Signs of the Seasons: A Maine Phenology Project

http://umaine.edu/signs-of-the-seasons/

Mapping and Graphing Your Phenology Observations

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Grade level: 7-12
Themes: Mapping, field observation, data collection, graphing, data literacy
Activity type: Field observation and data collection, classroom data analysis
Setting: Outdoors and classroom

QUESTIONS
How can we use GPS and mapping tools to plot the locations of research plants?
How do we conduct proper field research, including site selection and data collection?
How can we graph data to compare two groups?
Can we find evidence to support our predictions about dandelion growth?

OVERVIEW

Using dandelions, since they are numerous and easy to identify, students learn basic mapping and graphing skills, and practice making sense of the phenology data they have collected. Students will develop their own research field site, learn to make observations and collect data outdoors, build their own dataset and then will learn to plot graphs of that data. They will also learn to use GPS and mapping tools and resources. They will be asked to make predictions and claims and explain their reasoning, and then try to find evidence to support (or refute) their claims. They will analyze the data according to site variability and will create graphs showing two-group comparisons.

Students are encouraged to infer meaning from the graphs, engage in speculation, and learn to articulate and support claims and conclusions. Students' graphs can be used as a basis for classroom discussion focused on telling stories with data, and exploring new lines of inquiry.

EDUCATION STANDARDS
Maine Learning Results

Science and Technology
A3 Unifying Themes – Constancy and Change
3-5 a. Recognize patterns of change including steady, repetitive, irregular, or apparently unpredictable change.
6-8. Students describe how patterns of change vary in physical, biological, and technological systems.
B1 Skills and Traits of Scientific Inquiry
3-5 a. Pose investigable questions and seek answers from reliable sources of scientific information and from their own investigations.
6-8. Students plan, conduct, analyze data from, and communicate results of investigations, including simple experiments.
C1 The Scientific and Technological Enterprise – Understandings of Inquiry
3-5 a. Describe how scientists answer questions by developing explanations based on observations, evidence, and knowledge of the natural world.
E2 The Living Environment – Ecosystems
3-5. Students describe ways organisms depend upon, interact within, and change the living and non-living environment as well as ways the environment affects organisms.
6-8. Students examine how the characteristics of the physical, non-living (abiotic) environment, the types and behaviors of living (biotic) organisms, and the flow of matter and energy affect organisms and the ecosystem of which they are part.

Mathematics
B. Data Analysis
3. Students read, construct, and interpret bar graphs.
4. Students collect and represent data in tables, line plots, and bar graphs, and read and interpret these types of data displays.
7. Students use graphs and charts to represent, organize, *interpret*, and draw inferences from data.
a. Create tables, pictograms, bar graphs, line graphs, pie charts, stem and leaf plots, box and whiskers plots, and histograms using pencil and paper and electronic technologies.
b. Draw conclusions based on graphs and charts including tables, pictograms, bar graphs, line graphs, pie charts, stem and leaf plots, box and whiskers plots, and histograms.
8. Students use the mean, median, mode, range, and quartiles to solve problems involving raw data and information from data displays.
9-Diploma. Students understand and know how to describe distributions and find and use descriptive statistics for a set of data.
a. Find and apply range, quartiles, mean absolute deviation, and standard deviation (using technology) of a set of data.
b. Interpret, give examples of, and describe key differences among different types of distributions: uniform, normal, and skewed.

LEARNING OBJECTIVES
- Students learn how to use GPS and maps, and/or Google Earth
- Students learn to prepare a field site for research

- Students learn to make observations and collect data in the field
- Students learn how to create graphs showing comparisons between two or more groups
- Students practice making predictions, engaging in inference and speculation, and interpreting information contained in graphs
- Participants learn about climate and ecological principles affecting species, i.e., that the timing of phenological events may vary according to geography, microclimate, or climate change.

Expectations and Misconceptions: It's important to mention to students that variability is normal in the natural world. If they do not see changes when they expect to, or among all individuals of the same species, they should be cautioned against leaping to conclusions. Encourage them to think carefully about what they have observed and consider as many explanations as possible.

MATERIALS

- GPS unit(s) (optional)
- Topographic maps and/or Google Earth
- *Signs of the Seasons* Field Guide and species list
- USA-National Phenology Network *Nature's Notebook* data sheets

Note: see Resources section below for links to these items on the Web

And, depending on how you choose to complete the activity:

- Field kit materials as needed (flagging tape, plant markers, marker pen, hand lens, etc)
- Science notebooks
- Whiteboards
- Computer and internet connection
- Graphing supplies (by hand or computer)

TIME NEEDED (assumes minimum grade level and experience)

--One 30-minute class period to discuss site selection, a field observation plan and schedule (you may want to organize small teams)
--One 30-minute class period to make predictions and claims, and record ideas and notes in scientific notebooks.
--One or two 30 or 40-minute class periods for setting up the site, labeling plants, recording the first dataset and mapping locations with GPS and topographic maps (may need to give them a GPS/mapping introduction before doing this in the field).
--One 40-minute class period for scaffolding students on making graphs that compare two groups.
--One 40-minute class period to graph data (after a series of observations has accumulated) and talk about what the graphs show (do they support the students' original claims and predictions?)
--One 30-minute class period to plan how to present their results to the rest of the class or another group of students.

ACTIVITY PROCEDURE

1. Visit the *Signs of the Seasons* website to get a copy of the *SOS* Field Guide, see the *SOS* species list, and learn how to sign up as an *SOS* phenology observer (http://umaine.edu/signs-of-the-seasons).
2. Decide on when and how to collect the data. If you will be observing a number of different sites, you may wish to assign small teams to keep track of different sites.
3. Follow the *SOS* protocols in the Field Guide for selecting a site and marking any individual dandelion plants you are observing; establish a schedule and system for making regular observations.
4. Ask students to establish a science notebook or journal to be used in the course of this project. Talk about basic information that should be included in a science-minded journal. This depends on the activities and research but might include things like dates, weather information, careful observations of species, phenophases, behavior, predictions and hypotheses, drawings, samples (pressed leaves or flowers) or notes about the process and any limitations.
5. Use *SOS*/USA-National Phenology Network (NPN) Data Sheets to record your observations. Establish a plan for logging your data into the NPN online database, *Nature's Notebook,* and make sure the data are added to the database. Instructions for how to do this can be found in the *SOS* Field Guide, and on the *Nature's Notebook* website.
6. Use a GPS unit and a topographical map with a Latitude/Longitude grid, or Google Earth, to mark the locations of your class phenology observation sites (schoolyards, parks, students' homes, etc.). It's good to choose at least 5 sites with different characteristics as a class, and at least 3 dandelion plants at each site, so you have a greater likelihood of seeing trends or differences between sites.
7. Gather and record other data about each of your sites, such as the elevation, whether they are sunny or shady, fertilized or unfertilized, watered or not watered, etc.
8. Based on your map and your site data, ask the students to make claims/predictions about when/where the dandelion blossoms and seeds will appear first or last during their observation period. Then ask them to record why they made the claims they did, and to list what types of evidence they'll need to collect to support their claims.
9. Have each student use an SOS "Forbs datasheet" to record dandelion phenology daily (or every other day) at his or her marked site for several weeks in early spring.
10. Use the data on the datasheet (in addition to entering it online at www.usanpn.org) and your site characteristic data to graph the timing of your dandelion blooms/seeds against the other site characteristics to test their claims.
    a. For example, if they thought sites at higher elevations would bloom later, then group all of the higher elevation observations together, take an average first bloom date, and compare with the average first bloom dates of all the lower elevation sites. **Note:** Creating graphs that show average differences (if there are any) between two groups will be most useful for this activity. *[See Resources below for links to a website that offers activities and resources related to teaching students graphing skills and data literacy.]*

b. For most students, it is good to keep this very simple – only graph the phenology timing with one other site characteristic at a time.

11. Ask the students to look at their graphs and check their claims and write why they do (or do not) show the evidence they needed to support their claims. If the graphs don't support their original claims – do they show any other surprising differences between sites, or other trends they didn't expect?
12. Ask the students to present their results to the rest of the class/group, and explain what their data show about the dandelion plants they observed. What would they do differently next time? What other claims might they test?

REFLECTION IDEAS

Ask students to interpret the graphs and explain what they show. Engage them in speculation about meaning in the graph. Talk about any other questions the graphs raise. Were there other trends or surprising results? How might they conduct the research differently next time? Point out to them the value of engaging in these kinds of speculations and inquiry and how this process is central to the experience of "doing" science. For any questions that you can't answer now, how might you find the answers? Do they need additional data to answer their questions? If so, what additional information would be most useful? Often, it is essential to come up with recommendations for further research or enquiry.

EXTENSION IDEAS

Consider expanding the project to include more diversity in study sites, perhaps by partnering with other teachers and students at other schools. Also visit the USA-National Phenology Website and try out the Phenology Visualization Tool (http://www.usanpn.org/results). Here you can download and visualize data, view the map gallery and view historic data sets. You may find other sets of dandelion data in other parts of the country to compare with yours. *[We recommend that you complete the Tutorial (http://www.usanpn.org/node/6208) to learn how to make full use of the visualization features.]*

RESOURCES

Signs of the Seasons (http://umaine.edu/signs-of-the-seasons)
USA National Phenology Network (http://www.usanpn.org)
Acadia Learning Data Literacy Project (http://participatoryscience.org/data-literacy/introduction-data-literacy-project)

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