needed

- Slides presentation
- Engineering design template
- KLEWS chart

SESSION 2:
Imagining the solution

Warm-up

Re-introduce the task that students have at hand by reminding them of the driving question. "We will engineer a tool that will help Shanelle to pollinate her blueberry plants."

Main activity

1. Ask students to think about the different structures that we studied that pollinators have to pollinate plants. Take a look at the KLEWS chart and also have students look at their pollinator research tables from the previous lesson.

2. Have students use their engineering design template to start to think of a tool that they could design that would help Shanelle pollinate her blueberry plants. Which animal or animals inspire them the most? Which structure could they mimic? Ask students to individually sketch their ideas. Multiple ideas are great.

Wrap-up

Have students share their idea with a partner to get feedback. Ask students to specifically share which animal's structure they are mimicking. Circulate the class to see if students are indeed understanding the concept of biomimicry (using inspiration from nature to design a tool).

Materials Needed

Slides presentation

Engineering design template

KLEWS chart

SESSION 3:
Planning the solution

Warm-up

Tell students that in this next part of the engineering design process, we will plan which materials we will use for our tool.

Main activity

1. Have students work in groups of 2-3 to create a plan that uses at least one part of each person's imagined ideas. Ex. if there are 3 people in the group, the plan should have one idea from each team member. Talk to students about the terms **criteria** and **constraints**. Criteria are specifications and requirements for what the device should be able to do. Ask students what our tool should be able to do (pollinate blueberry flowers). How will we know it was successful? **Constraints** are limitations or rules—in this activity, constraints could be the materials that students have to use. Have students work together to draw their solution on a large piece of chart paper. Students can also sketch their drawings in their template packets and then transfer their ideas to the chart paper.
2. Ask students to make note of which animals they took inspiration from. Which structures does their device have that are similar to the structures that an animal pollinator has?
3. Have students create a "materials list" which they will then use to collect materials when they start to build.

Wrap-up

Have each team share their design with another group to get feedback. What is something they were unsure about and could use help with? Ask teams to take turns sharing their ideas and getting feedback. After about 5 minutes, ask teams to switch roles. The Charrette Protocol is one possible way for you to facilitate a session where students ask for and provide feedback to their peers.

Materials Needed

Engineering design template

Chart paper

Markers, crayons, colored pencils

Building materials: pipe cleaners, felt, construction paper, straws, coffee stirrers (plastic), toothpicks, string, pompoms, cotton swabs, aluminum foil, beads, other recyclables

Model of a blueberry flower for thinking/testing

Charrette Protocol

What is it? The Charrette Protocol is used by engineers and other STEM professionals to get meaningful feedback from their colleagues regarding work that is in progress. The point of the Charrette is to use collaboration to optimize a specific piece of work. Each team decides where they need feedback, which gives them control over the feedback process.

Directions to charrette:

1. Ask students to work with their team to identify one area of need in their design that they need help with. Where were you struggling and what could you still use help with?
2. Pair up student teams. Try to be intentional about the pairings (ex. pair teams that have complementary strengths).
3. Actual ProtocoL
    a. 1-2 minutes: One team shares their design plan and presents their problem area where they would like feedback. Then, this team must stop talking (can be very hard for kids, or adults).
    b. (5-10 min) The other team discusses the first team's problem and talks through some potential solutions. The first team is not allowed to talk, they have to listen to the other team discussing their problem.
    c. When the first team feels they have gotten enough out of the conversation to answer their question or to address their problem, they thank the second team for the feedback and end the session.
    d. Teams switch roles and go through protocol again.

Tips and tricks:

- ★ Give students 5 minutes to discuss their project with their own team and come up with a problem that they need help with. This may be hard for students to identify, but every project has something that can be improved.
- ★ Emphasize that the team that is presenting the problem should not be talking while the other team discusses.

SESSION 4:
Creating the tool

Warm-up

Tell students that they are ready to build their tool!

Main activity

1. Give students one session to build their tool. Provide support if students are having trouble working together or building their project.

Wrap-up

Have students "huddle" with their teams and decide if they are satisfied with their design or if there is something they would like to change. In the next session, students will have a change to optimize and to explain how/why their model is effective.

Materials Needed

Engineering design template

Building materials: pipe cleaners, felt, construction paper, straws, coffee stirrers (plastic), toothpicks, string, pompoms, cotton swabs, aluminum foil, beads, other recyclables

SESSIONS 5-6:
Optimize & explain

Teacher set-up: Locate the thimble (small metal cap used to shield fingers during sewing) in the kit. This thimble will represent a blueberry flower. Anything of this size and/or shape should work. Put a couple pinches of white flour into the cap. Cut out the outline of a flower and glue onto a piece of black construction paper. This will serve as a model of the flower receiving the pollen. Students will be able to test and see if their pollinating tool is able to enter the flower, catch some pollen, and transfer to the model flower on black construction paper.

Warm-up

Tell students that today we will be testing to see if their tools work! Ask students: what should each pollinating tool be able to do? How will we know if your tools are effective? Have students share their ideas.

Main activity

Use this general process to test, make modifications based on your students' ideas/input. Before having groups test, use a toothpick and cotton swab and perform a teacher demo to have students distinguish between different amounts of pollen that are being picked up/deposited.

Each group will:

1. Come to the testing station.
2. Insert their tool into the blackberry flower model (the thimble with flour), no swishing around. Just a clean insert.
3. Take out the tool.
4. Hold the tool over the receiving flower (black construction paper) and tap three times.
5. Make observations
6. Optimize design by making necessary changes.

Have students use this data collection sheet to record their test results.

Optimizing: Give students time to make changes to their model if they were not satisfied with the amount of pollen that their tool picked up. Also have students look at the model of the tool that they created on chart paper. This model will serve as a visual when they are presenting their tool to other teams and community members. Give students time to make adjustments/changes to their poster models. Make sure that students have drawn or listed the animals that inspired their design.

Wrap-up

Tell students that we will be sharing our tools with the community. What are some great features of your tool that make it so effective? Have student teams pair up and share their designs. How will their device help Shanelle?

Materials Needed

- Thimble (model of blueberry flower)
- White flour to represent "pollen"
- Black construction paper with a flower
- Measure and Test your Tool Data Collection
- Materials to make improvements

Measure and Test

Construction

How well constructed was our pollinator? Did it stay together after it was used?	It fell apart	Only a small insignificant part fell off	It completely held up
Construction indicator (circle)	Does not pass this test	Good	Superior

Effectiveness

Was our pollinator effective? How much pollen did it carry out of the flower?	None	Only a few grains of pollen	A medium amount	A large amount
indicator (circle)	Does not pass this test	Fair	Good	Superior

What can we do to improve our pollinator design?

_____

_____

_____

Let's improve and retest!

This is an adapted version of worksheet created by Jeri Faber:
https://betterlesson.com/lesson/resource/3141319/vanilla-pollinator-measure-and-test

Image of blueberry by Douglas Schneider

SESSION 7:
Share!

This is a culminating session where you can invite guests to celebrate students' hard work by providing a place where they can share their design solutions. Invite parents, administrators, other teachers, or other classes for a design solution showcase. Students can also showcase for a neighboring class if a larger event is not feasible.

Materials Needed

Student projects

Slides from session 1

Warm-up

Start the session by showing the audience the problem that students were trying to solve. Slides from session 1 can be used to present Shanelle's problem. Share the driving question with the audience. Share the KLEWS chart with guests, showing a visual representation of all the learning that students have done over the span of the unit.

Main activity

Organize a gallery walk style layout where student teams are able to converse with guests about their projects. Make sure students had ample time to practice talking about their tools, how they created their designs, and which animals specifically inspired their model.

Wrap-up

Thank guests for attending and commend students for their excellent work! Student presentations can be videotaped and shared on YouTube or with a local berry farmer to have maximum impact.

How Lesson 5 Supports Next Generation Science Standards

2. Interdependent Relationships in Ecosystems

Performance Expectation	**Connections to Classroom Activity,** *Students:*
2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	• Create a model to help solve Shanelle's problem of not having enough pollinators to pollinate her blueberry plants. • Use research of different animal structures to create a design that mimics a structure found in nature while helping to pollinate crops.
SCIENCE & ENGINEERING PRACTICES	
Asking Questions and Defining Problems Developing and using models Designing Solutions Using Mathematics and computational thinking	• Ask questions about the problem that Shanelle is facing and why exactly it is a problem. • Develop a visual model that incorporates the ideas of all team members to help perform the function of pollinating a blueberry plant. • Design a tool that is able to effectively pick up pollen from one blueberry plant to transfer to another. • Determine if the quantity of pollen being picked up by the tool will be effective in pollinating. • Communicate information about how the tool is effective in solving Shanelle's pollinator problem.
DISCIPLINARY CORE IDEAS	
LS2.A: Interdependent Relationships in Ecosystems ETS1.B Developing Possible Solutions	• Determine why the lack of pollinators is a serious problem for Shanelle in producing blueberries. • Describe how structures and behaviors of pollinators are beneficial for plants. • Develop a possible solution to help a farmer pollinate her crops so that they will fruit.
CROSSCUTTING CONCEPTS	
Structure and Function	• Identify the structures that inspired the design of the tool in addition to how different parts of the tool have a certain structure so that they can perform a specific function. • Create a model to show the structure of the tool and how it aids in pollination.

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

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