Draw Your Own Visualization

Purpose

To learn about visualizations by designing and drawing one.

Overview

Students draw a visualization based either on their interests and ideas about the world or based on actual GLOBE data. Students are asked to justify the design choices they make and to interpret the visualizations of their peers.

Student Outcomes

Students learn to identify and communicate important patterns in a dataset by drawing a visualization, and begin to interpret those patterns.

Students select and specify colors, units, and ranges of values to communicate data effectively in a visualization.

Science Concepts

General

Visual models help us analyze and interpret data.

Geography

Geographic visualizations help organize information about places, environments, and people.

Scientific Inquiry Abilities

Identify answerable questions.
Use appropriate tools and techniques.
Use appropriate mathematics to analyze data.
Develop and construct models using evidence.
Communicate procedures and explanations.

Time

One 45-minute class period

Level

Middle

Materials

Blank paper maps
Coloring media for each student: crayons, colored pencils, water paints, or pastels
Globes and atlases for students to consult when drawing their visualizations.

Preparation

Copy the blank paper map and *Work Sheet* for each student.

Prerequisites

None.

Background

We all use data all the time: for example, we might check out sports statistics or look at a weather map, or grade papers.

Data can be presented in many different ways. Sometimes data are presented in the form of numbers, as in tables of GLOBE measurements like precipitation or water quality. Tables of data offer precise values that are good for calculations or comparisons. However, tables of numbers can be difficult to understand at a glance, especially with large or complex scientific datasets.

Visualizations are a way to turn data into a picture to make it easier to understand. Visualizations help us begin to make sense of the data, find patterns within it, and use it to answer questions about the world. This activity is an introduction to visualization: a chance to design and draw one of your own on a topic that interests you.

A visualization can be designed in many different ways — there is not a single “right way” to draw a visualization. Authors make design choices in order to communicate something specific. A topographical map, for example, is one common way to show patterns of elevation; topographical maps use contour lines to show areas of equal elevation.

In this activity, you will use color as a way to illustrate patterns in data. The colors you use, and what each color represents, depends on what you want your visualization to show.

Four key questions to answer when creating a visualization are:

What is the *purpose* of the visualization?
Are you working with *numeric* or *categorical* data?
What *colors* will you use, and what do they represent?
What *geographic area* is being covered?

Purpose

A visualization is meant to communicate something to the people who look at it. For example, a weather map with temperature ranges in different colors helps to show weather patterns across the displayed region. The first step in designing a visualization is deciding what it is intended to communicate.

Type of Data/Units/Range of Values

The data shown in a visualization can be *numeric* or *categorical*.

With *numeric* data, the visualization shows a quantity of something: the number of bird species in different parts of the country, or the average noontime temperature in different parts of the world. To make it clear what the numbers mean, we specify *units of measure*. For example, temperature might be measured in degrees Celsius, Fahrenheit, or Kelvin.

To simplify the illustration of data and show patterns, one can divide numeric data into *ranges of values* and assign a color to each range. A temperature visualization might use one color for temperatures in the range -20˚C to 0˚C, and another color for temperatures in the range 0˚C to 20˚C. If exact values are not known, it is also possible to use *qualitative* values (descriptive words like high, middle, and low for cloud heights). Usually, numeric ranges are better to use because they are more precise and uniform; what is "warm" to one person might be "hot" to someone else, but everyone agrees on what 20˚C means.

Some visualizations show data that are not numeric at all: for example, the most popular sport in different cities ("hockey," "football," etc.) or types of land cover in different regions ("broadleaf evergreen forest," "desert," etc.). This type of data is called *categorical*. With categorical data, the visualization designer must decide whether to group similar categories to show patterns. For example, depending on the question the "favorite sport" visualization is designed to answer, it might be important to show each individual type of boating activity, or it might be simpler to group them all under the category "water sports."

Colors

Once the ranges or categories have been selected, the next step is to choose *colors* to represent them. Sometimes it is possible to choose colors that resemble the phenomenon being visualized (for example, in a visualization of land cover you may want to use green for forests). Using colors in this way helps to make the visualization easy to understand. Another strategy is to use a standard progression such as the colors of the rainbow, so that values that are close to each other look similar. For example, a temperature visualization might use blues and purples for cold temperatures and reds and oranges for hot temperatures. These visual techniques can help to make patterns in the data easier to recognize and comprehend.

In most hand-drawn visualizations, 4 to 6 colors are enough; too many colors complicate the picture and make it hard to read.

Geography and Scale

Many visualizations show data that are collected in different places: for example, a visualization might show average rainfall in different parts of the world. To show where the data come from, many visualizations are drawn on maps. Maps have *geographical elements* (e.g., continent outlines) to show spatial aspects of the data at a glance, like the location of wetlands near a bay. When you draw a visualization, it is important to start with a blank map that shows the part of the world that the data are from. It is also important to select a *scale* for the visualization: will it show July rainfall in a particular country, or around the world? The scale you select will depend on what data you have and what the visualization is intended to communicate.

Preparation

Hand out crayons (or other color media) to each student, and distribute the available globes or atlases.

Each student will also need a blank map on which to draw his or her visualization. A blank global map with country outlines is provided with this activity, and can be enlarged on a copier to show a particular continent or global region. For more local maps, you or the students can use the map generation facility on the GLOBE Website.

What To Do and How To Do It

Go through the following four steps.

1. Introduction to visualizations
2. Students design and draw a visualization
3. Group discussion and interpretation
4. Class discussion

Step 1. Introduction to Visualizations

Begin with a discussion of why visualizations are important, both in science and in everyday life.

- Show samples of visualizations that the students may have seen recently in the local paper (e.g., a weather map), or ask students to find an example as homework.
- Use an atlas, which will often have many color visualizations of Earth and Earth science.
- Discuss why it is easier to understand the visualizations than a table of numbers. What does this visualization allow you to see at a glance that numbers would not? What types of interpretation does it support?
- Relate the discussion to an activity you plan for your class to do using GLOBE data: why would visualizations be helpful in that activity?

Tell students that they will be designing their own visualization in this activity. There are two ways to do this:

1. You can ask students to draw a visualization on a topic they are familiar with, mapping data they already know something about; or
2. Students can use measurements from the GLOBE program, such as air temperature, rainfall, or cloud cover.

If you choose 1, students have the opportunity to be creative and to connect the concept of visualization to something in which they are interested, potentially outside of science. For example, students might choose to draw a visualization about agricultural crops in various regions of the world or number of languages spoken in each country. If students are having trouble coming up with a topic they feel they have sufficient data to draw, talk to them and elicit from them ideas about data that are appropriate to represent spatially, guiding them to appropriate topics if necessary.

If you choose 2, students can begin to explore the concepts behind GLOBE measurements and understand an important step in data analysis – visualizing spatial data to detect patterns. If students do their visualization on a topic related to data they are or will be collecting, you may wish to view the visualizations on the GLOBE Website as a class or have individual students do so. Once there, students can see how GLOBE data are drawn onto maps.

As you introduce the activity, explain to students that their job is to communicate a set of data in a way that makes it easy for others to understand. There is no “right” or “wrong” way to design a visualization. The students’ design choices can make it easy or difficult for someone else to understand what they are trying to communicate.

Step 2. Students Design and Draw a Visualization

Give each student one of the blank maps you have prepared. Each student will select a topic and draw his or her own visualization.

The *Work Sheet* for this activity will step students through the decisions they need to make to design their own visualization as described in the *Background* section. As they work, you may want to offer some guidance.

- Students may need help in defining the purpose of their visualization, and in making design choices that allow them to communicate the data clearly (e.g., dividing numeric data into ranges and selecting colors).

- Encourage students to sketch their plans in pencil before they color them in, since students may focus on one value or range first and not save space for all the data.
- Students should be encouraged to complete their designs fairly quickly (approximately 15 minutes).
- The Work Sheet also asks students to look at their visualization and check their work to see if it is easy to understand. Students may need help in reflecting carefully on their drawings. As you work with individual students, refer to the Purpose statement on their Work Sheets. Based on that statement, ask them to think of questions about the data that their drawing would be useful in answering, and help them check to see whether it supports that analysis.

If only pencils are available, and not color media, students can use different patterns or symbols of shading to represent different areas.

Step 3. Peer Review

After the students are through drawing their visualizations, divide them into small groups. Ask students to interpret each other's visualizations within the group, deciding what each visualization is intended to communicate. How easy is it for students to understand the intent of the visualization, and what the colors represent? What design choices were helpful in communicating the data? What design choices might have offered better communication? Give students the opportunity to make modifications after this discussion, if needed, to improve their visualizations.

Step 4. Class Discussion

Bring the class together for a discussion of what makes a good visualization. If time allows, invite individual students to present their visualization or one they looked at within their group, and to say what aspects of the design made it easier or more difficult to understand. This discussion is a good opportunity to link the general tool of visualization to the GLOBE data that students are or will be working with, and to discuss how visualizations can make that data easier to analyze.

Further Investigations

Drawing visualizations can also be done as a group project by using a poster-sized blank visualization. This can be created by copying one of the blank visualizations onto an overhead, projecting it onto the wall, and then tracing that image onto poster board. These large visualizations are also well suited to class presentations because they can be seen by the whole class. Drawing a visualization as a group is a good way to conduct preliminary analysis of a set of GLOBE data.

The basic activity defined in *What To Do and How To Do It* is a generic introduction to the language of visualization as a tool for interpreting and communicating data. The extensions below offer suggestions for specific analytic activities that you can choose based on your goals for this class.

- Ask each student to think of a question that their visualization can be used to answer: for example, "What city has the highest population density in the country?" Trade visualizations with another group, and ask them to use the visualization to answer the question. This activity reinforces the perception of visualizations as a tool for problem-solving.
- Ask each student to come up with a headline or caption for their visualization as it might appear in a newspaper, and then write the first several sentences of the story. For example, the caption on a weather map might be "Heat wave sweeps the West Coast!" This activity reinforces the perception of visualizations as a tool for communication of patterns in data.
- If you are using GLOBE data for this activity, add a class discussion in which you predict trends in the data you will be collecting based on this visualization. For example, you might want to predict how the visualization will change as data are collected over the year. This activity helps to establish the idea that visualizations

will be useful in the work your class will be doing with GLOBE as you try to answer questions about the World throughout the year.

Resources

Blank maps can be designed on the GLOBE Website and printed out for students. (From the GLOBE home page, select *Visualizations* and then *GLOBE Maps*. Under Other Options on the Maps page, you can choose *Create a blank map*.)

The *GLOBE Earth System Poster* offers good examples of color visualizations from Earth science data and the patterns that visualizations can show in large datasets. These are located at https://www.globe.gov/teaching-and-learning/materials/earth-system-science-posters.

The Internet has a large collection of scientific visualizations created by research organizations. Searching for the word "visualization" along with the name of an environmental science research organization can bring up a useful set of examples.

Draw Your Own Visualization

Work Sheet

Name_____

In this activity, you will draw a visualization of something that interests you, using colors and a blank map. A visualization is a picture that makes a set of data easier to understand and may help you to recognize patterns within it. It is up to you to decide what data you want to communicate in this visualization.

This Work Sheet will step you through the process of designing a visualization. Remember, your design choices can make it easy or difficult for someone else to understand your visualization.

1. What is the *purpose* of your visualization? For example, you might want to show temperature patterns across the region, or the average height of trees in different regions. Write the purpose of your visualization here.

   _____
   _____
   _____
   _____
   _____

   On your blank map, give your visualization a title that communicates its purpose.

   _____

2. What *geographic area* is being covered by your visualization? Examples are: the whole world; Africa; your hometown. Write down the area your visualization covers here, and make sure you have a blank map that shows the correct region of the world.

   _____
   _____
   _____
   _____
   _____

3. Are your data numbers or categories? (circle one)

   Data that are numbers are called numeric; data that are categories are called categorical.

4. For *numeric data, answer a and b*; for *categorical data, answer c*.

   a. What are the *units of measure* (e.g., degrees Celsius, height in meters)?

   _____

   b. What *ranges* will you show? Remember, a range groups similar data together by color so that patterns are easier to see. If you are mapping temperature, you might want to use ranges like *-20˚C to 0˚C* and *0˚C to 20˚C*. Write down the ranges you will show here, and skip to question 5.

   _____
   _____
   _____
   _____

   For *categorical data*:
   c. What *values* will you show? For example, if you are showing ecosystems, values might include desert or rainforest. Write down the values you will show.

   _____
   _____

5. Now choose the *colors* you will use to represent each range or value. Remember that, if possible, it helps to use colors that mean something about the data (e.g., red for hot or green for forest) or that help illustrate a particular pattern (e.g., temperatures close to each other have similar colors). Write a description of the color scheme you picked and say why you picked it.

   _____
   _____
   _____
   _____
   _____
   _____
   _____

   On your map, create a *legend* that shows each range or value, and next to it the color you will use.

6. Draw your visualization. Now pretend that you have never seen this visualization before. Would you be able to figure it out? Is everything clearly labeled and drawn? Revise your visualization if necessary.

Draw Your Own Visualization Work Sheet

*Name*_____

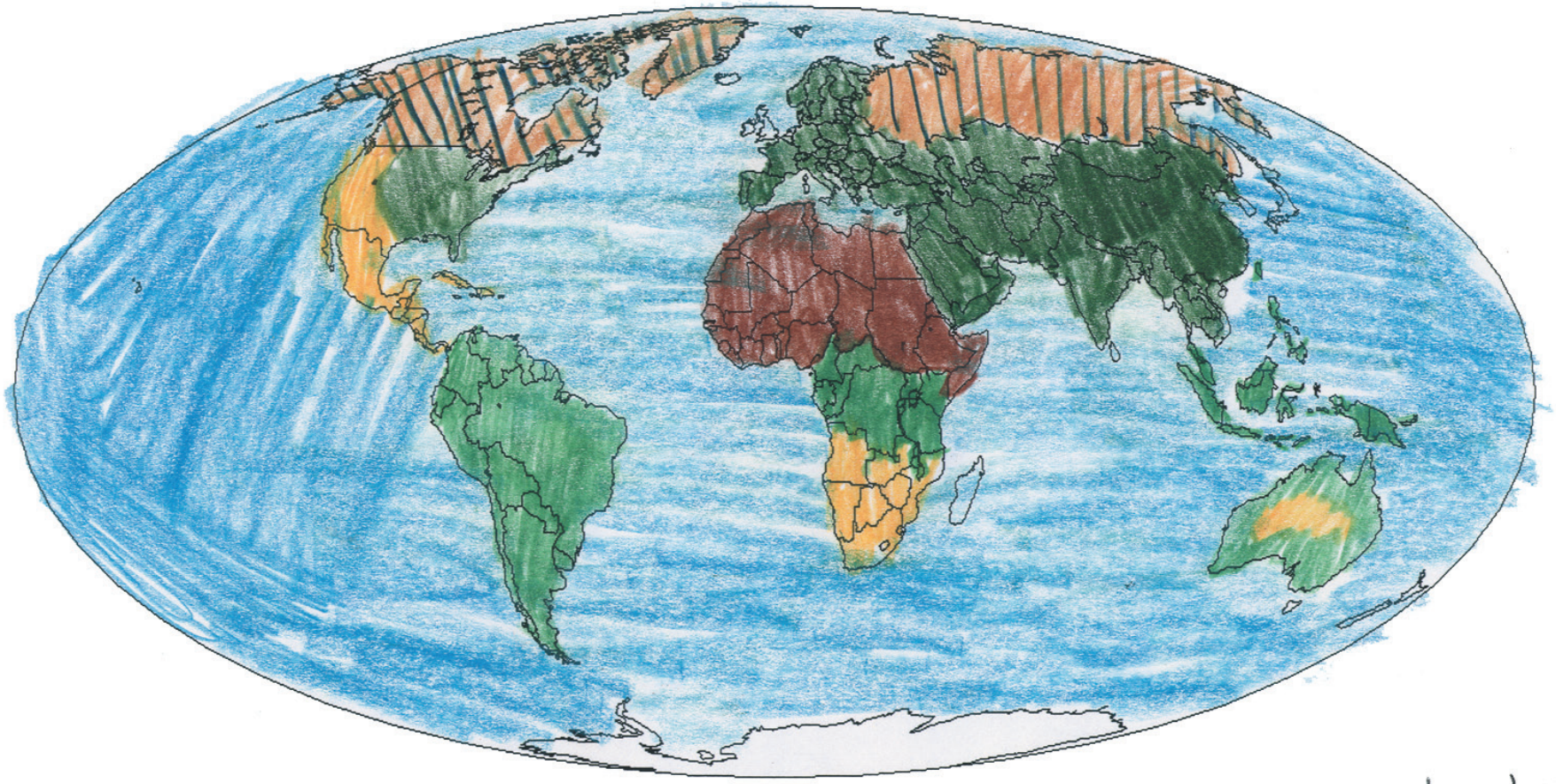
Title:_____

Color Legend

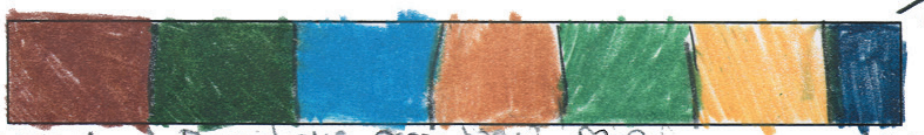
Draw Your Own Visualization Work Sheet

Name Eileen E.

Title: The 7 Biomes of the world.



Color Legend



Grassland, Decidious forest, ocean, taiga, rain forest, desert, tundra

When colors have lines of diff. colors on them the area is also inhabeted by that biom also

Draw Your Own Visualization

Rubric

For each criterion, evaluate student work using the following score levels and standards:

3 = Shows clear evidence of achieving or exceeding desired performance

2 = Mainly achieves desired performance

1 = Achieves some parts of the performance, buts needs improvement

0 = Fails to perform or performs in an inadequate way

1. Designing a visualization using the key elements of quantity, units and range (if numeric) and category (if categorical), as well as organization of colors used, geographic area, and scale.
   A. Color
   - Did the student choose colors that are clearly distinguishable from one another?
   - Are the colors organized in a reasonable way?

Score Level	Description
3	Colors are clearly distinguishable from one another; use of colors is organized and appropriate for the intended purpose. For example, if the student is illustrating continuous set of data, colors are graduated; if the data are categorical, colors are chosen to show distinct categories. On the Work Sheet, the student's explanation of the color scheme demonstrates that it was a conscious, logical choice.
2	Colors are difficult to distinguish in some places and/or colors could be better organized to achieve the intended purpose. For example, in a visualization of temperature, colors are selected at random for each range or do not illustrate a gradual shift from hot to cold. The Work Sheet explanation has flaws.
1	Use or choice of colors is inappropriate or inconsistent; colors are not tied to ranges or categories of data. Work Sheet explanation is unclear.
0	Work is blank or incomplete.

B. Units and range of values

- Does the student's choice of unit match the quantity being visualized?
- Is the chosen range of values appropriate for the quantity being visualized?
- Are colors appropriately mapped into the chosen range?

Score Level	Description
3	Units are clearly stated and appropriate to the quantity being measured. Ranges of values are clearly stated and appropriate and values are generally divided into 4-6 ranges. Selected ranges or categories span the entire set of values; for example, an "other" category is included if necessary.
2	Work shows some understanding of the use of units and range of values in designing and drawing visualizations, but demonstrates need for improvement in one of the areas described above. For example, the unit chosen may not be entirely appropriate for the quantity being visualized, or the range of values chosen may leave large portions of the visualization blank.
1	Work shows a poor understanding of the use of units and range of values in designing and drawing visualizations, demonstrating a need for improvement in each area (e.g., units and value ranges).
0	Work is blank or incomplete. Units or ranges are not specified.

2. Using a visualization to communicate data.

A. Was the student able to highlight, interpret, and communicate patterns in the data?

Score Level	Description
3	The visualization overall serves as an effective tool to communicate the intended message or idea. Colors and ranges are selected to point out important patterns in the data. For example, in a population visualization, areas of highest population density are easy to identify.
2	The visualization overall communicates some aspects of the intended message or idea, but is unclear or ambiguous in some ways. For example, the visualization is clearly labeled, but chosen ranges mask some important patterns.
1	The visualization overall fails to communicate the intended message or idea and requires some basic revisions in order to serve as an effective communication tool.
0	The visualization is blank or incomplete or confusing so that no patterns can be recognized.