Introducing statistical tools in biology labs to facilitate student research

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Introduction

Why teach stats in bio labs?

- Data analysis is key to the scientific method.
- Enable students to analyze results from inquiry-based laboratory projects.
- Just-in-time teaching makes statistics more relevant and interesting to students.

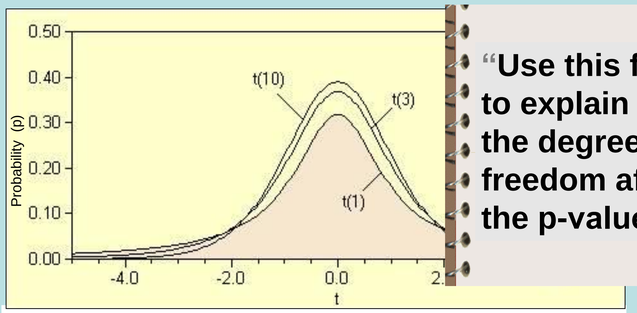
We designed and assessed statistics instructional materials that can be implemented in four weeks of a biology laboratory. We interspersed statistics tutorials and active learning lessons as students were entering into each phase of their research project

What should students be able to do after this unit?

- Design experiments to test a stated hypothesis.
- Choose, conduct, and interpret statistical tests to compare means
- Appreciate the role of statistics in research

Approaches to student learning

- Collection & graphing of stream data
- Readings & questions from statistics primer we wrote
- Mini lecture on experimental design, summary stats & graphs, with examples from variety of biology disciplines
- Critiques of experimental designs
- Presentations of research proposals
- Group project written reports
- Immediate feedback questions to practice t-test selection: paired or independent, followed by discussion
- Small group presentations using "jigsaw" approach so that each group explained different aspects of t-tests (Fig. 1)



"Use this figure to explain how the degrees of freedom affect the p-value."

Fig. 1. Example of t-test question that students discussed in a group and then explained to other students in lab.

Assessment of student confidence & learning

"Please rate your skill" (0= none; 6= very high)

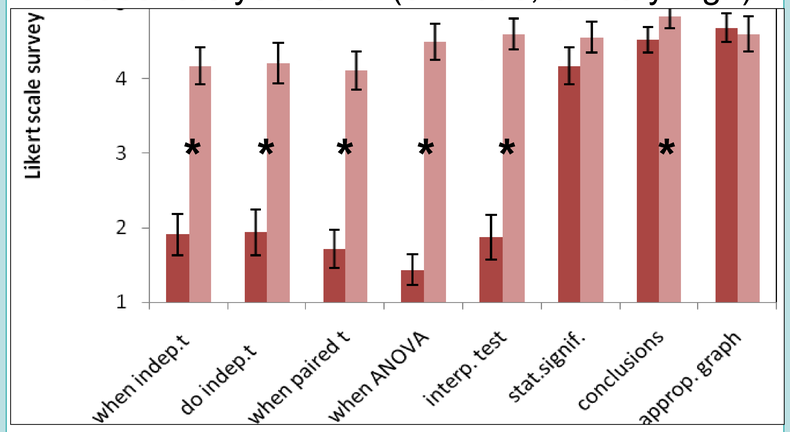


Fig. 2. Mean (+- 2 SE) self-reported skills **before (red) and after (pink)** our instruction. Asterisks (*) indicate significant differences based on permutation tests paired by individual student (n = 78; p < 0.005).

Student performance on ungraded essays:

	Pre	Post
Identified appropriate statistical test to compare treatment means (n = 65; McNemar's $\chi 2 = 31$, $p < 0.0001$)	2 %	45 %

On final research reports, most groups (88%) drew appropriate conclusions from hypothesis tests. On data reporting tasks that we did not discuss during lab (but made available in the statistics primer), only 34 % followed directions.

Increased student appreciation:

More students planned to take a full semester statistics class after experience in this lab than before (McNemar's $\chi 2 = 7.4$, df = 1, p = 0.007).

The University of Wisconsin - Madison Biology Core Curriculum

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