bright Girls

Broadening Research Interest in Geoscience, Habitat, and Technology (BRIGHT)

Investigation 6: DATA VISUALIZATION

Grades 9-12
Time requirement: 2 hours

Next Generation Science Standards (NGSS)

Science and Engineering Practices
Analyzing and Interpreting Data • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. **Obtaining, Evaluating, and Communicating Information** • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).
Disciplinary Core Ideas

Earth and Space Science
• ESS2: Earth's Systems
   ○ ESS2.E: Biogeology
      ▪ The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Crosscutting Concepts
Science is a Human Endeavor • Scientific knowledge is a result of human endeavor, imagination, and creativity.

OVERVIEW

Students analyze and draft visualizations of field data.

LEARNING OBJECTIVES

Students will be able to:

- tabulate and analyze data with Excel or Google Sheets.

- make drafts of how to represent data visually.

- communicate about their visualizations.

INSTRUCTIONAL APPROACH

Students' data visualizations or "vizzies" are sketches of how they could represent their data. They experience the iterative process of drafting an idea, getting feedback, and making revisions. Ideally, students feel ownership of data they have collected, and creative agency as they make choices about how to visualize it. The instructor should accept all student responses as value-neutral, and encourage specific feedback (e.g., what was effective or ineffective, and why).

SCIENCE BACKGROUND

(https://www.nsf.gov/news/special_reports/scivis/vizzies-about.jsp)

Scientists use visualizations, or "vizzies," to communicate their findings with each other and with the public. The National Science Foundation recognizes outstanding vizzies in an annual challenge.

MATERIALS

- Field instruments and manuals, if applicable

- Rite in the Rain 4x6" notebooks, 1 per student

- Computers, 1 per group

- Markers, 1 pack per group

- Large sticky paper easel pad

- Small sticky notes

ACTIVITY

Setup

This investigation assumes that students have already gathered data and recorded it in field notebooks and/or in instruments' memory, if applicable. Install any needed software on computers and ensure access to Excel and/or Google Sheets.

Investigation
2 hours

Examples
10 minutes

Show and discuss the following examples of data visualizations. Ask students to consider how and why scientists use visualizations to understand and share their work.
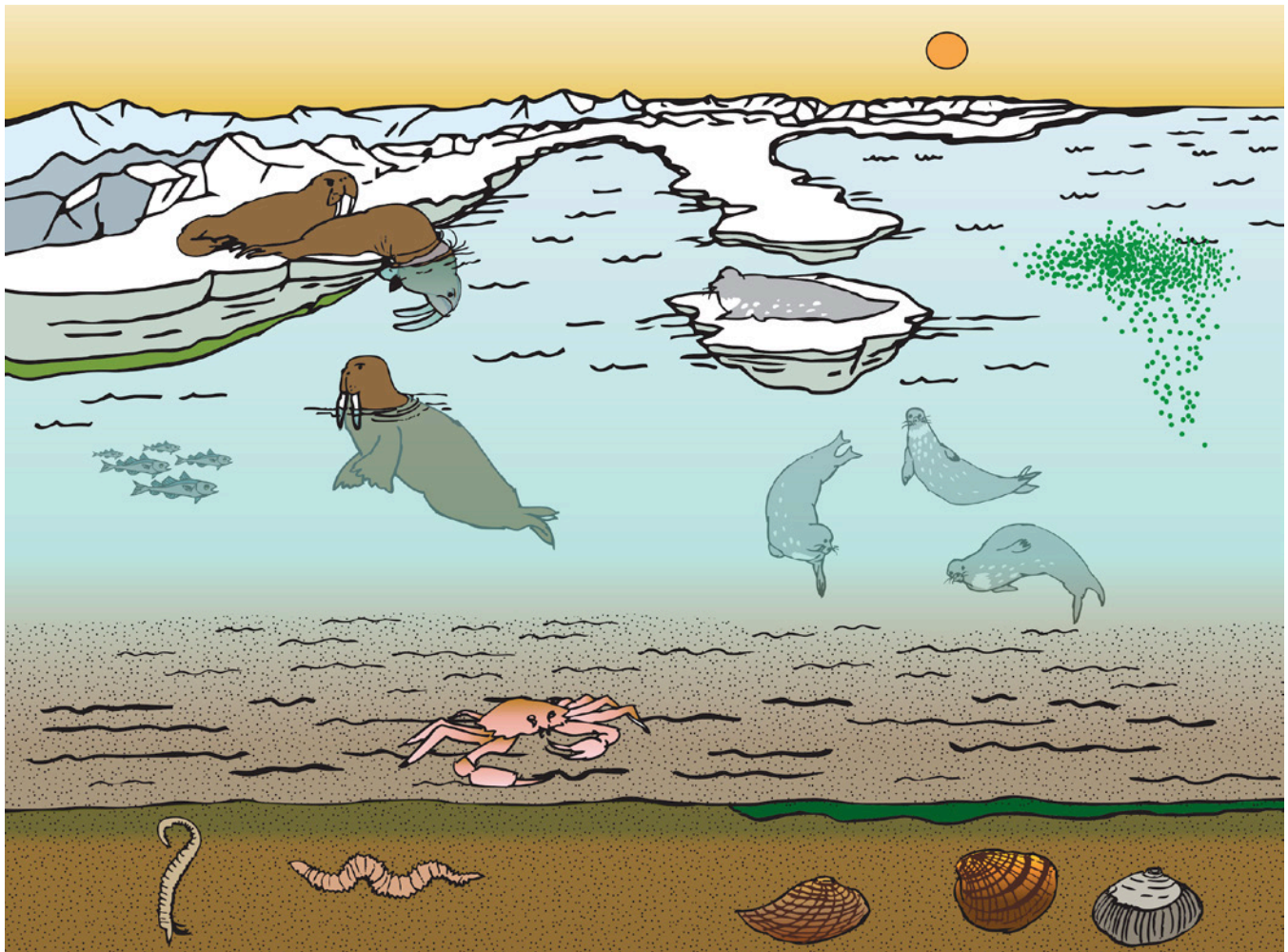
Figure by Cassidy Phillips, from Laura Oxtoby's Ph.D. thesis defense, Carbon sources and trophic connectivity in seafloor food webs in the Alaska Arctic and sub-Arctic, *University of Alaska Fairbanks, 2016.*

Information is Beautiful:

- http://sciencepaths.kimalbrecht.com/
- http://www.informationisbeautiful.net/visualizations/which-fish/
- https://www.informationisbeautifulawards.com/showcase/1753-bears-of-finland

National Science Foundation The Vizzies Visualization Challenge:

- https://www.nsf.gov/news/special_reports/scivis/vizzies_winners_2014-2015.jsp
- https://www.nsf.gov/news/special_reports/scivis/images/2014/ice_ocean_l.jpg

Data analysis
50 minutes

1. Divide students into groups of four or five. Circulate among the groups, facilitating thinking by asking questions:

   - *How will you format your data table?*

   - *Will you focus on data from a specific field site?*

2. Have students enter their field data into Excel or Google Sheets. Encourage experimentation with shortcuts, formulas, graphs, and charts as students gain familiarity with their chosen spreadsheet platform.

3. Depending on the group and the amount of data, explore appropriate representations (e.g., dot plots, histograms, box plots, scatter plots); statistics (e.g., median, mean, and spread (interquartile range, standard deviation)); outliers; correlation coefficients and correlation vs. causation. Ask:

   - *What patterns do you notice?*

   Accept all answers as value-neutral.

Data visualization
1 hour

Vizzie first draft
20 minutes

1. Ask students to discuss the question "how could you represent your data?" with their groups.

2. Distribute easel pad paper and markers. Have students make draft sketches of how they could represent their data.

Vizzie review
10 minutes

1. Have students post their draft vizzies. Distribute small sticky notes and give everyone time to circulate silently, writing and posting value-neutral feedback on sticky notes on each vizzie.

2. If time allows, have each group gather in front of their vizzie and present it to the rest of the group. Encourage students to reflect on their choices, and the feedback they received, in a non-judgmental way. Guide students away from evaluating their visualizations as good/bad or right/wrong; instead, prompt students to notice that there are multiple possible ways to visualize a given data set and that the process of design is one of trying out solutions, evaluating them, and then refining them. Asking the following questions can help students think about how to optimize their visualizations:

   - *What works? Why?*
   - *What could be improved or changed?*

Vizzie second draft and review
30 minutes

1. Students collect their draft vizzies and feedback and discuss with their groups:

   - *What worked well?*
   - *What could be improved?*

2. Have students get new pieces of paper and create a second draft of their vizzie based on the feedback they received on their first draft and their own observations of what was and was not effective.

3. When finished, have students present their two vizzies side-by-side to the rest of the group. Ask students to share what they discovered in the iterative process of evaluating and refining their vizzies.

   - *What changed about your vizzie from the first draft to the second?*
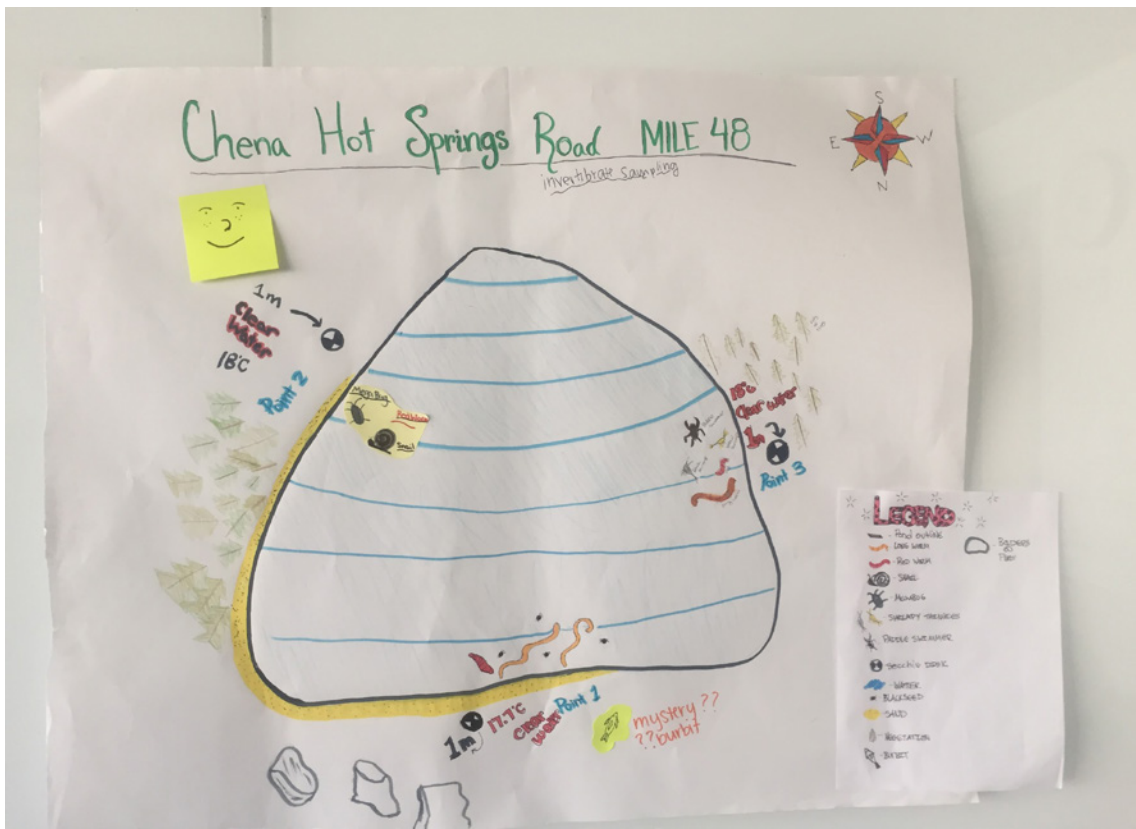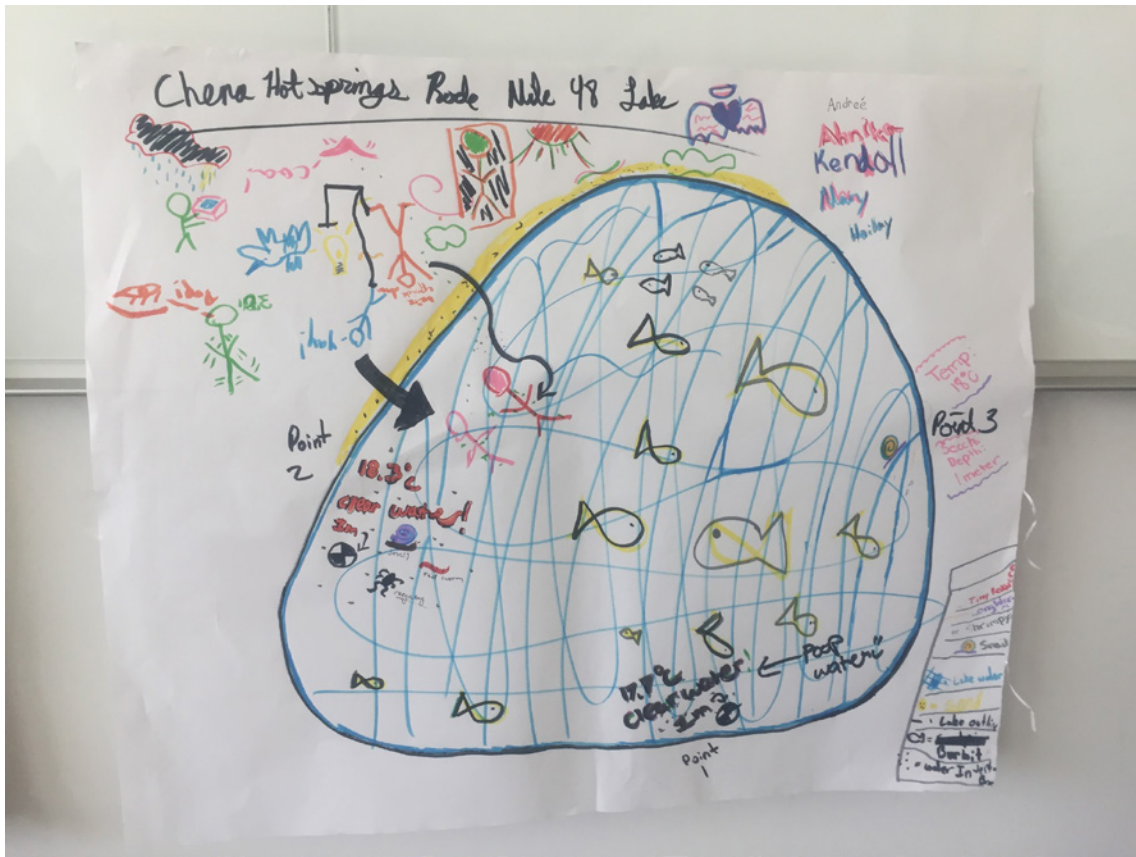   - *What did you discover in this process that could be applied to visualizing different data?*

Student "vizzie" with feedback on sticky notes. Photo by Suzanne Perin

First draft of a vizzie (top); second draft, incorporating peers' feedback (bottom). Photos by Gabrielle Vance

Extension

Give students the opportunity to refine their vizzies yet again, incorporating feedback from their second drafts. Consider using Tableau Public (https://public.tableau.com/s/), charts in Google Sheets, or Google Data Studio (https://datastudio.google.com/u/0/navigation/reporting) to create and share vizzies digitally.

OTHER RESOURCES

Excel 2016 tutorial:
https://www.gcflearnfree.org/excel2016/

- Formulas: https://www.gcflearnfree.org/excel2016/intro-to-formulas/1/

- Tables: https://www.gcflearnfree.org/excel2016/tables/1/

- Charts: https://www.gcflearnfree.org/excel2016/charts/1/

Google Sheets tutorial:
https://support.google.com/a/users/answer/9310369?hl=en