Lesson 5: Introduction to Graphing

Timeframe:
One-two 50 minute class periods.

Supplies:
- Graph paper (optional)
- Butcher paper (optional)
- String
- Tape
- Color pencils, pens, or crayons
- Sticky notes (one per student)

Knowledge and Skills Developed:
Students will:

Learn three main kinds of graphs (bar, line, and pie)
Decipher what kind of data representation the different graphs are best used for
Understand the difference between independent and dependent variables
Relate data to their guiding question (take time for students to create guiding question if the class did not do previous lessons above)

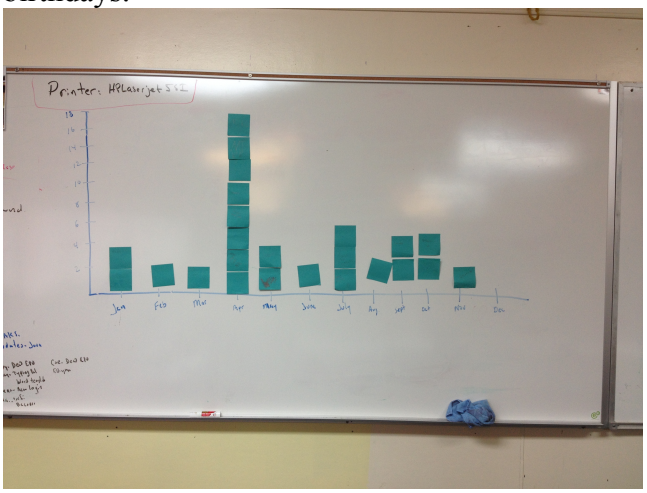
Teacher Background:
Understanding the meaning of the word data, how to graph, interpret, and use data can be very overwhelming to students. Helping students understand that data is simply information, that can be many things depending upon what we are studying, or how we are using data is an important first step. Data changes per project and is based upon the objective of your own goals. Data is evidence of a certain thing, change, idea, preference, or quantity and is often measured over time, especially for accumulated data. By helping our students feel more comfortable using data and learning about graphs, and how to make them, we are setting students up to be successful in the future by giving them transferrable skills.

This lesson is designed to help students understand that we are all potential users of data, and that data is something we all give or receive. For example, we may add information to the grocery list being created at home. Or we may look up movie times, track our spending habits, or want to know if the amount of time we spend doing one activity affects another area of our life (such as television watching and grades). This is similar to the ways that scientists use data. In StreamWebs we collect data about watersheds to help us better understand water quality and the overall health of a stream, river, or watershed. For example, by tracking water quality parameters such as temperature and dissolved oxygen levels over time, we might be able to better determine if our stream can support a certain species, such as coho salmon. In the next few lessons we will work directly with StreamWebs data, graphing, analyzing, interpreting, and presenting it to our schools, partners such as watershed councils, and/or community members. This lesson will help teach or remind students what data is, and about the different functions of three main kinds of graphs (bar, line, and pie).

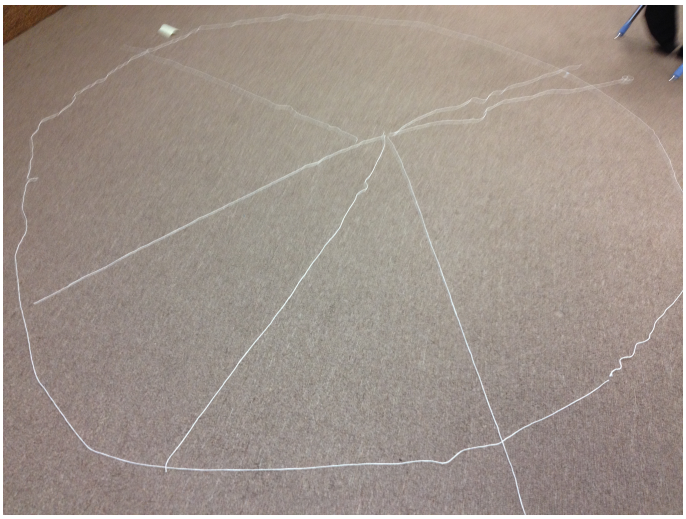
By articulating what data is, and how we use it, we can help remove students potential fear, or discomfort with using and understanding data. This lesson uses kinesthetic learning to help students understand and remember graphing concepts, and to break-up some of the routine of school. Students will get up, move around, and act out parts of the various graphs in order to physically experience graphing concepts with their bodies, and in a relevant, personal way.

Preparation:
You may need to rearrange your classroom for this activity so that students have room to move around, and form the graphs with their bodies. You may arrange desks into groups so that students can work together while sketching out the graphs after they form them.

If using butcher paper, tape up a big piece ahead of time onto the chalkboard or a wall where everyone can see-otherwise the plain chalkboard will work too. Draw the following onto the chalkboard or paper: an 'L' bar graph shape big enough to write out each month of the year along the x-axis (independent variable), and a scale based upon the number of students in your class, along the y-axis (dependent variable). This bar graph will be used to record students' birthdays.



Tape down a circle with the string, or draw a big circle onto a piece of butcher paper and tape that down to the floor. You can also make a graph around each group of desks, if breaking the room up that way. This pie graph will be used to record the different colors of shirts being worn by students that day.



Tape down a long piece of string to represent a x-axis, and another one to represent a y-axis. This will look like a big L in the middle of the room, or around desks. Again, you may want to have one line graph for each group of students. This will be especially helpful if you have a big class. This line graph will be used to record water temperature over time as months of the year. Write the following table of information on the board, or butcher paper somewhere that students can see it.

Date (2014)	Water Temp(°C)
Jan	5
Feb	6
Mar	8
Apr	10
May	11
Jun	12
Jul	20
Aug	20
Sep	13
Oct	12
Nov	8
Dec	6

Introduction:
Let students know that they will be learning about three main kinds of graphs-bar, pie, and line graphs, acting out the graphs, and drawing them. They will learn about independent and dependent variables along with the different parts that make up a graph, such as the title, legend, axes, bars, lines, and pie pieces. They will also think about how this might relate to their StreamWebs data, and will work more closely with their data graphing it in future activities.

Procedure:
1. Ask students what they think data is? What does it look like? *Data is pieces of information that can be represented by numbers, words, observations, or pictures. Data can be qualitative, meaning that it describes something, or it can be quantitative, meaning numbers. Qualitative data represents observations like color, levels of energy, or stories collected over time about a watershed. Quantitative data is numbers like levels of dissolved oxygen, recorded temperatures, or amounts of money. Data is often represented by making graphs that give us a visual tool to better understand our data. Graphs can be made to represent both qualitative and quantitative data.*

2. Discuss the three main kinds of graphs with students. Explain that choosing the correct type of graph is an important first step in analyzing and understanding what data tells us. There are several different types of graphs and each one tends to have a specific use.

- Line graphs are often used to show how something changes over time, such as student attendance. They have an x-axis on the horizontal line, and a y-axis on the vertical line. The x-axis usually has the data for the time period, such as months, days, or time; and the y-axis usually has the data for things being measured such as student absence.
    - How might we use a line graph for our StreamWebs data? We may measure water temperature or dissolved oxygen over time.
- Bar graphs are often used to represent categorical data. They may have an x-axis that represents time or what is being measured, and a y-axis that represents the amount of the information/data being measured. However they may measure things that have nothing to do with time, like a survey that asks people questions about their favorite parks, books, or preferences for cable television providers. Bar graphs would be a good way to demonstrate favorite activities among students at your school. In this case the categories, or x-axis, might be talking on the phone, going to the movies, skateboarding, playing an instrument, or attending a SMILE club. While the y-axis is the number of students that chose each activity as their favorite. The bars are different heights representing the amount of each category.
    - How might we use a bar graph for our StreamWebs data? We might use it to show the amount (y-axis) of different species of macroinvertebrates (x-axis) found during a field day.

- Pie Chart/graphs are good for showing percentages, or portions of a whole. They show data at a certain, and set point in time, and are not used to show information over time. For example, you may want to show what percentage of your friends like different types of movies such as: drama, horror, comedy, and/or romance (your categories of information).
    - How might we use a pie chart for our StreamWebs data? We might use it to show the percentage of the three different kinds of macroinvertebrates at a stream, based upon tolerance to water quality: Sensitive/Intolerant, Somewhat Sensitive, and Less Sensitive/Tolerant.

3. Discuss important steps and aspects of creating graphs with students.

- Graphing is used by scientists, or other users of data, to display the data that is collected during an experiment, or to organize and learn from information collected. For example, tracking our spending to make better decisions about how we spend our money, or surveying students to understand their study habits better. Another example might be tracking water quality information such as stream temperature and turbidity in order to study watershed health over time.

- A graph is a way of showcasing data and will be used to interpret, or to better understand data. If it is not created well, it may lead scientists or other users of data to incorrect conclusions, or hypothesis.

- The graph should contain 5 major parts: the title, the independent variable, the dependent variable, the scales for each variable, and a legend.

    1. **The title:** this shows what the graph is about. Reading the title should give the reader an idea about what they will see or learn about in the graph. It should be a concise and placed above the graph.

What are variables? Variables are objects, people, fish, events, preferences, time, money, or any other category you are trying to measure or observe, like we will do with water quality health in StreamWebs.

    2. **The Independent Variable:** this is the variable, or part of the data that changes, and that can be controlled or manipulated by the scientist, or any other user of data. This variable should be placed on the horizontal or x-axis, or represent the outside circle, or slices of the pie chart. This variable stands alone and cannot be changed by the other variable being measured. For example, someone's age, or time cannot be changed by the dependent variable such as how much time one spends on FaceBook, watching television, or playing guitar. However, someone's age may affect how much time they spend on FaceBook, watching television, or playing guitar. We are often trying to see if there is a relationship between variables, and if the independent variable possibly changes or affects the dependent variable.
        In our StreamWebs data the independent variable might be time, such as months.

    3. **The Dependent Variable:** this is the variable directly affected by the independent variable. It is the result of what happens because of the independent variable, in other words, it depends on the other variables or factors. This variable is placed on the vertical or y-axis, or represents how big the sizes of the pieces are (usually percentages) of a pie chart. The pieces should be drawn out using radial lines from the center to the outside of the circle (much like the spokes on a bicycle wheel). This variable can change based upon the independent variable. For example, a test score may depend upon other factors like how much you slept or studied beforehand, making it a dependent variable.

In our StreamWebs data the dependent variable might be water quality parameters such as temperature, dissolved oxygen, or types of macroinvertebrates, all of which might change based upon stream health.

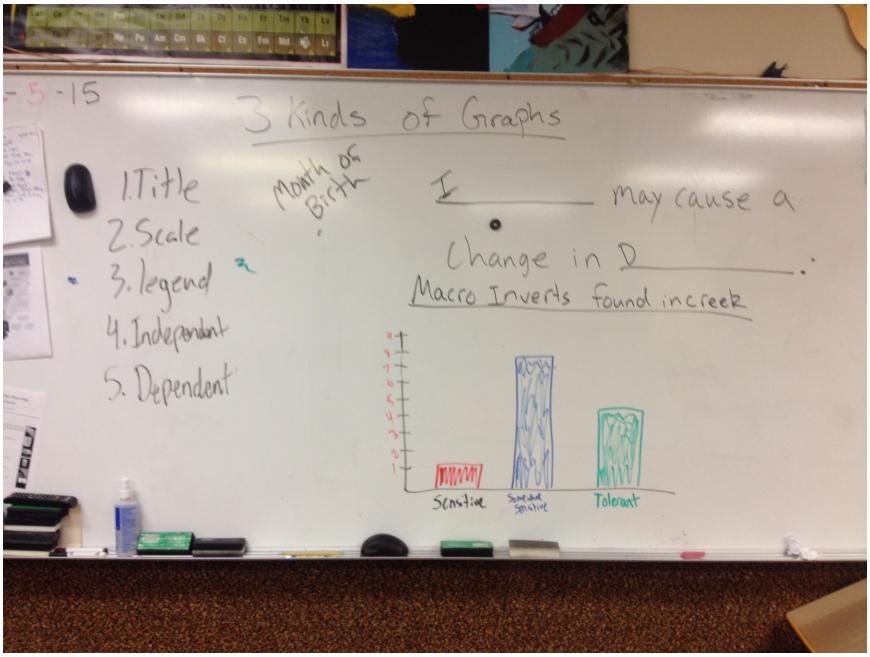
We are often trying to figure out what makes the dependent variable change the way it does when we study and graph data.

It can be very tricky for most people to think about and remember which variable is which, so a way to help you remember can be plugging your variables into this sentence to see if you have them right:

Write this sentence on the board:
(Independent variable) may cause a change in (Dependent Variable) and it probably isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

Write the sentence on the board again filling it in with examples:
(Age) may cause a change in (FaceBook usage time) and it probably isn't possible that (FaceBook usage time) could cause a change in (Age).

Now write the sentence again but leave the parenthesis blank. Ask for a student volunteer to fill in the parenthesis with examples of potential StreamWebs data, such as water temperature and time of year.



4. **The Scales for each Variable:** this guides where we plot the points, or symbols, representing the data when we construct our graph. In order to do this a scale must be designed that will include all the data points, and fill the graph space as much as possible. Each space or mark in the scale should have a consistent increase in amount, or increment, on a particular axis. Be sure to set up the scale in a way

that is manageable. For example, multiples of 5 or 10 are good, while multiples such as 2.77 are not! Your scale will be dictated by the data points to be graphed.

5. **The Legend:** this is a short description concerning the graph's data. Just like a map, it tells the reader what they are looking at. For example, it may explain the different colors of bars, pie pieces, or lines in a graph. It should be short and to the point and placed directly under, or beside the graph.

All graphs should be big enough, (for example, half of a piece of 8.5x11 page) so that information and data points can be located on them clearly and accurately.

The quantity and units must be labeled for each axis, bar, or pie piece.

Data points, bars, or pie pieces should be recorded, or drawn with a clear dot, bar or easy to see symbol. Depending upon what the graph represents and who it is being prepared for, symbols may be used instead of simple plotting dots. For example, for our StreamWebs data we may use fish to represent our data, and draw them stacked upon each other to represent each bar.

- Choosing correct colors for data visualization and representation is another important step. For example: choose colors that are easy to see and that align with what people may already consider in relation to a color, such as: red symbolizing hot and blue symbolizing cold, or water.

4. Handout:

Graph paper (if using it), or paper if students need it
Colored pens, pencils, or crayons-about 5 colors per student
One sticky note per student
Have string handy

5. Tell students that they will now demonstrate the three different graphs based upon data about themselves. First they will act out the graph, and then create it on their paper, or on the class butcher paper.

6. Create and act out a pie chart based upon the color of students shirts. Explain to students that the class as a whole will represent 100%. Look around the room and choose 4-7 colors of shirts (dependent variable) that students (independent variable) are wearing to represent the pieces of the pie, or percentages. Ask students to stand in the circle, according to shirt color, to form the chart. If your class is too big divide each shirt color group and have them form smaller versions of the graph within their own strings.

Ask a student volunteer to complete (out loud or writing it on the board) the sentence you wrote on the board based upon this graph:

(Independent variable) may cause a change in (Dependent Variable) and it probably isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

(Students) may cause a change in (Shirt color) and it probably isn't possible that (Shirt Color) could cause a change in (Students).

Ask students to draw the graph on their own paper-explain that it does not need to be perfect and they can free draw it for now. Explain that you will work on scale, labels, and legends next time with your StreamWebs data. Have a volunteer share their graph.

7. Create and draw a bar graph on butcher paper or the chalkboard based upon the students birthdays. Ask students to write their name on their sticky note. Now ask students to come up to the butcher paper/chalkboard and attach their sticky note above the corresponding month (dependent variable) that matches their birthday month, in order to see the number of students (independent variable) in each month. Instruct them to stack them neatly on top of each other so that they will represent the bars of a graph.

Ask a student volunteer to complete (out loud or writing it on the board) the sentence you wrote on the board based upon this graph:

(Independent variable) may cause a change in (Dependent Variable) and it probably isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

(The Months of the Year) may cause a change in (Number of Students with Birthdays) and it probably isn't possible that (Number of Students with Birthdays) could cause a change in (the Months of the Year).

Ask students to draw the graph on their own paper-remind them that it does not need to be perfect and they can free draw it for now. Have a volunteer share their graph.

8. Create and act out a line graph based upon mock StreamWebs data (or your own if you already have it). Explain to students that we are now going to work with data that represents the type of information we (will) gather(ed) in the field when we collect(ed) StreamWebs data. We are going to create a line graph using water temperature (dependent variable) over time (independent). Use the table with months and water temperature that you put up or drew on the board during the preparation (or a table with your own data).

Ask students what sort of scale you should use to represent this data? Most likely time in increments of one, for each month along the x-axis. And, temperature in increments of 5s, for the y-axis.

Ask volunteer students to line up along the x-axis and give them sticky notes to put at their feet with the number of each month (or to hold). Do the same with sticky notes for the temperature increments in degrees celcius along the y-axis, and have volunteer students create the y-axis.

Ask a student volunteer to complete (out loud or writing it on the board) the sentence you wrote on the board based upon this graph:

(Independent variable) may cause a change in (Dependent Variable) and it probably isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

(The Months of the Year) may cause a change in (Water Temperature) and it probably isn't possible that (Water Temperature) could cause a change in (the Months of the Year).

Ask students to draw the graph on their own paper-remind them that it does not need to be perfect and they can free draw it for now. Have a volunteer share their graph.