

Seasonal Leaf Change/Difference Inquiry Learning Activity

Purpose

- To increase student awareness of changes/differences in/among leaves other than those used in the plant phenology protocols (color and size)
- To provide students with an opportunity to conduct an inquiry using leaves in their local environment

Overview

Students will observe leaves looking for changes/differences that might be associated with particular seasons or environmental conditions and then make inferences and ask questions about possible causes for leaf changes/differences. They will also work in groups to develop testable/researchable questions for an inquiry based on their observations.

Student Outcomes

Students will work as a class or in small groups to ask and answer questions about changes, differences and/or damage that happen to leaves in their local environment. Students will share the results of their inquiries with the class.

Essential Question

How and why do leaves change or get damaged?

Science Concepts:

- Changes/differences observed in leaves can be the result of a variety of factors including weather, disease, insect damage, nutrient deficiency, lack of or too much soil moisture, etc.
- Leaf changes/differences can also be associated with particular seasons.(that may or not be linked to disturbance such as drought, floods, hail. insect
- Changes can be both temporal and/or spatial (leaf, branch, landscape, regional).

Inquiry Abilities

- Observe
- Infer relationships between observed phenomenon and influences on their observations
- Ask questions, identify testable research questions versus information questions
- Conduct investigation
- Measure
- Collect data
- Use appropriate methods to describe, summarize and analyze data
- Consider and examine alternative explanations
- Communicate methods, results and predictions

Time

Three to twenty class periods depending on inquiry level

Level

Beginning, Intermediate, Advanced

Materials and Tools

- Hand lenses (2 per group)
- Rulers (1 per group)
- Lighted microscopes (small, portable and hand held)
- Cm grid sheets (1 per group) (cm grid on overhead transparency)
- Large clear packing tape (1 per group)
- Access to leaves that display some change or damage
- Materials needed for inquiries (may vary according to question students choose)

Preparation

Collect changed/damaged leaves and bring them into the classroom for students (optional)

Prerequisites

None

Background

This activity is designed to accompany or follow data collection with the Green-Down Protocol where change in leaf color is used to indicate change in season and date of color change is used to indicate the end of the plant growing season. However, this learning activity can be done any time of year (using laminated leaves if fresh leaves are unavailable) to provide an opportunity for students to conduct an inquiry. Leaf change, leaf difference or leaf damage may result from a variety of other factors such as extreme weather conditions, disease, insect damage, nutrient deficiency, drought, flooded soils, ozone damage, salt damage, etc.

A Few Words About Science Inquiry

Student inquiry is defined in the *National Science Education Standards* (1995) as “the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.”

The *Standards* define the *necessary abilities* for students to conduct scientific inquiry. These are the ability to “identify questions and concepts that guide scientific investigations, design and conduct scientific investigations, use technology and mathematics to improve investigations and communications, formulate and revise scientific explanations using logic and evidence, recognize and analyze alternative explanations and models, and communicate and defend a scientific argument”.

According to Wenning (2004), inquiry labs/activities:

- are driven by questions requiring ongoing intellectual engagement using higher-order thinking skills making for independent thought and action.
- focus students’ activities on collecting and interpreting data to discover new concepts, principles, or empirical relationships thereby moving from concrete toward abstract.
- require students to create their own controlled experimental designs; require students to independently identify, distinguish, and control pertinent independent and dependent variables; promote student understanding of the skills and nature of scientific inquiry.
- commonly allow for students to learn from their mistakes and missteps; provide time and

opportunity for students to make and recover from mistakes.

- employ procedures that are much more consistent with authentic scientific practice; show the work of science to be recursive and self-correcting.

Colburn (2000) identifies three levels of inquiry:

- **Structured inquiry**— The teacher provides students with a hands-on problem to investigate, as well as the procedures, and materials, but does not inform them of expected outcomes. Students are to discover relationships between variables or otherwise generalize from data collected.
- **Guided inquiry**— The teacher provides only the materials and problem to investigate. Students devise their own procedure to solve the problem
- **Open inquiry**— This approach is similar to guided inquiry, with the addition that students also formulate their own problem to investigate. Teacher provides support only when needed.

What To Do and How To Do It

Gear up

- Read students a story where a leaf plays a prominent role (See References following for suggestions)
- Ask students to get in small groups, brainstorm together and list their ideas about what kinds of leaf change/difference/damage they have seen at their GLOBE site or might expect to find when they go outside
- Go over worksheet together to be sure everyone understands
 1. Observations can be qualitative (use four senses) or quantitative (use tools for measurement) Ask students why it may be important to note the environmental conditions where they will be collecting their changed/damaged leaves
 2. Observations can be done outside and continued inside the classroom
 3. Inference—What are students' ideas about why the leaf looks the way it does – possible causes. Students should be able to provide their evidence for their inference.
 4. Question- Students should come up with at least one question during their investigation

Explore

- Note: It is important to provide time for students to explore in a less structured environment in order to give them a good foundation to generate questions appropriate for an inquiry
- Take /Send students outside. Have each group collect three leaves that have evidence of change or damage OR collect leaves yourself and bring them in for students to observe or examine
- Challenge students to try to find leaves that appear to have changed or been damaged in three different ways
- Back inside, have each group pool their leaves and collaboratively fill in the chart on leaf differences/changes

Generalize

- Ask each group to share an important observation, inference and a question they have based on their observations.
- Record the questions on paper or the board for everyone to see
- Classify the questions as a testable research question (Can you answer your question by conducting an experiment?) or as an information question (Can you answer your question by asking experts, reading books and/or searching reliable sources on the Internet? Information questions usually start with “why” “how”, or “what” while research questions usually begin with “do”, “are”, or “is”. Kelsey and Steel, 2001 further state that an information question is designed to gather a broad spectrum of information on a topic, for example “Why is it colder in the North?” versus a research question, “Is the air temperature colder or warmer than the ground under a wet leaf?)

Note: As students are sharing, to support their learning, ask open-ended questions such as

- How can you tell the difference between an inference and an observation?
 - How can you get the answer to the question you are asking?
 - What do you think needs to be done?
- Draw a concept circle on the board or chart with “Leaves” in the center
 1. Draw spokes around the outside of the circle and have students supply the kinds of change or damage they observed
 2. Next, draw a line from each observed change and ask students for possible (inferred) cause(s).
 3. Question students to elicit any missing variables that might need to be considered even though they were not observed (Did anyone notice the condition of the soil/ground- very dry, moist wet, with standing water?; Did you see any insects- what stage- eggs, caterpillars? Were the leaves collected in the shade, on the ground or from a tree/plant? Do the changed leaves that were collected, represent the whole tree/plant?)
 4. Next go around the spokes and ask how students might set up an inquiry related to each variable.
 - Discuss what GLOBE protocols might be used to address the questions or quantify variables
 - Call students attention to the list of questions they generated.
 - In their small groups have students select one of the listed questions, modify one, or write a completely different one or select a variable on the wheel.

Note: if this is the first time your students are doing an inquiry, you might consider having the whole class investigate one question

- Inquiry questions can be answered by any or all of the following procedures:
 - Conduct hands-on investigation
 - Conduct research using journals, books or the Internet
 - Consult experts

Investigation/Inquiry

Have students work in groups or individually to:

- Refine their testable or researchable question
- Develop the procedure through which they will gather data
- Check other sources for what is already known
- Collect data
- Analyze their data to determine results (what does the data say) by determining some basic statistical parameters, e.g. mean, standard deviation
- Summarize data through tables and graphs
- Interpret the data to determine implications (what does the data suggest, what might it mean)
- Prepare and give presentation to communicate findings

Extensions

NA

Adaptations

- The inquiry process allows for adaptations to all different kinds of learners.
- Beginning inquirers can work together and investigate a question as a class under the teacher's supervision

Student Assessment

- Inquiry - rubric following
- Journal entry – rubric following
 - What are your ideas about what causes leaves to change or be damaged? Give examples from your observations.
 - Give examples of how leaf change can be temporal and spatial. Give examples from your observations

References

Colburn, A. 2000. An Inquiry Primer. ScienceScope, March 2000, 42-44

Kelsey, K. and Steel A. 2001. *The Truth About Science : A Curriculum for Developing Young Scientists*. National Science Teachers Association. NSTA Press

NRC (1995). *National Science Education Standards*. National Research Council. Washington, DC:

NRC (2000). *Inquiry and the National Science Education Standards*. National Research Council. Washington, DC: National Academy Press.

Wenning, C.J. 2004. *Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes*. www.phy.ilstu.edu/pte/311content/inquiry/levels_of_inquiry.pdf

Some books for *Gear Up* introduction:

Buscaglia, L. 1982. *The Fall of Freddie the Leaf*. SLACK Inc, Thorofare, NJ.

Ehlert, L. 2005. *Leaf Man*. Harcourt Trade Publishers, NY.

Fletcher, R. 19997. *Ordinary Things: Poems from a Walk in the Early Spring*. Atheneum Books for Young Readers, Simon and Schuster, NY.

Following are a few sample of websites for further information about leaf changes/damage in Alaska and other areas. There should be similar sites for your area.

Birch leaf rollers

<http://ublib.buffalo.edu/libraries/e-resources/ebooks/records/efc8636.htm>

Remote Sensing Aspen Leaf Miner Infestations

<http://nrm.salrm.uaf.edu/~dverbyla/gradstudents/doug.html>

Alaska Forest Highlights

www.fs.fed.us/r10/spf/fhp/condrpt06/2006_AK_foresthealth_highlights.pdf

Birch Leaf Miners

http://whatcom.wsu.edu/ag/homehort/pest/birch_leaf_miner.htm

Forest Health Protection, <http://www.fs.fed.us/r10/spf/fhp/>

Forest Health Highlights <http://www.fs.fed.us/r6/nr/fid/health/2002highlights-ak.shtml>

<http://www.extension.umn.edu/yardandgarden/diagnostics/index.html>

Wong, Melvin. 2005. Visual Symptoms of Plant Nutrient Deficiencies in Nursery and Landscape Plants, SCM-10, University of Hawaii, College of Tropical Agriculture and Human Resources.

<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-10.pdf>

Identifying Nutrient Deficiency

<http://gardening.about.com/od/gardenproblems/a/NutrientDeficie.htm>

Symptoms of Deficiency in Essential Minerals

<http://4e.plantphys.net/article.php?ch=t&id=289>

Salt damage in urban areas

<http://www.lakesuperiorstreams.org/understanding/media/MNExtJan2005SaltDamage.pdf>

Effects of Ozone pollution on plants

<http://www.ars.usda.gov/Main/docs.htm?docid=12462>

Leaf Curling

<http://www.hort.cornell.edu/departments/faculty/pritts/BerryDoc/raspberry/leavesstems/Raspcurling.htm>

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SAMPLE SCIENTIFIC INQUIRY SCORING RUBRIC

Criteria	Developing	Proficient	Exemplary
Developing Questions	Unable to develop testable or researchable question	Develops questions that are testable or researchable with a little help	Uses observations and scientific knowledge independently to develop testable and researchable questions
Designing Investigations	Unable to develop a plan for a simple investigation to answer the question	Develops a plan for a simple investigation to answer the question with some assistance	Independently plans a simple investigation to answer the question that includes orderly, safe and workable procedures
Conducting Investigations	Requires considerable assistance to conduct simple investigation Data gathering is inconsistent, inaccurate or incomplete	Conducts investigations with some assistance Data appear to be mostly accurate and complete	Conducts investigations with little or no assistance Data appear to be accurate and complete
Analyzing and Interpreting Data	Analysis and interpretation are not supported by the data	Analysis and interpretation of data are supported by the data	Analysis and interpretation of data are supported by the data collected. New insights are provided
Communicating	Unable to clearly communicate explanation of the investigation. Findings were unclear.	Clearly communicates explanation of the investigation. Findings are mostly clear	Clearly communicates explanation of investigation in a variety of ways (written, spoken, drawn, PowerPoint, etc.). Findings are clear

JOURNAL ENTRY RUBRIC

Criteria	Developing	Proficient	Exemplary
Reasons for change	Did not clearly explain several reasonable reasons for leaf change	Clearly explains several reasonable reasons for leaf change with some supporting evidence	Clearly explains several reasonable reasons for leaf change and gives good supporting evidence
Change can spatial and temporal	Did not clearly explain how change can be spatial and temporal and/or did not give one example	Clearly explains how change can be spatial and temporal with one example	Clearly explains how change can be spatial and temporal with several examples

Leaf Differences/Changes Worksheet

Leaf No.	Observations (Use four senses and measurement)	Inferences (Why do you suppose..? What do you think caused the thing you are observing)	Predictions (What will happen if one of the variables changes or is changed?)	Questions that come up during the Investigation