

2018 Investigation Teacher Instruction Sheet

INVESTIGATION TITLE: Herbaceous Plant Structure: The Same or Not the Same... You Decide.

Inquiry Scale

Confirmation	Structured	Guided	Open				

Investigation Designer: Kate Narita

Grade level: 4

Time Required: three, 45-minute class periods plus one post-assessment day at the end of the unit.

- Day 1: engagement activities (pre-assessment, vascular/nonvascular plant sort and class discussion).
- Day 2: begin investigation (review protocol, collect data, analyze and interpret data).
- Day 3: finish investigation (construct explanations, draw conclusions, present findings).
- Day 4: Post-assessment (draw a model of two herbaceous plants).

Unit Context: This investigation is part of a larger unit called Plant and Animal Structures at Center School, an effort to understand the various structures of woody and herbaceous plants at Center School and how diversifying the plant structures in our butterfly garden will attract a variety of other pollinators such as bees, wasps, flies and ants.

Sequence and Lesson Title	Investigation or Activity Description
1. Woody Plant Structure: The Same or Not the Same... You Decide	Students will learn about woody plant structure and identify some of the woody plants that are growing in the woods behind The Center School.
2. Herbaceous Plant Structure: The Same or Not the Same... You Decide	Students will learn about herbaceous plant structure, identify some of the herbaceous plants that are growing in the woods behind The Center School and note any pollinators present on their plants.
3. Pollinators and Plants, Perfect Partners	Students will increase their knowledge of herbaceous and woody plant structure, identify some of the plants growing in The Center School pollinator garden, understand that different types of plant structures attract different pollinators and that insects and plants have coevolved over time to attract one another. Students will complete a design challenge: can you draw a plant that will attract a new pollinator to our butterfly garden?
4. Pollinator Paradise	Students will use data from the other three lessons to help them choose a variety of plants to put in our existing butterfly gardens as well as in other areas of the school to attract a variety of other pollinators such as bees, wasps, flies and ants.

Investigation Focus: Students will learn about various herbaceous plant structures, identify some of the herbaceous plants that are growing in the woods behind Center School and note any pollinators present on their plants.

State Learning Standards:

- **MA Science and Technology/Engineering Standards: 4-LS1-1.** Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior and reproduction. Clarification statements: Animal structures can include legs, wings, fins, feathers, trunks, claws, horns, antennae, eyes, ears, nose, heart, stomach, lungs, brain and skin. Plant structures can include leaves, roots, stems, branches, flowers, fruits and seeds. State assessment will be limited to macroscopic structures.
- **MA Digital Literacy and Computer Science Standards: 3-5.CT.c.2** Collect and manipulate data to answer a question using a variety of computing methods (e.g., sorting, totaling, averaging) and tools (such as a spreadsheet) to collect, organize, graph, and analyze data

Learning Outcomes:

- Students will use observation to collect and record qualitative and quantitative data.
- Students will compare and contrast woody plant structure to herbaceous plant structure.
- Students will compare and contrast two herbaceous plant structures and observe how different plant structures attract different insects.
- Students will identify two herbaceous plants growing in the woods behind The Center School
- Students will draw and label a herbaceous plant

Materials List:

- Science notebooks
- Writing implements
- Clipboards
- Colored pencils
- Magnifying glasses
- Document camera
- Chromebooks with Plantnet and inaturalist apps
- Measuring tapes
- Craft gloves
- Attached student instruction sheets
- Timer for teacher
 - ❖ Structured-level Instruction Sheet
 - ❖ Guided-level Instruction Sheet

Advanced Preparation:

- Submit permission slip to nurse and administration in August before school starts. Send home permission slip on the first day of school.
- Explore woods behind school ahead of time to get a sense of herbaceous plants growing in the wooded area.
- Ask for parent volunteers to accompany us in the woods.
- Teacher will take photos of plant specimens from home as well.

Introduction/Background Information

Plants differ in various ways. One way in which plants differ is that they are either woody or herbaceous. Woody plants have a stem made out of lignin a “solid, rigid structure that prevents damage” all year-round no matter the temperature. Herbaceous plants have a stem made out of cellulose which is strong, but not nearly as rigid as lignin, and crushes easily.

But not all herbaceous plants are the same. There are forbs, otherwise known as herbs, which are vascular (has xylem for transporting water and minerals) plants that don’t have significant woody tissue above or at the ground and have buds below the ground surface. An example of a forb is a fern. Use the pneumonic device that both words have four letters and start with an “f” to remember that a fern is an example of a forb. Graminoid is another type of herbaceous plant. These are also vascular and are grasses or grass like and include, grasses, sedges and rushes. Use the pneumonic device that graminoid and grass both start with the same three letters. There are nonvascular plants (do not have a xylem) such as mosses, hornworts and liverworts. Use the pneumonic device that nonvascular has an “o” as opposed to vascular which lacks an “o” and that “moss,” “hornwort,” and “liverwort” all have the letter “o.”

Then of course there are herbaceous plants with flowers. But flowers differ because they are pollinated in different ways. “Pollination is the crucial event in a plant’s life because it is essential for production of seed and future generations of a species (Holm 2).” We know from Professor Gegear’s presentation that, “plants select traits for specific pollinators.” These structural traits vary widely depending on the pollinator the plant is trying to attract. “Plants lure pollinators to visit their flowers by offering rewards including pollen, nectar, resin and oil (Holm 4).” Plants use the following structural traits to attract pollinators:

- Color
- Contrasting Colors
- Symmetrical or asymmetrical
- Landing pads presence or absence
- Odor pleasant or unpleasant
- Size

- Corolla (all the petals of a flower) width and depth
- Location of nectaries
- Presentation of pollen
- Morphology
 - Composite-open flower like a daisy or an aster
 - Umbelliferous-numerous, small shallow flowers like Queen Anne's lace-flies, short-tongued bees, sweat bees
 - Tubular-prairie phlox-long tongued insects
 - Bilabiate-great blue lobelia-long tongued insects
 - Nodding-harebell/bluebell-small bees
 - Complex-columbine reached by long-tongued bumblebees

Engaging Experience: Students will complete the vascular/nonvascular plant sort found at this link: <https://www.teacherspayteachers.com/Product/Vascular-and-Nonvascular-Plant-Sort-3636712>

Although this resource costs \$1.50, it is well worth the money because it has student friendly pictures and definitions as well as an answer key.

Guiding Question(s): Does a herbaceous plant's structure differ from a woody plant's structure? Do all herbaceous plants have the same structure? Why or why not?

Investigation:

Day One: Pre-assessment and Engagement Activities

- Draw and label a model of an herbaceous plant on a loose piece of paper. Have students write names on models and collect the models so that they can be photocopied.
- Complete vascular/nonvascular plant sort.
- Whole group discussion about which herbaceous plants we'll find in the woods behind Center School. Teacher will create a chart with the various categories: flowering herbaceous plant, forb, graminoid and nonvascular.

Day Two: Begin Investigation

- Review behavioral expectations for being in the woods
- Complete the collect and analyze data sections in the structured or guided student forms.

Day Three: Finish Investigation

- Students will construct explanations and draw conclusions.
- Share explanations and conclusions with another set of partners.
- Partners will present findings to class.

Day Four: Assessment

- Students will draw and label models of two different types of herbaceous plants.

Vocabulary: Definitions from various sources such as *Pollinators of Native Plants*, <https://web.wpi.edu/Images/CMS/PIEE/3d1.pdf> and https://plants.usda.gov/growth_habits_def.html

- Structure- the arrangement of various plant parts.
- Leaf- a usually flat, green, plant structure used in photosynthesis and transpiration (breathing).
- Root- a plant structure that provides stability to a plant, collects water and nutrients from the soil, and is usually found below the ground.
- Stem- a long part of a plant that connect various structures (leaves, flowers, roots) to each other and functions in the transport of water and nutrients
- Vascular-Has a system of tubes to move water and nutrients.
- Nonvascular- Does not have a system of tubes to move water and nutrients.
- Forb- Vascular plant without significant woody tissue above or at the ground. Forbs and herbs may be annual, biennial, or perennial but always lack significant thickening by secondary woody growth and have perennating buds borne at or below the ground surface. Ferns, horsetails, lycopods, and whisk-ferns are included.
- Graminoid- Grass or grass-like plant.
- Herbaceous- an annual, biennial or perennial plant with leaves and a stem that die back every year when the weather gets cold.
- Composite- open flower like a daisy or an aster
- Raceme-stalked flowers attached to a central stem forming an elongated cluster
- Complex-a flower with various racemes
- Umbelliferous- numerous, small shallow flowers like Queen Anne’s lace-flies, short-tongued bees, sweat bees
- Cellulose-a substance found in plant cells that is strong, but not woody and rigid.
- Lignin-a chemical compound found in plant cells making them woody and rigid.

Assessment:

Pre-Assessment: Students will draw and label a model of an herbaceous plant.

Embedded Activity Assessment: Student created data charts in notebooks observed while floating through the classroom and classroom chart and discussion about plants’ similarities and differences.

Post-Assessment: Students’ will draw and label a model of two different herbaceous plants and answer the guiding questions in their notebooks.

Resources for Educators:

Holm, Heather. *Pollinators of Native Plants: Attract, Observe and Identify Pollinators and Beneficial Insects with Native Plants*. Pollination Press. Minnesota; 2014.

Leopold, Donald J. *Native Plants of the Northeast: A Guide for Gardening and Conservation*. Timber Press, Portland. 2005.

Rice, Graham. *Encyclopedia of Perennials*. Dorling, Kindersley. London: 2006.

Teachers Pay Teachers:

<https://www.teacherspayteachers.com/Product/Vascular-and-Nonvascular-Plant-Sort-3636712>

Resources for Students:

Aston, Diana Hutts. *A Seed Is Sleepy*. Chronicle Books, San Francisco. 2007.

Bersani, Shennen. *Achoo! Why Pollen Counts*. Arbordale Publishing, Mount Pleasant. 2015.

Castaldo, Nancy. *The Story of Seeds: From Mendel's Garden to Your Plate, and How There's More of Less to Eat around the World*. Houghton Mifflin Harcourt, New York. 2016.

Glaser, Karina Yan. *The Vanderbeekers and the Hidden Garden*. Houghton Mifflin Harcourt, New York. 2018.

Gray, Rita. *Flowers Are Calling*. Houghton Mifflin Harcourt, New York. 2015.

Hirsch, Rebecca E. *Plants Can't Sit Still*. Millbrook Press. 2016.

Sanchez, Anita. *Karl, Get Out of the Garden!: Carolus Linnaeus and the Naming of Everything*. Charlesbridge, Watertown. 2017.

Stewart, Melissa. *A Seed Is the Start*. National Geographic Children's Books. 2018.

Wrap Up:

Discuss as a class:

1. Does a herbaceous plant's structure differ from a woody plant's structure?
2. Do all herbaceous plants have the same structure? Why or why not?
3. What are the various types of herbaceous plant structures?

Following the discussion students will be asked to write the answers that the group creates in their notebook. This will help address any gaps that they may still have had when they answered the guiding questions with their partner.

Connection: This lesson connects to day two, three, four and five of our class. It connects to day two at Tower Hill because we talked about plant structure and identified herbaceous plants on the grounds. In addition, the lesson connects to day three at Wachusett Meadow because we studied the structure of milkweed. The lesson also connects to day four at Tower Hill because we looked at native vs. cultivated plants and how the native plants attract bumblebees while the cultivated plants do not (with the exception of *Bombus impatiens*). We also learned how different flower structures appeal to different bee species. It connects with day five because we observed other native bee species on different native flowers on composite flowers at Broad Meadow Brook. In conclusion, most of the days of the institute we spent part of the day learning about plant structure and becoming aware of the different types of plants around us.