

Chapter 2

Making Connections: The Two-Sample t -Test, Regression, and ANOVA

Investigation

This chapter asks students to evaluate data from a student project that is based on research psychologist John Stroop's research on reaction time. Stroop found that students took a longer time identifying ink colors when the ink was used to spell a different color. For example, when students were told to identify the ink color, if the word "yellow" was printed in green ink, students took longer to identify the green ink because they automatically read the word "yellow."

Note: The research project corresponding to Chapter 4 describes in detail how students can collect their own data for this project.

Goals

This chapter builds a foundation for more advanced chapters by emphasizing the importance of statistical models when determining which type of analysis should be conducted. By the end of the chapter students learn:

- proper algebraic notation for statistical models,
- how to compare underlying models for the two-sample t -test, regression, and ANOVA (prior knowledge of these techniques is helpful, but not required), and
- how to evaluate whether model assumptions are violated.

Suggested Schedule

Day 1: Before class the students (often in groups of 2-3) are expected to read the introduction and complete Questions 1-6. *Students may struggle with Question 5.* This question appears very simple to some, but it is key to understanding the statistical models. We work through this problem in detail (writing out all 6 equations) in class and typically do not grade that problem. We spend some time discussing the study, asking students to vote on which technique they think is best (students can only vote if they have not completed the chapter). We typically lecture about model assumptions for the t -test and ANOVA, but students could also just work through questions in class.

Day 2: At the beginning of the second day, students submit Questions 7-15. Students can spend class time working through questions in groups or the instructor can lecture about ANOVA.

Day 3: Student groups submit Questions 16-27 at the beginning of class. It is useful to spend 10-15 minutes answering questions and reviewing key concepts of this chapter. I also review Figure 2.4, demonstrating the importance of the size of the variances in determining significance. We use class time to discuss/work through Sections 2.8 and 2.9.

Day 4-6: Students submit Questions 28-33 at the beginning of class. Depending on other chapters incorporated into the course, Section 2.10, Section 2.11, and the chapter project are discussed at varying levels of detail.

Extended Activities

Sections 2.8 (Normal probability plots) and 2.9 (Transformations) are particularly useful for students and we typically work through these in detail.

Sections 2.10 and 2.11 can be assigned as reading outside of class. Section 2.10 (Calculations for ANOVA) can be useful for students completing the chapter project.

Research Project

The goal of the helicopter project is to understand the relationships between regression and ANOVA when there are more than two groups (levels). Clearly the models are no longer equivalent. *A shortcut for the project is to simply use the Winglength2 data. However there are 6 levels of wing length instead of 4.*

I have found that resume paper instead of standard printer paper tends to give more reliable results. *I usually buy 1-2 reams before the project.*

This project should be done in groups. Cutting out the helicopters can be rather tedious - especially if they properly create separate helicopters for each drop. When separate helicopters are not developed, I have seen groups that have strange data at certain levels. For example, a small tear or bent corners can impact flight time. I had one group that kept their final helicopter with wings folded in their textbook. This pressure weakened the strength of the folds and it dropped much more quickly than expected. Students should also determine in advance what to do if the helicopter hits a wall, or other objects, during the flight.

To save time, the instructor can fix all the extraneous variables. Overall, I think the project is better if the entire class holds all these variables at the same level. This is a great opportunity for students to actually observe the impact of lurking variables: the amount of pressure placed when making a fold, type of paper, drafts, how it is dropped, how the strength of the wing fold can wear down after a few flights can all impact flight time. In addition, a helicopter that does best at an 8 foot drop is not always best at a 16 foot drop.

If possible, I have students all drop their helicopters off a balcony. Several students help me judge which helicopter has the longest flight time. It is easiest to simply have groups simultaneously drop their helicopter and observe which take the longest to hit the ground. I offer a small prize (highlighter/book store gift card/Minitab t-shirt) or a very small percentage of extra credit to the group with the helicopter that has the longest flight time.