The Data Game

Purpose

To learn how to estimate data results in order to minimize errors in reading or recording data

Overview

Students participate in a game in which they collect data using various instruments and calculations and then try to fool other data collection teams by exaggerating some of the data numbers. They do this activity first with data describing objects in the classroom, then with soil moisture measurements, and then with other GLOBE data.

Student Outcomes

Students will be able to recognize the accuracy of data.

Students will be able to analyze GLOBE data for outliers and accuracy.

Scientific Inquiry Abilities

Identify answerable questions.
Design and conduct an investigation.
Use appropriate tools and techniques including mathematics to gather, analyze, and interpret data.
Develop descriptions and explanations, predictions and models using evidence.
Communicate procedures and explanations.

Time

One class period

Level

All

Materials and Tools

For younger students:
Rulers
Measuring tapes
Measuring cups and spoons

For older students:
Instruments for measuring:
a) distance
b) volume
c) circumference
d) weight

Prerequisites

None

Background

Scientists rely on the accuracy of the data submitted by schools. However, even the most careful observer can make a mistake in data collection and recording. It is essential to make sure your data are as accurate as possible. One way to avoid mistakes is to have students critically evaluate any number they write down. Does this number sound reasonable? Is it even possible to have this number? As students become more familiar with the measurements they are taking, they will get a feel for what to expect.

There are two elements necessary for students to judge the reasonableness of data values. First, students have to understand the units of measure: About how far is a meter? How much water is a liter? How much does a liter of water weigh? Second, students need to have a sense of the expected range of data values for the protocol: what are the lowest and highest values one might expect for soil water content? For air temperature?

In this activity, your students will deal with both elements in the form of a game. They will work in groups to collect and record data. Then they change some of the values and have the other students guess which ones are wrong, based on a sense of "reasonableness" of the values.

Using this "reasonableness" criteria is a fundamentally important skill, as it requires students not only to know what values one might expect, but also to take personal responsibility for the accuracy of their data.

It should be stressed that your students may collect accurate data that is unexpected. Estimating what to expect will also help students recognize when their data are unusual and should prompt more investigation.

What To Do and How To Do It

Stage 1 — Estimating data about classroom objects

1. Divide your class into teams of four students. Provide each team with measuring instruments and have the teams collect classroom data. Each team should collect and record 5 to 10 classroom data values.

   Beginning students might:

   - count the number of books, tiles, fingers, etc. in the classroom
   - measure the length of ten books, the room, around a desk, etc.
   - measure the amount of water in a glass, the sink, etc.

   Intermediate students might:

   - measure and add distances (the height of a desk and all the desks in the room)
   - calculate the height of all text books piled together.

   Advanced students might:

   - calculate areas in square meters, volumes in cubic centimeters, and weights..
2. Now have each team "disguise" part of their data by exaggerating the numbers. For instance, a cube with a volume of 10 cubic centimeters should be changed to 20 or even 200 cubic centimeters. The less the exaggeration, the greater the challenge for the other students. (You may want to begin with the rule that the exaggerated value is at least double the measured value.)
3. Each team takes turns reporting their data. The other teams must guess whether or not the report is accurate. Each team that is correct gets one point.
4. After all teams have taken turns reporting their data, the team with the most points wins.
5. At the end of the activity, discuss the process of estimating, and the concept of reasonableness. You might want to repeat this activity to see if the students improve.

Stage 2 — Estimating soil water content data

Your students will apply the same concept to soil moisture (you can play the data game with any type of data). You can use soil moisture data that your students have already collected as part of the protocol, or with soil moisture data from the samples students brought from home as part of the learning activity *Soils as Sponges: How Much Water Does Soil Hold?*

As described in Stage 1 above, have your students change some of the data values for soil water content, and then have other students guess which values are accurate and which are exaggerated. Score as described above.

Stage 3 — Using data from the GLOBE Student Data Server

1. Have the students access the GLOBE Student Data Server to browse through soil water content data that have been gathered by other GLOBE sites. They should find:
   - the range of data for each depth
   - the range of data for schools nearby
   - the range of data for schools in arid regions or forests or grasslands
   - the most common values.
2. Discuss the ranges and common values, and have your students reflect on how this information would help them to do better in the data game.
3. Have your students play the data game again, using global data from the GLOBE Student Data Server.
4. Discuss with your students how this process – reviewing sample data first in order to get a sense of what to expect – is an essential step in estimating values and judging "reasonableness."
5. You can repeat this activity with any of the GLOBE datasets.
6. It is also important to point out that abnormal data, often called "outliers,"

are not necessarily wrong, but certainly need to be looked at closely. Outliers, in fact, are often the most interesting or important data to investigate further.

7. If any of the values in the GLOBE Student Data Server do not seem correct, then have your students communicate with the school which submitted the data, and ask the students if there are reasons for the abnormal value or if there might be errors in the data.

Adaptations for Intermediate and Advanced Students

With older students, you can have them try the same activity with soil texture or color to identify how variable these properties can appear from one student to another. Differences between soil texture measured in the field and the texture class determined by the particle size distribution method are also good places to look for differences in the same data measurement obtained by 2 different methods.

Students can also graph data (especially in Stage 3), and then do an analysis of the range, the outliers, the average values, the most common values, and so on. They might also discuss why there are variations from one site to another in the global data set. This in turn relies on a deeper understanding of the science domain, such as soil.

Further Investigations

Whenever your students have problems knowing what are typical values for a protocol, you can have them play the data game. Be sure they review the protocol and sample datasets first so that they will have a basis for assessing reasonableness.

On a regular basis, review the soil water content, soil texture, and other data submitted by other schools to look for errors or outliers, and communicate with the schools to discuss any abnormal values.

Student Assessment

Periodically, when your students do the GLOBE protocols, have one of your students announce the values to the class, including an erroneous value, and see if any other students notice the error. You could reward the error-finding with a reward appropriate to the age level. Make sure that the error is corrected before your students submit the data to GLOBE!