

# Teaching Data Analysis and Presentation (as well as some Statistics) in an Introductory Biology Class

*David Hougen-Eitzman*

Carleton College  
Biology Department  
1 North College Street  
Northfield, MN 55057

[deitzman@carleton.edu](mailto:deitzman@carleton.edu)

**Abstract:** Biological researchers are often required to analyze and present data, and as such, these skills are important for biology students. Using a methodical approach in the design of laboratory exercises, students can be taught how to analyze and present data. A set of example exercises are presented for an introductory biology class that introduce data entry and manipulation in a spreadsheet program, graphing with error bars, and use of the Student's t-test.

*Find teaching materials online at :* <http://people.carleton.edu/~deitzman/ABLE2006/>

## Introduction

**An introductory biology course is the ideal place to teach data analysis.** Being able to analyze and present data is an important skill with which all biologists should be comfortable. When an introductory biology class is a gateway into the curriculum of the biology department (i.e., all students must take the introductory courses before taking mid- and upper-level courses), this introductory course provides an ideal venue for teaching these skills.

**Students can do this.** From my experience at Carleton College, students in an introductory biology class can learn how to analyze data. They can manipulate data sets and create legible graphs, they can even do elementary statistics such as a t-test or chi-square test. From a teaching perspective, the important thing is to teach students how to do **all** the necessary steps, and to do so in an organized and methodical manner.

**Make the data analysis fit in with the course content and goals.** Though an introductory class presents an excellent opportunity for teaching students how to deal with data, it is important to have realistic expectations. Designing a good set of laboratory exercises is a challenging task, and there are compromises that must be made. There will no doubt be a host of teaching goals, dealing with both content and techniques; data analysis and presentation can certainly be included in these goals, but one must keep in mind that the class is a biology class, not a statistics class.

**Issues to consider and an example class.** Below I list several issues to consider and show how I have incorporated data analysis, presentation, and statistics into the laboratory exercises of an introductory biology class at Carleton College.

### **What are the teaching goals?**

Before finalizing the laboratory exercises for the class, it is important to first decide on the teaching goals (with respect to data analysis). It helps to ask a few questions:

- What analysis skills do you want students to learn?
- What data will be used for analysis?
- What types of graphs will students make?
- Will students manipulate data with a computer program such as Microsoft Excel?
- What types of graphs will students make? What software is to be used?
- Will students use a statistical test? Which one?

### **An example course: Biology 126**

This is a 9½ week introductory Biology course, one of two required intro courses at Carleton College. There are no course prerequisites.

**Lab sessions:** Nine 4-hour labs

**Analysis goals:**

- Use spreadsheet program (Microsoft Excel) to enter and manipulate data
- Make scatterplot and bar graphs, calculate standard error and put on graphs
- Conduct simple statistical test (t-test), use p-values, interpret results

### **Teaching tools used in Biology 126**

In teaching data analysis, statistics, and graphing, I have come up with a set of tools to help students accomplish their tasks. Most of these have make use of computers, partly because computers are effective tools for data analysis and graphing, and partly because modern students are usually adept at using computers and the internet. Many of the documents described below are available online at <http://people.carleton.edu/~deitzman/ABLE2006/>.

**Computer teaching lab:** a computer teaching lab (which has a computer for each student and a on-screen monitor for the instructor) is an excellent location for giving students an introduction to using a computer program such as Microsoft Excel. The first lab of the term meets in a teaching lab. We present a dataset to the students and then teach them how to do some data analysis and graphing. See the lab assignment at [go.carleton.edu/c5](http://go.carleton.edu/c5)

**College computer network:** I use the college computer network as a place to store class datasets. When we run an experiment during lab and then use the whole-class data for analysis, the dataset is stored on the college network. We have a computer in the lab room, at which students can enter data into to the dataset as data is collected. Later, the network provides a way for students to access the data on at their convenience to do data analysis. Make sure to set the dataset to be “read-only” so that students do not inadvertently alter the dataset.

**Methods Primers:** During the term, students analyze data from several lab experiments, however the data generated by each experiment requires slightly different analysis, statistical, and graphing techniques. To help students through each analysis, I have created what I call “methods primers” – these are Microsoft Excel documents that use an example dataset to show students how to do an analysis and/or how to graph data. These primers are linked off of the class website, however they could easily be accessed from a folder on the college network. It is important that the primers be stand-alone and that they present the analyses clearly, so that students can do the work late at night (when there is no one available to ask questions). When I make the primers, I use data from an experiment that is similar to the one we do in lab, but not identical. See several methods primers used in Bio 126 at <http://people.carleton.edu/~deitzman/ABLE2006/>.

### **About the Author**

**David Hougen-Eitzman** is a senior lecturer in the Biology Department at Carleton College. He teaches introductory biology, as well as classes in entomology and agroecology.

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## Building a set of skills and tools

### Teaching Concept

Use a spreadsheet program to manipulate, analyze and graph data

#### Start at the beginning

- even though many students are computer-literate, start at the beginning so that all students are included.
- students who claim they “know it all” usually learn some new things.

#### Progressively build set of tools and use experiments to generate data for analysis

- don't be afraid to progress quickly
- repeat skills in subsequent labs  
A → AB → ABC → ABCD
- students are more interested in the data when they collect the data themselves. And it's always more exciting to work with real data.

#### Internet and College Computer Network are useful tools

- students are internet savvy, so web is good way to dispense information
- college network provides location for class datasets
- Methods primers – provide online documents to show students how to do analysis and graphing. Students can study the primers outside of class while working on their assignment

### Application in Class

#### Use Microsoft Excel

- Excel can manipulate data, do graphing, and do simple analyses

**Lab 1 – Whole class introduction to Excel** in a computer lab. Each student has a computer and instructor leads exercise with computer that projects onto a screen

**Lab 2 – Protein assay and standard curve.** Plot data and fit curve. This assignment builds on data manipulation and analysis skills from lab 1.

**Lab 3 – Enzyme kinetics.** Plot two curves – Michaelis Menten and Lineweaver-Burke plots. Repeats skills from lab 2.

**Lab 4 – Experiment about membrane function.** Bar graph with error bars. Repeat data manipulation skills from lab 3.

**Lab 6 – Experiment about effects of CO<sub>2</sub> on plants.** Bar graph with error bars. Conduct t-test. Repeats skills from lab 4.

**Lab 9 – Experiment on Aquatic Ecology.** Bar graph with error bars. Conduct t-test. Repeat skills from lab 6.

Note: Labs 5, 7, 8 deal with other content and lab skills

**In-lab data entry** – For whole class experiments (labs 4, 6, and 9 above), students enter data during lab onto a single datasheet on the college computer network.

**Data Analysis** – Dataset is on the computer network and is available to all students. Students analyze data outside of lab.

**Methods Primers** – Excel spreadsheet Primers show how to use Microsoft Excel to do graphing, error bars, and statistics. These primers can be on a class webpage or the college network.