CHANGE OVER TIME

Students describe a developing organism (e.g., a bean plant in a cup, a marked wildflower); a changing object (e.g., a decomposing orange); or a landscape feature (e.g., a sandy stream bank) as it changes over multiple observation sessions.

Time

Introduction: 10 minutes

Activity: 30-minute initial observation, with 10–20-minute follow-up sessions over the period of change (which may be months, with more frequent sessions during periods of intense change)

Discussion: 10–15 minutes

Materials

- ☐ Journals and pencils
- ☐ Twist ties to loosely mark plants or other objects in the field
- ☐ Rulers or measuring tapes

Teaching Notes

Students will be most successful with this activity if they have an approach or plan for structuring the page to facilitate data collection over time. If necessary, guide students through the process of planning how to arrange sequential observations on the same page or a spread of pages, and how to add symbols (such as arrows) to show the progression of observations over time.

Most times when we go outside to look at nature or record observations in our journals, we just see snapshots of longer processes. Yet the fruit on the trees, the spit of sand by the river, and the leaves just fallen are all in states of change. This activity gives students the experience of observing and recording changes in a phenomenon over time, leading to deeper understanding of the subject, the forces that cause it to change, and change as a general process.

NATURAL PHENOMENA

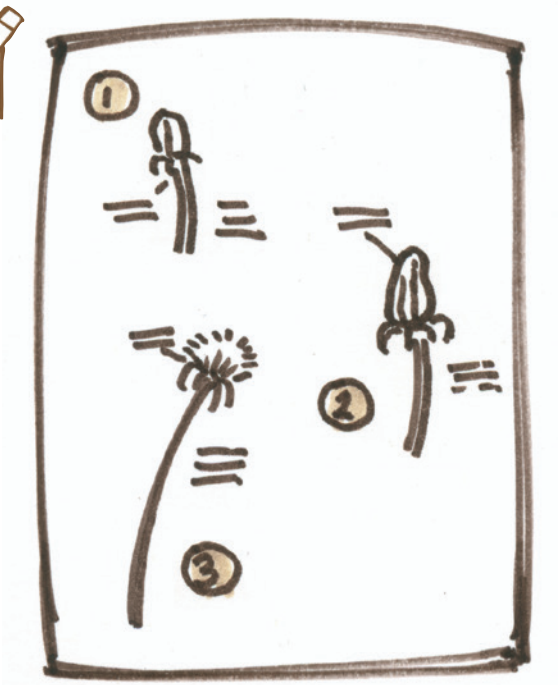
Look for objects that change over time at a rate that can be regularly observed and documented. This might include developing plants in a nearby garden or natural area, a potted plant or sprout in a cup; butterfly caterpillars (or eggs if you can find them; separate and place individuals in labeled containers to keep track), frog eggs in an aquarium (avoid releasing invasive species into the wild), a section of a branch of a deciduous tree (beginning when the tree is in bud), a decomposing vegetable in a compost bin (mark with a nondegradable tab so that you can find it as it rots), or a dead animal.

PROCEDURE SUMMARY

1. Use writing, drawing, and numbers to describe the subject.
2. Take detailed notes, especially about parts of the object that you predict will change the most.
3. Measure the object and create a table to record future measurements.
4. Leave space on the page for future observations, and label this 1.

DEMONSTRATION

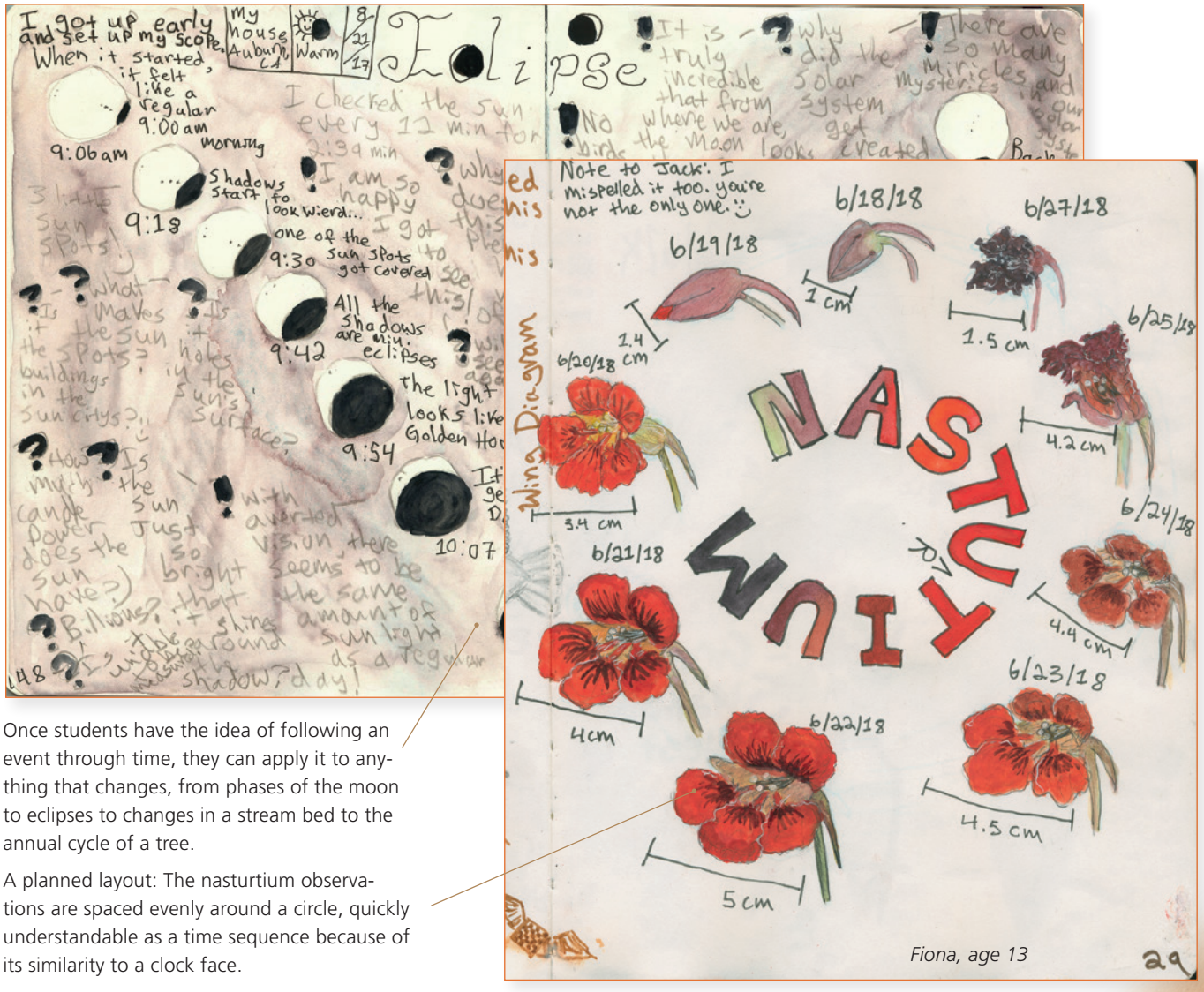
When the whiteboard icon appears in the procedure description: Draw a bud of a plant (not the species that the students will be working with). Draw sets of horizontal lines to suggest written notes. Number the drawing 1. Then add and number subsequent stages until you fill the page. Then explain that you would continue your notes on other pages in your journal as the plant continued to develop.



PROCEDURE STEP-BY-STEP

1. **Explain that students will use their journals to record the changes in an object (or phenomenon) over time, using words, pictures, and numbers to show observations.**
   - **a.** "Many changes are too slow for us to see. We can use our journals to freeze one moment in time and then compare that with what we see in the future."
   - **b.** "You will use words, pictures, and numbers to describe the object [this orange, this leaf, this section of stream bank] as accurately as you can."
   - **c.** "Then we will come back and observe it every day [or once a week, once a month, etc.], making a new journal entry and looking for things that have changed."
2. **Tell students to begin by making a drawing on one half of a journal page and to focus on parts of the object that they think will change the most, then ask them to share which details it will be important to record.**

   - **a.** "To begin, you might draw the subject on the top half of your paper with written observations next to it, leaving space below for your next observation."
   - **b.** "As you describe your subject, try to predict aspects that you think will change the most, and include notes about them so you will be able to compare future states."
   - **c.** "What kinds of details might be important to record?"
3. **Talk students through the process of measuring a few "landmark" aspects of the object they will be able to find again, using consistent units.**
   - **a.** "We are also going to measure one part of this object and remeasure it each time we make observations. This will help us be more accurate in noticing changes."
   - **b.** "Choose clear landmarks [e.g., a stem from the attachment point of one leaf to the base of a bud; one side of a decomposing orange to another] at which to start and stop measuring. You need to be able to find them again." (For a stream or other landscape feature, make sure one



Once students have the idea of following an event through time, they can apply it to anything that changes, from phases of the moon to eclipses to changes in a stream bed to the annual cycle of a tree.

A planned layout: The nasturtium observations are spaced evenly around a circle, quickly understandable as a time sequence because of its similarity to a clock face.

landmark is something that is unlikely to wash away, such as a tree.)

c. "We also need to decide what units we will use to record our measurements. If the units are too big, we will not be able to notice change over time. Please talk with the people near you about whether you think it would be better to use millimeters, centimeters, or some other unit of measurement."

4. Set boundaries, ask students if they have any questions about what is expected of them, and send them out to journal.

a. "Are there any questions? You'll have ten minutes to do this initial observation. Go for it!"

5. As students journal, take time to circulate and support them, offering reminders about time and the goal of the journal entry.

a. (When there are about 5 minutes left) "Remember to use words, pictures, and numbers to record what you see."

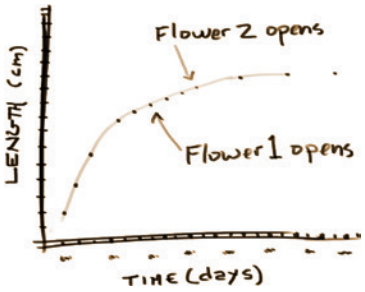
b. "This will be the only opportunity you have to see your subject in this state. It will be different when we return. Are there any other important details to include? Are there parts of the subject that you want to be sure to record now so that you can compare possible changes later?"

6. Call the group back together and explain how to set up a table to record measurements over time by making a column for the date and a row for the length, demonstrating this on a whiteboard.

a. "We will create a simple table to record your measurements over time. You will need a column for the date (and the time if what you are observing will grow quickly) and the length, distance, or other measurement. Be sure to specify the units of measurement."

7. Explain how to create a graph to record measurements, showing time on the *x*-axis and length on the *y*-axis.

a. "We'll also create a graph that has time on the horizontal (x) axis and length on the vertical (y) axis. Leave room on the right side of the graph for future observations."



8. Ask students to discuss some predictions of how the object might change, and the rate of change they expect to see.

a. "Discuss with a partner: When should we next check in with the object to see whether changes have begun?"

b. "What changes do you expect to see first? Why?"

c. "Do you think that this object will change at the same rate during the whole period we are observing it, or do you expect the rate of change to vary? Why?"

d. "It is hard to predict how fast this object will change without previous experience. To be on the safe side (so we do not miss a state of change), we will check again [state the time until the next observation period]."

9. During each follow-up observation, students should do the following:

a. Repeat the measurement, record it in the table, and add a new point on the graph.

b. Redraw the object, adding written notes detailing changes or newly observed details. (Depending on the size of their journals, this could occur on the original page or on subsequent pages.)

c. Make diagrams of any interesting features.

d. Record any questions that have been stimulated by their observations, and discuss their questions with their peers.

DISCUSSION

Lead a discussion using the general discussion questions and questions from one of the Crosscutting Concept categories. Intersperse pair talk with group discussion.

General Discussion

After all the observations have been completed, tell students to meet in small groups and discuss how the object changed over time, using their journal entries and measurements as data.

a. "Meet with a group of four and look over your journal entries together."

b. "Describe how the object changed over time. What changed, and when? Refer to your graphs, measurements, drawings, and notes."

c. "Were there periods of slower change or more intense change? What might have caused that?"

d. "What do you think caused the changes you observed in your object?"

Stability and Change

a. "How did different parts of the object change?"

b. "What parts of the object changed the most or least?"

c. "Where did you find growth spurts on your graph? Where did you find periods of less change? What are some possible explanations for these periods of change and stasis?"

d. "What changes may have occurred before our observations began? What changes do you think will take place next?"

e. "People tend to think that the state in which they see an object is how it has been and will always be. Are there any ways in which you could apply the lessons learned from observing this object over time to observations of other parts of the world?"

Structure and Function

a. "Plant structures perform different functions. Look at the structures you recorded and discuss what some of their functions might be."

b. "In your notebook, write some ideas about the possible function of structures as you have drawn them. Draw a box around your function notes so that they stand out from your other notes, and include a question mark if you're not sure."

c. "Is there a reason the structures develop in the order that they do? How might that help the organism survive?"

d. "Pick one structure and observe how it changed over time. Then discuss how its function might have changed over time, and the evidence and reasoning behind what you think."

Cause and Effect

a. "What mechanisms or forces could be behind some of the changes you observed?"

b. "Plant structures [or other organisms' structures] develop and are lost at different times. What environmental forces may affect the timing of the development of different structures?"

c. "Do you see any evidence of external forces or elements that have affected this object during the observation period?"

d. "What specific forces might have caused some of the changes you observed?"

Systems and System Models

a. "What outside factors influenced our subject when we observed it?"

b. "How might we label the parts of the subject of our study [e.g., orange skin, orange inside, orange stem, mold on orange]? How did those parts interact?"

c. "How might the external factors have influenced each of those parts and interactions?"

Matter and Energy

a. (If students have studied something decomposing) "What were some of the changes you observed over time?"

b. "Did any part of the object change form or appear to go missing?"

c. "Where might those parts be now? What could have happened to them? Did you see any evidence of this?"

d. (If students have studied something growing) "What were some of the changes you observed over time?"

e. "Did any part of the object change form, or grow?"

f. "Where did those parts come from? How did the plant seedling get so big?"

FOLLOW-UP ACTIVITIES

Observing an Area

Direct students to use a similar approach to study change at a larger scale and make regular observations in an area that is rapidly changing. This could be a section of a sandy beach that is close enough to the water to be affected by waves, or a meander in a sandy stream bank. (Entrenched river systems also change, but over a much longer period, and may take years to record.)

Watching Decomposition (Gross but So Cool)

In nature, we will encounter dead and decomposing animals. These are memorable phenomena for study and a way to learn about the way matter cycles, and they prompt interesting conversations. The FBI maintains several Forensic Anthropology Research Facilities, or "body farms," throughout the United States. These are used to study human decomposition under natural conditions. This research gives forensic experts vital clues to solving crimes.

Decomposing bodies go through several stages. Timing varies with environmental conditions.

Fresh. Rigor mortis (stiffening of muscles) and liver mortis (pooling of blood in lower parts of the body) set in; blowflies and flesh flies arrive.

Bloat. Gasses released by microbial decomposition fill the body cavities with air; the skin marbles; and fly larvae (maggots) hatch and begin to feed. Oh, and the smell…

Active decay. Maggots fill the body, rapidly consume tissues and organs, and pupate. Decomposing materials pool around the body, creating a "cadaver decomposition island" (CDI). The smell persists.

Advanced decay. Most of the soft body materials are gone. Soil may be stained from body fluids. The vegetation may be dead in the CDI.

Dry/remains. Only leathery skin, cartilage, and bone remain. Bare bones bleach in the sun. There is lush vegetation growth in the CDI.

If your students find a freshly dead animal, they can initiate their own investigation, visiting the carcass over successive days and months, noting changes and rates of change. Make sure that they take reasonable and appropriate precautions to avoid contact with carcasses and the potential for spreading disease.