This Module for Interactive Teaching (MINT) may be found online at
https://ivv.rit.edu/wg-mint.php

Scientific data presentation

- Populations exhibit variability due to abiotic influences
- Correct data visualization allows analysis

Contents:

MINT Learning Objectives

- Describe ways that a set of raw data could be presented as analyzed data.
- Analyze data sets (continuous and categorical) to make accurate conclusions about the experimental data
- Create a graph that is an accurate representation of a set of categorical data and include error bars to show variance.
- Create a graph that is an accurate representation of a set of continuous data and include error bars to show variance.
- Form a logical/viable hypothesis that would explain variation that is present in a data set.
- Design an experiment in which the need for multiple sampling is recognized and is included in the proposed methodology.
- Explain why statistical tools are needed to illustrate variance in data.

National Standards Alignments:

- Vision and Change Core Concepts and Competencies (http://visionandchange.org)
    - Core Concept:
        - Systems: Living systems are interconnected and interacting.
    - Core Competencies:
        - Ability to tap into the interdisciplinary nature of science: Biology is an interdisciplinary science
        - Ability to communicate and collaborate: Biology is a collaborative scientific discipline.
        - Ability to use quantitative reasoning: Biology relies on applications of quantitative analysis and mathematical reasoning.

- Next Generation Science Standards (https://www.nextgenscience.org/)

    - Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)
- Process of Science Skills, Pelaez, N, *et al*. "The Basic Competencies of Biological Experimentation: Concept-Skill Statements" (2017). PIBERG Instructional Innovation Materials. Paper 4. http://docs.lib.purdue.edu/pibergiim/4
    - Posing problems
    - Generating hypotheses
    - Designing experiments
        - Multiple samples required due to variation within a population
    - Testing hypotheses
    - Interpreting/evaluating data
        - Visual representations used for interpretation of data

Interactive Video Vignette Information

IVV Title: *Whose Graph is Better?*

IVV URL for students: https://ivv.rit.edu/WG/2/
Copy the URL to the Clipboard. Either paste it into an email to your students, or use it to create a link in your course management system.

IVV description:
Two students collecting field data disagree over the appropriate number of samples to take as well as how to represent the quantitative data. In the computer lab the students seek the help of a TA and work to understand the difference between raw and analyzed data, the correct way to represent categorical data, and the importance of proper statistics.

Novice ideas and IVV learning Goals

Novice Ideas

- Students assume graphs are simply representations of raw data. They do not provide any further information.
- Students are unaware of the differences between categorical and continuous data. Therefore, data can be treated and graphed in the same way.
- Students think all organisms in a population are the same (therefore, organisms do not vary in any relevant way)
- Only genetic differences among organisms play a role in determining phenotypic differences.
- Students think that taking a sample from a population is sufficient because the population in uniform (therefore there is no reason for multiple sampling)
- Students think that averaging data, without further statistical analysis, is sufficient to make viable conclusions about the data

Ideas addressed in the IVV

- A graph has a purpose beyond just displaying the data in a visual way. Graphs help scientists draw conclusions. (to show a trend, a difference between samples, etc…)
- Bar graphs are an appropriate way to show categorical data.
- Line graphs are an appropriate way to show continuous data.
- Populations (e.g. a particular plant species) vary depending on the environmental ("abiotic") conditions in which they are growing.
- Phenotype depends on both biotic and abiotic factors
- Conclusions about a data set may be faulty if the number of samples was too low to account for the natural variation in the population.
- Statistics help show the variance within a data set.

Recommended In-class Curricular Material

Please see the MINT FAQ (https://ivv.rit.edu/FAQ.php) for general information on the use of MINTs and IVVs with your class. The following curricular materials are provided as examples of resources that may be used in class to further student learning towards IVV and MINT learning objectives.

- DeBoy CA. Student Use of Self-Data for Out-of-Class Graphing Activities Increases Student Engagement and Learning Outcomes. J Microbiol Biol Educ. 2017. doi:10.1128/jmbe.v18i3.1327

Assessment Question Information:

The research team has developed multiple select questions for assessing IVV effectiveness. Please contact the research team (https://ivv.rit.edu/about.php) if you are interested in assessing IVV use in your course.

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