The Benefits of Peer Instruction and Collaborative Study in Acquisition of Data Analysis Skills

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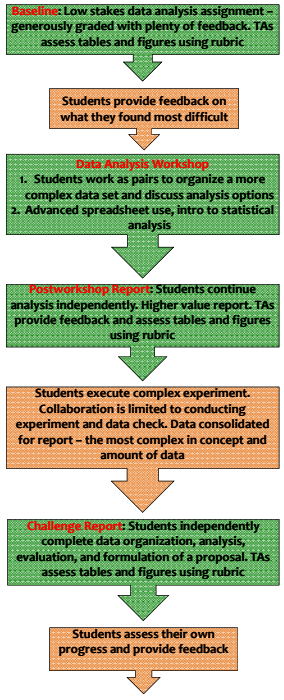
Introduction: The Problem

The goals for my lab are to have students become good in content, critical thinking, and scientific writing. However, incoming students often lack prior experience in any of these categories. Once the guidelines of an experiment are established, students have little difficulty in accumulating data. When the information is descriptive, as in the results from physiological tests, students are fairly intuitive in organizing their thought processes and thus in ordering their data and completing their analyses. However, faced with large amounts of numerical data, as in a water contamination study, or an enrichment and enumeration experiment, students are overwhelmed and have little idea where to begin. This is reflected in simplistic analyses in lab reports. The challenge was to enhance their organizational and critical thinking skills in 10 weeks and to do so in a manner that promotes practice ad skill retention. This year, I reorganized the course to address these issues on a daily and systematic basis. The main strategies are described.

A systematic approach to understanding data analysis and presentation.

Method



ABSTRACT

Data organization is a fundamental part of any scientific writing and is invaluable to the development of analytical and critical thinking ability. I run a data analysis workshop in the early stages of the course in which students work in pairs to organize, analyze, and summarize a moderately complex data set using a spreadsheet program such as Excel, with subsequent independent work. The format of the workshop promotes healthy dialogue between students, and between students and instructor **while** the students are in the learning process. This provides the opportunities to:

•Answer questions in real time
•Gauge student understanding before misconceptions set in
•Monitor and guide work as it proceeds to avoid frustration and fatigue

Research shows that students make more rapid gains in problem solving through peer instruction and collaborative work. We have found that students working with partners go much further in suggesting and testing approaches than they do when working independently. Measurable gains have been recorded based on a comparison of pre and post workshop homework, lab reports, as well as student self-evaluation. High levels of skill retention in the 8 weeks following the workshop and continuing development of expertise with incrementally difficult analyses have also been recorded. The methodology is readily adapted to students at all levels in their college career.

HELP! Top 5 student requests after Baseline assignment:

1. Teach me how to use Excel (or other spreadsheet program).
    a. How to sort data when there are multiple variables
    b. How to calculate averages, standard deviation, standard error, etc.
    c. How to plot and add error bars
2. How to determine the correct control condition
3. How to identify trends in data
4. How to condense results into a few tables/figures.
5. How not to panic!

Solution:

A. Data analysis workshop:

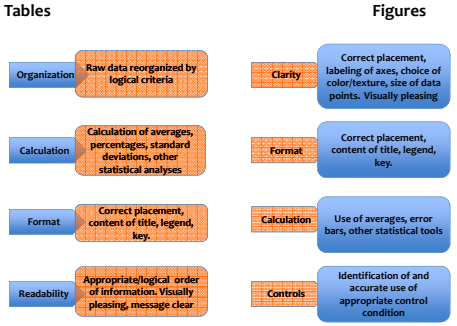
1.Preliminary reading on topics related to expected analysis
2.Complex data set provided – larger number of samples, more calculations necessary
3.Students work in pairs or small groups.
4.Goals for the session:
    a. Identify the question/hypothesis
    b. Identify the appropriate controls
    c. Sort data by relevant criteria
    d. Construct charts or figures
    e. Identify trends
    f. Find ways to plot data in condensed format
5.Address as many questions as possible.
6.Follow up one-on-one help as required

Assignments

The three major assignments – Baseline, Postworkshop, and Challenge – are incrementally more challenging. Tables and figures in each of the assignments are assessed with the same degree of rigor using the rubric shown at right. Results of the assessment are shown in figures 1-3.

Assessment Rubric Criteria

The same rubric, devised with information from Stevens and Levi[1], is used with each assignment. Each criterion was scored good, moderate or poor. Assessment with the rubric for the study is separate from the scoring for grades.



RESULTS

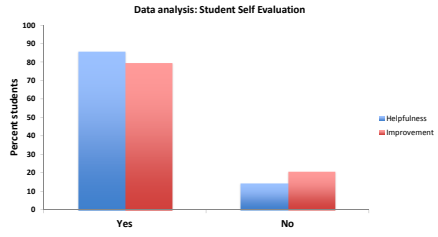


Figure 2. Results of an anonymous self-evaluation survey conducted at the end of the course. 100% of the students responded. Panel shows their response to the question "did they find the collaborative efforts in data analysis useful" and my analysis of their responses to the level of expertise at the beginning and the end of the course.

Conclusions and Future Directions

1. Collaborative data analysis workshops are very effective tools for raising cognitive skill levels, both as measured by student performance and by their self-evaluation
2. Students enjoy guided collaborative work, peer instruction, and collaborative learning as shown by their feedback.
3. Peer instruction and collaboration reduces stress and increases communication
4. There are still gaps in student understanding of higher order data and concept analysis and synthesis. Future efforts will be directed towards addressing these issues.

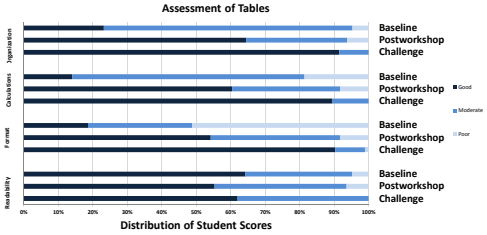


Figure 2. Data analysis and representation in tables; an assessment of progress over one quarter. Tables in 100 sets of student reports (Baseline, Postworkshop, and Challenge) were assessed using the criteria listed above. Performance in each criterion was ranked as Good, Moderate, or Poor and the percentage of students ranked at each level was plotted for each report. The dark blue portion of each column represents the highest level of performance in that criterion.

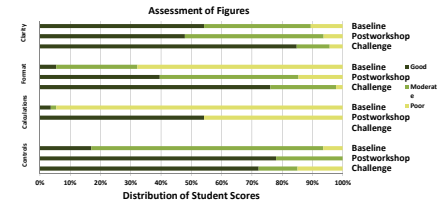


Figure 3. Data analysis and representation in figures; an assessment of progress over one quarter. Tables in 100 sets of student reports (Baseline, Postworkshop, and Challenge) were assessed using the criteria listed above. Performance in each criterion was ranked and reported as in Figure 2. Data was not available for the Calculations criterion at the Challenge level. The dark green portion of each column represents the highest level of performance in that criterion.

Summary:

Students showed significant gains in all aspects of data organization and analysis except readability of tables, as shown both by self-evaluation (Figure 1) and TA assessment (Figures 2 and 3). The workshops helped us identify immediate and larger issues and address them in a timely manner. Both students and instructors benefited from the interaction and students participated much more in follow up discussions.

References:

1. Stevens DD, Levi AJ. 2005. *In* Introduction to Rubrics. Stylus, Sterling, VA.