Data Explorations in Ecology: What do students know, and need to know, in order to make environmental citizenship decisions?

Cornelia Harris, Angelita Alvarado, Alan Berkowitz, & Celia Cuomo
Cary Institute of Ecosystem Studies

Background

We are exploring how to help high school teachers and students make sense from data they collect themselves (first hand data) and get from the internet or other sources (second hand data). Our conceptual framework recognizes two “directions” of data exploration (inquiry and critique) and the distinct but interacting facets of the process (collecting and dealing with raw data, data transformations, analyses and representations, filtering evidence, making claims based on data). This framework helps teachers and their students see the context of their explorations when dealing with first versus second hand data. We have formed a professional learning community (PLC) of seasoned biology and environmental science teachers to help us investigate different sequences and types of supports for student data exploration. To date, we have piloted several instructional modules, and continue to revise and refine our instructional materials, professional development plans, and assessment tools.

Results

What do students understand about data exploration?

1. When asked to identify which period in Figure 1 had the most variability, 86% of students were able to correctly do so.
2. When asked what variability is (open-ended question), 72% of students were able to explain it.
3. However, when asked to apply these ideas (using Figure 2), 77% of students did not invoke variability. Instead, when asked to explain “How does a bar graph compare with a scatter plot, in terms of variability?” they thought that:

- 10% thought that a bar graph was easier to read than a scatter plot
- 20% thought that a scatter plot was easier to read
- 30% thought that a bar graph was easier to read
- 40% thought that a scatter plot was easier to read
- 50% thought that a bar graph was easier to read
- 60% thought that a scatter plot was easier to read
- 70% thought that a bar graph was easier to read
- 80% thought that a scatter plot was easier to read
- 90% thought that a bar graph was easier to read
- 100% thought that a bar graph was easier to read

How does data exploration relate to environmental citizenship?

When students were asked to interpret the second graph on the right, and explain whether they agreed or disagreed with the salt company’s claim that there are no problems with salt pollution in the river, 43% of students disagreed, while 30% agreed.

Of those who disagreed, the most common reasons were:
1. The graph shows a shorter time period OR student pointed out that the dataset is smaller (30%)
2. Induced error (21%)

For students who agreed, the most common reason (47%), was that the graph showed a decrease in chloride levels.

Conclusions

...about data exploration

- Students know what variability is, and how to identify it, but they don’t know how to apply that information or why it is important in scientific studies.
- Students find bar graphs easier to read than scatter plots.
- Students are very comfortable invoking reduced error as opposed to real error.
- Students believe that graphs = truth, and are not critical of data that are supplied to justify a claim.

...about motivation and engagement

- Students enjoy working with their own, and with others’ data.
- Students felt that the teaching modules helped them learn about something relevant, gave them an opportunity to learn from others’ data, and made them think about the causes and effects of pollution.
- Students thought that the teaching module helped them make sense of their own data, and taught them the importance of conducting scientific investigations.
- Students became interested in using data to evaluate a scientific claim or argument.

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Current teaching modules include:
- Salt pollution in Freshwater Streams
- Ecological Consequences of Hydrofracking
- Biodiversity of Hudson River Fish
- Acidity Changes in Local Waters
- Soil Lead Contamination