Chapter 4.2 Lecture Notes & Examples Day 2

Learning Targets

- Describe how to randomly assign treatments in an experiment using slips of paper, technology, or a table of random digits.
- Explain the purpose of random assignment, control, and replication in an experiment.

Section 4.2 (Part 2) pp. 236-242

How to Experiment Well

1. Random Assignment

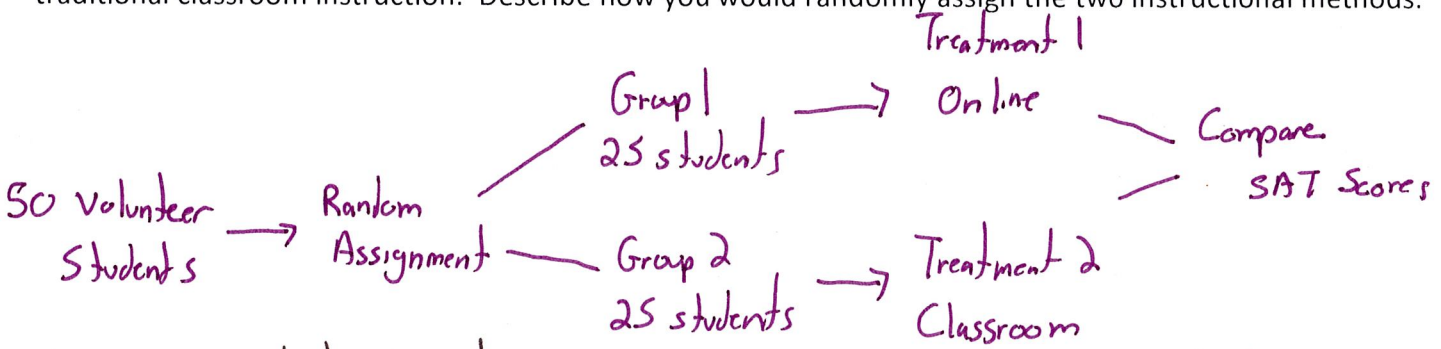
The remedy for confounding in the SAT Prep course example is to do a *comparative* experiment in which some students are taught in the classroom and other similar students take the online course.

Comparison alone is not enough to produce results that can be trusted. If the treatments are given to groups that differ greatly when the experiment begins, *bias* will result. The solution is random assignment.

> Definition: In an experiment, random assignment means that experimental units are assigned to treatments at random, that is, using some chance process.

Methods for random assignment are: technology, random # table, or drawing identical slips of paper from a hat

Example - 50 students have agreed to participate in an experiment to compare the online SAT course with traditional classroom instruction. Describe how you would randomly assign the two instructional methods.



Technology: Label students from 1 to 50, in alpha order by last name. Then use calculator's randInt (1, 50) to generate #'s 1 through 50. The 1st 25 unique #'s generated select the students for the Online Course (Ignore Repeats). The remaining 25 subjects will take the classroom course. (Pg 237 explains Table D method)

2. Three Principles of Experimental Design

Logic of randomized comparative experiments:

- Ensures that influences *other* than the experimental treatments operate equally on all groups.
    - Controls for the effects of *other variables*.
- Balances out the effects of lurking variables that we cannot control or do not think of on treatment groups.
    - Random assignment forms groups of experimental units that should be similar.
- Since groups are roughly equivalent except for treatments, any differences in average response must be due either to the treatments or to the play of chance in the random assignment.

Principles of Experimental Design

The basic principles for designing experiments are:

1. **Control for other variables that might affect the response**: Use a comparative design and ensure that only the systematic difference between the groups is the treatment administered.

2. **Random Assignment**: **Use impersonal chance to assign experimental units to treatments.** This helps create roughly equivalent groups of experimental units by balancing the effects of other variables that are not controlled on the treatment groups.

3. **Replication**: **Use enough experimental units** in each group so that any differences in the effects of the treatments can be distinguished from chance differences between the groups.

Example - Many students regularly consume caffeine to help them stay alert. Thus, it seems plausible that caffeine might increase an individual's pulse rate. One way to investigate this is to have volunteers measure their pulse rates, drink some cola with caffeine, measure their pulse rate after 10 minutes and calculate difference. Unfortunately, even if every student's pulse rate went up, we could not attribute it to caffeine.

Explain how to use all three principles of experimental design in the caffeine experiment.

1) **Control:** There should be a control group that receives noncaffeinated cola. Subjects should receive same amount of cola, served at room temp. Cola should look and taste the same. Subjects should drink cola at the same time and wait same amount of time before measuring pulse rates. If lurking variables are controlled, they will not be confounded with caffeine or be an additional source of variability in pulse rates.

2) **Randomization:** Randomly assign subjects to one of the two treatments. This should roughly balance out the effects of lurking variables we cannot control such as body size caffeine tolerance, and amount of food recently eaten.

3) **Replication:** We want to use as many subjects as possible to reduce the chance variation in the results due to random assignment. (Larger sample, better depiction of population.)

3. Completely Randomized Designs

This diagram details the SAT prep experiment: random assignment, the sizes of the groups and which treatment they receive, and the response variable.

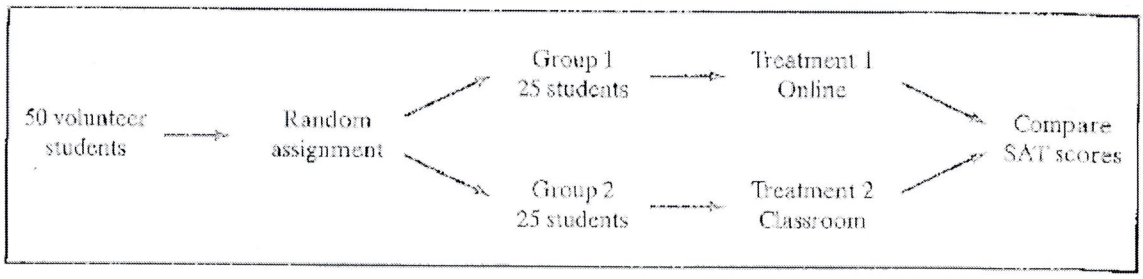


FIGURE 4.4 Outline of a completely randomized design to compare online and classroom instruction.

Definition: In a **completely randomized design**, the treatments are assigned to all the experimental units *completely* by chance.

- Completely randomized design does *not* require that each treatment have equal number of experimental units.
- Assignment of treatments *must* occur *completely* at random. (The best bet is to choose them using the "hat method.")

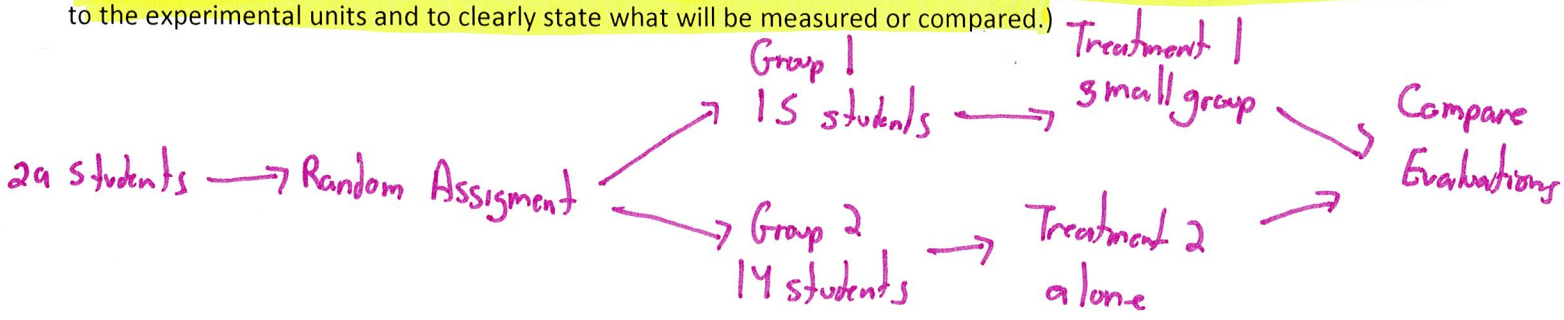
Some experiments include a **control group**. The primary purpose of a control group is to provide a baseline for comparing the treatments of the other treatments. Refer to example on p. 241.

It should be noted that although many experiments include a control group that receives an inactive treatment, a control group can be given an active treatment. For example, if researchers are only concerned with comparing two active treatments and do not care to determine if they are different than no treatment.

CHECK YOUR UNDERSTANDING

Music students often don't evaluate their own performances accurately. Can small-group discussion help? The subjects were 29 students preparing for the end-of-semester performance that is important part of their grade. The 15 students in one group each videotaped a practice performance, evaluated it themselves, and then discussed the tape with a small group of other students. The remaining 14 students watched and evaluated their tapes alone. At the end of the semester, the discussion-group students evaluated their final performance more accurately.

1. Outline a completely randomized design for this experiment. Follow the model of Figure 4.4 Write a few sentences describing how you would implement your design. (AP EXAM TIP: If you are asked to describe the design of an experiment you won't get full credit for just a diagram. You are expected to describe how the treatments are assigned to the experimental units and to clearly state what will be measured or compared.)



We will randomly assign 15 students to group 1 with small group treatment and randomly assign 14 students to group 2 with the alone treatment. At the end of the semester the evaluation scores will be compared for the 2 treatments to see which was more accurate.

2. Describe how you would carry out the random assignment. Provide enough detail that a classmate could implement your procedure. (Let's Use Random Table)

Assign each student a # from 01 to 29 in alpha order. Pick a line of the random # table and choose the 1st 15 unique 2 dig.t #'s between 01 and 29, ignoring repeats, 00, and 30-99. These students belong in the treatment group where students will meet in small groups. The remaining 14 students will be assigned to the group that views the video alone.

3. What is the purpose of the control group in this experiment?

The purpose of the control group is to have a group with which to compare the treatment group. In this experiment, we have the treatment group of alone students to compare with treatment of small group so we can evaluate whether the group is actually better.

HW 4.2 Part B pages 254 – 256 problems 57, 61, 63, 65, 67