PHENOLOGY: SEED STRATEGIES AND INDICATOR SPECIES

Year Round Grades 3-5

Description:
a guide for using your schoolyard year-round to teach third graders about phenology through the study of seeds and indicator species

Duration & Type of Program:
variable length lessons (between 60-90 minutes each) with indoor and outdoor activities

Materials
Seed Strategies

1. Seeds and Indicator Species Journal
2. Samples of plant seeds that students can find in the school yard, including acorns, burrs, white dandelion heads, pine cones, and maple helicopters
3. Models of seeds: plastic Easter egg (acorns), Velcro (burrs), toy parachute (dandelion seed heads), shower head (pine cone), paper plane (maple helicopters)
4. Supplemental Reading: *Flip, Fly, Float* by Joann Early Macken or *Planting the Wild Garden* by Kathryn O. Galbraith

Goals:

- Analyze the strategies that plants use to disperse their seeds.

PRE-LESSON

- Gather materials

PROCEDURE

Part 1: Classroom

1. [inside the classroom] Tell the class that you will be learning about seeds and pass out a selection of seeds to small groups. Ask students if they recognize any of the seeds from the selection.
2. [inside the classroom] Explain that plants produce seeds to create new plants, and that many of those seeds do not produce a mature plant. Plants use different strategies to try to improve the chances that many of their seeds will survive and grow. Consider reading *Flip, Fly, Float* by Joann Early Macken or *Planting the Wild Garden* by Kathryn O. Galbraith. Ask students to look through their seed selection to guess what strategy the tree was planning when it created the seed.
3. [inside the classroom] One at a time, hold up a seed and ask students what strategy they think the tree was trying. After they have shared some of their ideas, compare the seeds to their models [plastic Easter egg (acorns), Velcro (burrs), toy parachute (white dandelion heads), shower head (pine cone), paper plane (maple helicopters)]. Through discussion and prompting, guide students to understand that different designs are used for spreading seeds through the air, protecting seeds, making seeds tasty so that animals will carry them away, and "hitching" a ride on animals' fur.

- design a system for a specific purpose
- construct a hypothesis, and design an experiment to test that hypothesis
- make detailed observations and track trends

Standards:

Science: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (**3-LS4-3 Biological Evolution: Unity and Diversity**)

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. (**3-5-ETS1-2 Engineering Design**)

Analyze and interpret data from maps to describe patterns of Earth's features. (**4-ESS2-2 Earth's Systems**)

Part 2: Outside

4. **[outside]** Take a seed walk. Ask students to look for seeds such as berries, pine cones, and nuts to point out, and to guess what strategy the plant was using to help its seeds survive. "Test" seeds to see if they stick to clothing, drift with the breeze, offer tempting food to animals, or protect themselves with a hard outer shell.

POST-LESSON/ CONCLUSION

[inside the classroom] Back inside, discuss the strategies that you think work best for the plants in your schoolyard. What if your schoolyard were a desert – how would that change the plants' seed strategies? What if there were lots of animals in the schoolyard– how would that change the plants' seed strategies?

Phenology: Engineering a Seed

Year Round Grades 3-5

Description:
a guide for using your schoolyard year-round to teach third graders about phenology through the study of seeds and indicator species

Duration & Type of Program:
variable length lessons (between 60-90 minutes each) with indoor and outdoor activities

Essential Questions:

Materials
Seed Strategies

- Seeds and Indicator Species Journal
- Materials for seed engineering: construction paper, clay, egg cartons, glue, tape, pipe cleaners, etcetera

Goals:

- Analyze the strategies that plants use to disperse their seeds.
- design a system for a specific purpose
- construct a hypothesis, and design an experiment to test that hypothesis
- make detailed observations and track trends

Standards:
Science: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (**3-LS4-3**

Pre-lesson

- Gather materials

Procedure

Part 1: Classroom

1. [inside the classroom] Re-cap the seed strategies that you learned about, including designs for:
    - spreading seeds through the air
    - protecting seeds
    - making seeds tasty so that animals will carry them away
    - "hitching" a ride on animals' fur
2. [inside the classroom] Students design their seeds using the craft materials, focusing on the strategy that will allow their seed to survive

Part 2: Outside

1. **[outside]** Students demonstrate their seed strategies outdoors. Ask others to evaluate what environment each seed strategy would be best suited for.
2. Ask students what amazed them about seed engineering, and what questions they still have.

Post-Lesson/ Conclusion

[inside the classroom] Present some other strange methods for seed survival, including fire-activated seed, seed carried by water, and exploding seed.

Biological Evolution: Unity and Diversity)

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. (**3-5-ETS1-2 Engineering Design**)
Analyze and interpret data from maps to describe patterns of Earth's features. (**4-ESS2-2 Earth's Systems**)

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PHENOLOGY: SEED EXPERIMENTS

Year Round Grades 3-5

PRE-LESSON

- Gather materials

PROCEDURE

Part 1: Classroom

1. [inside the classroom] Ask students to brainstorm a list of things that seeds need to grow. Consider nutritious soil, sunlight, air, and water.

Essential Questions:

Materials

- Seeds
- cups
- sand
- soil
- water
- vinegar
- plant food
- plastic wrap
- tape
- wire flag markers
- Seeds and Indicator Species Journal

Goals:

- Analyze the strategies that plants use to disperse their seeds.
- design a system for a specific purpose
- construct a hypothesis, and design an experiment to test that hypothesis
- make detailed observations and track trends

Standards:

Science: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (**3-LS4-3 Biological Evolution: Unity and Diversity**)

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. (**3-5-ETS1-2 Engineering Design**)

Analyze and interpret data from maps to describe patterns of Earth's features. (**4-ESS2-2 Earth's Systems**)

2. [inside the classroom] Introduce the concept of a hypothesis. If _____, then _____. Ask students to generate their own hypotheses about seed growth.

3. [inside the classroom] Introduce some "if" statements and ask students to complete them with their own "thens." Some "if" statements could be:
    - If the seed receives no sunlight…
    - If the seed is planted in sand…
    - If the seed receives plant food once a week…
    - If the seed is watered with vinegar…
    - If the seed does not receive fresh air…

4. [inside the classroom] Label cups with the different "if" statements, and set up your experimental conditions. With students, make periodic observations to test hypotheses. Discuss over the course of time, as you make new observations.

5. [inside the classroom] Tell students that they will be making their own hypotheses for outdoor seed growing.

Part 2: Outside

[outside] Walk around the schoolyard and brainstorm ideas for outdoor seed growing experiments. Consider planting seeds in the full sun, in the shade, in the forest, in marshy areas, under rocks, etc. Label seed locations with wire flag markers. Periodically return outside to make observations about seed growth.

PHENOLOGY: WATER QUALITY AND INDICATOR SPECIES

Year Round Grades 3-5

Description:
a guide for using your schoolyard year-round to teach third graders about phenology through the study of seeds and indicator species

Duration & Type of Program:
variable length lessons (between 60-90 minutes each) with indoor and outdoor activities

Essential Questions:

Materials

- Seeds and Indicator Species Journal
- *Kids Can Keep Water Clean*
- EarthForce Water Quality Test Kit containing testing materials for:
  - pH (acidity or basicity)
  - coliform screening (bacteria)
  - temperature
  - turbidity (particles)
  - dissolved oxygen
  - biochemical oxygen demand (the amount of dissolved oxygen needed to digest the

PRE-LESSON

- Identify a body of water that is accessible from your schoolyard throughout the year
- assemble materials

PROCEDURE

Part 1: Classroom

1. [inside the classroom] Ask students what an environment is. Why is it important to the animals that live there?

2. [inside the classroom] Explain that environments can change over time, and from different causes. Sometimes environments change naturally, because the Earth is changing. Human activity can change for the environment. Those changes can be immediate, such as when a person throws garbage where it doesn't belong, or they can take place over a long time, such as when human pollution causes the climate to change. Look at some examples of how different environments have changed over time. Show images from NASA's Images of Change app to the whole class or, if you have access to multiple iPads, divide the class into small groups to examine the images.

    - organic matter in the water)
    - nitrates and phosphates (chemicals that may be harmful to plant and animal life when found in large quantity).
- pH Test Materials: cups or test tubes, pH test chemical from Water Quality Test Kit, sample solutions (vinegar, lemon juice, seltzer, baking soda, and detergent)
- Safety gear: safety goggles, gloves, aprons

Goals:

- Analyze the strategies that plants use to disperse their seeds.
- design a system for a specific purpose
- construct a hypothesis, and design an experiment to test that hypothesis
- make detailed observations and track trends

Standards:

Science: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (**3-LS4-3 Biological Evolution: Unity and Diversity**)

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. (**3-5-ETS1-2 Engineering Design**)

Analyze and interpret data from maps to describe patterns of Earth's features. (**4-ESS2-2 Earth's Systems**)

3. [inside the classroom] Ask students to explain the changes in the environments they can see in the app. How might these changes affect the plants and animals that live there?

4. [inside the classroom] Introduce the concept of indicator species, which are species that scientists study in order to understand how changes in the environment are affecting living organisms. Scientists gather information about the environment, and then they observe how the indicator species are doing, and how many of them there are.

5. [inside the classroom] Explain that you are going to be researching some indicator species that live in water. As the creatures' environment, the water, changes, we want to understand how the creatures are affected. To do this, you need to be able to understand the ways that the water is changing, so we will be doing water quality testing.

6. [inside the classroom] Introduce the water quality test kit and safety gear. Explain that scientists do many tests to assess the quality of water. One of them is pH, which measures whether a substance is acidic or basic. Show your five test substances (vinegar, lemon juice, seltzer, baking soda, and detergent). Demonstrate, using the water quality test kit, how to do a pH test of each. Have students sort the resulting colors and interpret the order of the substances, from the strongest acid (1) to the strongest base (14).

Part 2: Outside

7. **[outdoors]** Divide students into small groups, and assign each group to carry their hula hoop and water sample collector. You will walk to the edge of the water and take a water sample. Then, you will place the hula hoop on the surface of the water and make observations of the species you see. Count them. Have students take pictures, if possible.

Part 3: Inside

8. [inside the classroom] Wearing safety gear, conduct pH test and record indicator species observations. Test water pH by collecting sample amount and adding the specified amount of test chemical. Compare the color of the test sample with the color chart to determine pH.
9. Repeat steps 7 and 8 throughout the year, as regularly as possible. You can teach the procedures for other aspects of water quality (dissolved oxygen, etc.) periodically throughout the year so that you can add as much water

quality data to your analysis as you would like. Consider reading *Kids Can Keep Water Clean* to supplement your learning.

Links and Resources:

Resources:
Fire-activated Seed

Ingenious Ways Plants Disperse Their Seeds

Flip, Fly, Float by Joann Early Macken

Planting the Wild Garden by Kathryn O. Galbraith

Junior Scientist: Experiment with Seeds by Susan Heinrichs Gray

Testing Water pH

Kids Can Keep Water Clean by Cecilia Minden

NASA's Images of Change app

Seeds and Indicator Species Journal