Overview and Purpose of Analyzing our HF Schoolyard Ecology Leaf Data

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Over the last few years, students in the Holyoke Catholic High School (HCHS) freshman Environmental Science class collected spring and fall data on our campus trees using the Buds and Leaves protocol. We collected data on 27 trees. These trees surround our urban school along the sidewalks and parking lot. Some trees are native species and some are ornamental.

Our school actively engages in the Next Generation Science Standards (NGSS). This protocol allows our students to fully engage in the science practices (1, 3-8 see below) as we address disciplinary core ideas (DCI) in both the Life Science (LS-2) and Earth and Space Science (ESS3) and the cross cutting concept: patterns. The integrative nature of NGSS is used effectively with the Harvard Schoolyard LTER across various ability levels.

Unfortunately, not all trees had data collected on them each year. This was due to the number of students I had in the freshman class each year and which class I incorporated it into the curriculum in a given year. Since, in the past, some of the analysis was considerably more complex, one year I only did the program with honors students. And one year, I only collected data and did not analyze, hence only used it in the regular level class. However, starting with this year, the plan is now to use it in both regular and honors level. Since the incorporation of the new 50% data software program built by Harvard, we are now able to more easily analyze data. Hence, I can effectively differentiate the final analysis of the data for all learning levels.

Usually, each tree has 2 students collect data, one for each branch. However, if the numbers are higher, I put 4 students on one tree in the regular class. Inevitably, there were some groups that even with careful monitoring do not collect the data correctly and it will go unnoticed until careful examination of the data, after the season. Hence some data could not be used for a tree in a particular season. Without both seasons of data in a given year, season length could not be calculated for all trees in all years. However, this problem created an excellent opportunity for students to work within parameters that were not all neat and perfect, emulating science more closely and seeing the difficulties large studies can run into.

NGSS Practices addressed.

1) Asking Questions and Defining Problems-
    a. HCHS Students recognize the part they play in our school's question- Is the growing season of our campus trees changing over the years?

b. Since this question cannot be answered in any one year, students understand the requirement in science for ongoing studies to answer a single question.

3) Planning and Carrying Out Investigations
- NGSS write: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.
- HCHS students recognize that to effectively carryout a long-term ecological study, they must follow the same protocol year after year. When student go to analyze the data, they witness first hand what happens if protocol is not followed well. When student in one season don't follow it, they cannot calculate the growing season for that tree.

4) Analyzing and Interpreting Data
- NGSS Write: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
- HCHS student spend 4-5 class periods, downloading, organizing, discussing, graphing, analyzing, and interpreting the robust amount of data from the Harvard database.

5) Using Mathematics and Computational Thinking
- HSHC student approached the data analysis a couple of different ways. Some of the students used the Harvard generated graphs and completed their own mathematical computations to determine season length. As a teacher, I was please to see them approach the graph analysis process from this angle, allowing me to emphasis the need to use their mathematical knowledge in science.

6) Constructing Explanations and Designing Solutions
- HCHS students throughout the time in the computer lab could be heard discussing the graphs and offering possible explanations for a variety of the trends they saw.

7) Engaging in Argument from Evidence
- HCHS students were regularly reminded as they offered explanations, to support their explanation with evidence from their graphs. This was especially emphasized in their final write up.

8) Obtaining, Evaluating, and Communicating Information
- NGSS write: Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

- HCHS students downloaded various graphs from the Harvard site, downloaded data into an excel spread sheet, then manipulated this data to create additional graphs, write result statements for the graphs and write general summary paragraphs for the trees they observed. This was submitted in final form and can be seen in the student sample work.

Teacher Reflection:
I was amazed at what my students were accomplishing while they worked through the Harvard Schoolyard data analysis. After working to create a step-by-step instruction guide (included,) I brought my students to the computer lab for an extensive period of time (4-5 days) to complete a full analysis of their Harvard Schoolyard Buds and Leaves data. From the honors levels, who have really developed the skills of analysis and interpretation of data and engaging in argument from evidence to my lowest level student who normally would not be able to process quickly enough for a general class discussion, every student was able to sit with their computer, either alone or with a partner, and walk through the steps to make and/or look at the graphs, and articulate in both speech and writing the trends she/he saw with only minimal of teacher support. I could not be happier with the learning that I witnessed. However, in the future what I want to include in the final summary is more on the background information and more on the constructing explanations. Though the students talked about it, and some wrote about, it was not in their instructions to include it directly, hence I need to be more specific in this regard.

Student samples include three levels. These all were done using both Harvard generated graphs and Excel built graphs using the new 50% data downloaded data. Some of these also have the Excel documents to support their written document.

- Honors level (Brad and Sophie, and Rachel S and Katie B) – showed a variety of approaches and personal styles.
- Regular level (Matthew N) shows the clear concise style straight forward approach.
- Severely learning challenge student, Keegan O who accomplished it with minimal mistakes and spot on interpretation.