

A CHANGE INCREASING STUDENT



The ability to accurately observe and notice small details is a skill important to scientists. To help students develop this skill, have them record and share observations, successively focusing in on smaller, more precise details. When students observe changes in the seasons, they can extend their science knowledge by carefully noting changes in color, shape, and patterns in vegetation, asking questions, and making predictions. Soon after the school year starts, have your students brainstorm questions or do a KWL (what I Know, what I Want to know, what I Learned) about the changes that they will observe in the seasons. A question to get started is: “What changes do you expect to see outside as the seasons change?” Then while pointing to a tree

ask, “What will happen to that tree in the fall when the weather gets cold?” or “How will that tree look different as the weather gets cold?” After students have discussed what they know, ask them to think of questions that they would like answered. Some student questions are: “Why do leaves change color?” “How are leaves different?” and “Does a tree change color all at once?”

To start making predictions, choose a tree or shrub outside the classroom window and ask the students what predictions they could make about how the plant will change this fall. There are many predictions that can be made, from what color the plant will become to when it will change.

Donna R. Sterling (dsterlin@gmu.edu) is a professor of science education at George Mason University in Fairfax, Virginia.

IN SEASONS

OBSERVATION SKILLS by Donna R. Sterling



When choosing what to make predictions about consider how the correct answer will be assessed. For example, predictions about what color a tree will become are simple to make, but difficult to assess. To provide structure for choosing a color, obtain a color chart from a paint store (the more colors the better) and have students select a shade of color from the chart. As the leaves start to change, bring in a daily sample and follow the progression of colors.

Making observations and extending predictions

To increase students' knowledge of changes in nature due to the seasons, have each student select a particular tree or shrub on school grounds to observe at five different times

during the school year (Figure 2). They can also make additional observations on their own as often as they like. During the first outdoor visit students will select a tree or shrub, make observations about the plant, sketch a picture of the plant, note the location of the plant so they can find it again, and collect two sample leaves to bring to the classroom for further investigations. Before proceeding outside we have a brief class discussion about safety for themselves and safety for the environment. We discuss poison ivy, which is found in our area, and students are shown a picture. The shape and arrangement of the three leaves are pointed out. Not touching poison ivy and the necessity of washing your hands and any part of the body that touches the plant are discussed. We also discuss why, for the health

FIGURE 1

National Science Education Standards

These activities address the following standards for grades 5–8:

- Unifying concepts and processes
- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Form and function

Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical science

- Properties and changes of properties in matter

Life science

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

of a plant, no leaves can be taken from plants with less than 10 leaves and why they should select a plant for this investigation so they can collect leaves. Of course, no tree climbing is allowed.

While outside, in addition to making observations about their plants, have students predict in their lab notebooks how the plant will look as the weather changes from summer to fall to winter. The importance of dating observations and predictions should be stressed.

When back in the classroom, ask students to predict color changes in their leaves. Then ask students in small groups to brainstorm the cause of these color changes, and from where these colors come. After having the groups share their ideas, suggest that they may want to look more

closely at what colors are in the leaf already. Tell them that there is a simple lab procedure called paper chromatography to separate chemicals. Give the class 15–20 minutes to research paper chromatography to find out what it is and how to conduct it. They can use resources such as their books, online encyclopedias, and the internet. There are many commercial websites with explanations and pictures available. Each group is to draw a picture of a chromatography apparatus they could set up and use in class. The groups share their pictures and determine a procedure.

Paper chromatography is a great way to separate the color pigments in plants and this information can then be used in predicting what color a plant will change in the fall. By grinding a small part of leaf against one end of a piece of chromatography paper or strip of coffee filter, students can deposit some of the color pigments on the paper. The strip is then suspended from a pencil into a container so that the end with the pigment barely touches the surface of a small amount of rubbing (isopropyl) alcohol. Water can be used too, but alcohol works best for separating most plant pigments. Of course, students should wear goggles.

To prepare the strip of paper, cut a piece of chromatography paper or coffee filter to 3 × 15 cm. About 2 cm from one end of the paper, deposit the color pigment in an area about 1 cm in diameter. Only one leaf is needed to collect pigment. To transfer the pigment from the leaf to the paper, place the leaf over the end of the strip of paper and firmly rub your fingernail or the edge of a spoon over the leaf, pressing the pigment onto the paper within the 1 cm circle. Move the leaf around, successively pressing the pigment on to the same spot. When the circle on the paper is green you have transferred enough pigment.

The container used to run the chromatograph is the size of a small drinking glass. To this container, add alcohol to about 2 cm in depth. Suspend the strip of paper in the glass with the pigment end of the chromatography paper barely in the alcohol, and without the pigment touching the alcohol.

FIGURE 2

Outdoor observation schedule

Visit	Time	Tasks	Focus
1	Early in school year	Select tree or shrub to study. Draw picture of plant and make observations. Make predictions about seasonal changes. Collect leaf samples.	Baseline data
2	Fall, during change	Draw picture of plant and make observations.	Color change
3	Fall, during change	Draw picture of plant and make observations.	Color change
4	Winter	Draw picture of plant and make observations.	Branch structure
5	Spring	Draw picture of plant and make observations.	Budding

Fold the other end of the paper over the pencil and attach using a paper clip. Adjust the length of the paper so that the pencil can rest across the top of the container with the pigment end of the paper hanging straight down and barely touching the alcohol. As the alcohol is absorbed and moves up the paper, it will pass through the pigment moving the different pigment molecules along at varying speeds depend-

ing on the size of the molecules and their adhesion to the paper. Watch the colors moving up the paper and separating. When the alcohol gets to the pencil or when the colors are no longer separating, remove the paper from the alcohol and allow it to dry. The separation takes about ten minutes.

After students have separated the pigments of a leaf from their plant, they predict again what color their plant

FIGURE 3 Exploring colors in nature

Paint mixing	Using the three primary colors red, blue, and yellow, students can mix paint to match the colors of the leaves they have collected. The idea is for the students to learn about mixing colors and at the same time to become aware of different shades of color in nature. For example, students mix paint to create different shades of green and not just one shade of green for all green leaves. After creating the shade of green for the leaf from their plant, students trace the shape of the leaf and then paint the leaf with the color they have mixed. To the paper with the leaves they have painted, the students attach a real leaf. To make storage easier, press the leaf between newspapers weighted down with books.
Paint chart/key	From the local paint store, collect a variety of green paint samples and any colors the leaves tend to change to in the fall in your area. Students can match leaves to these samples before and after they change.
Magazine colors	A variation of the above activity is for students to tear out swatches of color from magazines that closely approximate the colors of the leaves they have collected. In this case they do not usually fill in the whole leaf that they have traced unless they have enough of a good color match.
Nature color key	Students investigate the colors in leaves by rubbing them on a white piece of paper or cloth. This can be done with green and colored leaves or flowers. Because many students are familiar with grass stains on clothes, they will usually try grasses and weeds that tend to work well, especially dandelion leaves. Students can make their own color key with plant samples and the stains they get from rubbing.
Pigment drawing	To extend the above activity and as long as there is significant variation in colors in the vegetation in your area, the students can use plants to actually draw/rub a picture. They can use the color key they made in the activity above as a reference for choosing the colors they want.

FIGURE 4 Recording data to explore patterns

Leaf mobiles	After collecting and pressing a leaf from the same tree every week, the leaves can be hung consecutively by date with each leaf on a successively longer string to form a mobile. This helps students observe change over time. Laminate the leaves or press them between wax paper to increase durability. For a more natural effect, hang the leaves on a branch.
Tree strip charts	Create a strip chart by cutting printer paper in half lengthwise and folding the paper like a fan every 7 cm. On the first panel write the title of the chart. Each successive panel represents one week and is labeled with the date. Each week students are to sketch a picture of the tree they are observing. As time passes the tree will progress from green and full of leaves to branches with no leaves. Attach additional strips of paper as necessary. By having students choose different trees and comparing their charts, they will recognize that there is a great variation, but consistency among the patterns that trees follow.
Leaf growth	Leaves on the same tree are similar, though some may be larger or smaller than others. After having students find the smallest and largest leaf from the same tree, they are to enlarge the smallest leaf to be the same size as the largest leaf, either by using an opaque projector or graph paper. Then they are to compare the leaves to see if the small leaf is just a miniature version of the big leaf or if they are different.

FIGURE 5

Exploring size, shape, and structure

Leaf prints	By dipping leaves in paint and pressing them on a piece of paper, students can make creative prints of leaves. Students can make pictures with leaves all from the same tree or composites from several types of trees.
Leaf rubbings	By placing a leaf under a sheet of paper and rubbing with the side of a crayon on top of the paper, students can create leaf rubbings. This technique particularly illuminates the vein patterns and the edges of the leaf. Students can create composite pictures with different kinds of leaves to illustrate characteristics such as serrated or smooth edges, or alternating or opposite vein structures.
Leaf splatter paintings	Using a screen, toothbrush, and paint, students can create splatter paintings by arranging leaves on a piece of paper and then splattering them with paint by rapidly brushing the paint with a toothbrush over the screen. (Wear a smock or stand back!) When sufficient paint has been spattered on the paper for a silhouette to appear when the leaf is removed, you are finished. Carefully remove the leaves and allow the picture to dry.
Leaf books	A book can be created that has the cover and all of the pages in the shape of a leaf, whether each page is the same or a different leaf. The book can be used to describe information about different types of plants or illustrate a fiction story. For a nonfiction book, the cover title should be a question that is answered by reading the book such as, <i>How Do Insects Affect Leaves?</i> or <i>What Colors are Leaves?</i>
Tree charcoal sketches	Students can make charcoal sketches of trees. Using natural charcoal from a fire, commercially purchased charcoal for drawing, or pencils, have students sit around a leafless tree and sketch the shape of its branches. Then compare the sketches to see if the tree has the same general shape from all angles. To extend this activity, have students sketch different types of trees and compare them for different tree shapes. This can also be done for trees with leaves on them.
Sponge painted trees	Using an object such as a small piece of sponge instead of a paintbrush, paint a picture by repeatedly dipping the sponge into paint and pressing it on a piece of paper.
Torn paper tree collages	Cut strips of different colors of paper using a paper cutter. Rip each strip into small pieces to represent leaves and bark and then paste the leaves and bark on a sheet of paper to create the shape and coloring of a tree.
Tree books	This book is similar to the leaf book except the book is in the shape of a tree. Students can show their creativity by writing and illustrating a fiction story that includes many science facts and concepts.
Tree flip books	By staggering several pages equidistantly and folding them in the middle, a flipbook can be made. Secure the pages by stapling along the folded edge. Turn the book so that the pages open up. While the book is closed draw a picture of a tree, including the roots, across the cover of the book and the tabs. Now open the book and write about the part of the tree that is on each tab, for example the leaves, trunk, or roots. Or create a book showing the stage a tree goes through from a seed to a tree to lumber. Give the book a focus with a title such as, <i>What is the Life Cycle of a Tree?</i>
Tree bag or box	Place objects from the tree in a paper bag or box that has been decorated to represent some aspect of a tree. The objects could include leaf samples, branches, seedpods, bark, and products made from the tree. Students can share their projects with the class. Students can also write and draw on the sides of the box or bag.
Tree mobile	A tree mobile can be made by taking a green square of paper and folding it diagonally twice and then cutting from one corner along the fold to the center. The cut edges are overlapped, thus forming a tree shape. For the trunk a piece of brown paper can be rolled up to form a cylinder. The trunk is attached to the inside of the tree. String can be used for roots and branches can be cut and curled out from the outer layer of the trunk cylinder. Either large or small trees can be made. Reports can be written directly on the larger trees.
Forest leaf collage	Using different leaves, students can create a forest of leaves where each leaf represents a tree with the stem being the trunk. By placing the leaves with the stem end down and attaching them to paper, students can create a forest with the leaves. Plan on pressing leaves between newspaper before students make pictures or press the whole picture after students have added the leaves.
Forest life report	Life in a forest is complex and interrelated. Students can create illustrated reports about life in a forest, from animals and insects to decomposers. With clip art and pictures from the internet to augment research about life in a forest, students can create reports to answer questions asked by scientists.
Forest scene scratch art	Using fall colors, students randomly color a piece of paper solid with crayons. For a striking visual effect, it is important for the entire piece of paper to be covered with color. The paper is then painted completely with black tempera paint. To cover the crayon drawing completely and easily, the paint should be thick. Let the paper dry completely. Then using a paper clip that has been straightened, sketch a picture of a fall scene by lightly scratching the paint to expose the crayon colors beneath. When completed, the picture will be mostly black with bright colors showing through where the paint has been scratched away.

will turn in the fall and what evidence led them to this prediction. By having a class discussion of predictions, students may come up with some hypotheses. For example, they may hypothesize that leaves with yellow and green pigments turn yellow in the fall, or that leaves with only green pigment may just die. The chromatography papers and the second leaf should be secured in the lab notebook for further reference after the fall changes have occurred. After their predictions are made, students identify their plant using plant identification keys. Now that students have scientifically separated color pigments and identified their plants, have students extend their exploration of colors to become more aware of different shades of colors in nature (see Figure 3). As time permits, these activities can be repeated as leaves change colors.

Analyzing change and identifying patterns

The second and third visits are timed about two weeks apart when the plants are changing color, usually early October in the mid-Atlantic region. Because plants are different, not all turn interesting colors or change alike. Students observe their plant, take notes, draw a sketch, and collect one leaf each visit to save in their notebook. For any particular student, the leaves for their plant may change on only one of the visits. This is not a problem though, because students also compare their plant to what is happening to other plants. This comparison is crucial because it enables students to make more specific observations about their own plant. For example, they easily pick up on color differences, though colorblindness can create challenges for some students who will need to work with a partner for this. However, many students need to be prompted to consider the patterns of change. You can ask questions such as:

- Do the leaves change all at once on your plant?
- Did the color change move across the tree from top to bottom, from the center to the edges, or in some other pattern?
- Was the color change pattern the same on all leaves?

By leading a Socratic discussion while outside, students can be guided to make observations about plants in general, in addition to just their specific plant. Students can document the changes with realistic drawings of the plants they are observing. A variety of activities can further help students identify and demonstrate patterns in leaf or plant development and change (see Figure 4). After the fall color display is over, have students share how accurate their color predictions were after their first visit and then after the chromatography experiment. In particular, you are guiding

students to identify whether there are patterns of predictions and change across plants.

The fourth visit is after all of the leaves have fallen. Of course, some of the plants do not lose their leaves and on a few plants the leaves turn brown but remain on the branches. After students take notes and sketch their own plant, convene a discussion to extend their observation skills about plants. Introduce the term *deciduous*, and ask students to provide some examples of trees that fall into this category.

During this visit students are focusing on the branch structure of their plant. They also compare the branch structure and overall shape of their plant to others', and become aware that branch structure and shape can also be used to identify plants. To foster this discussion, ask students, "How are branch structures different?" The goal is for students to become aware of the variety of branch structures. For example, they may observe that a tall skinny tree can have a central trunk with short horizontal branches, or lots of tall vertical branches that are grouped closely together. A variety of art activities can help your students explore the shapes and sizes of leaves and plants (see Figure 5). The list includes simple to more complex activities to match the time and resources available. Even traditional classroom art activities, if augmented by discussions with students, make excellent ways to extend science observation skills. To focus art activities on science, all pictures need to be appropriately labeled to identify the aspects of science being illustrated.

The fifth visit is a follow-up spring visit to complete the summer, fall, winter, spring cycle. By this point students are generally ready with little prompting to observe and see winter storm damage as well as differences in leaf buds, color, size, and shape. They usually still need to be prompted to identify patterns.

Raking in the benefits

Using the seasons in the science classroom increases student observation skills as they focus on subtle differences such as shades of color and differences in structures. Activities that encourage students to make and record observations will enhance and extend their learning. ■

Resources

- American Association for the Advancement of Science. 1993. *Benchmarks for science literacy*. New York: Oxford University Press.
- National Research Council. 1996. *National science education standards*. Washington, DC: National Academy Press.
- Gardiner, M.F., A. Fox, F. Knowles, and D. Jeffrey. 1996. Learning improved by arts training. *Nature* 381 (6580): 284.