AP Statistics

Chapter 4:
Designing Studies

Day 4 Part 2

HW: Finish "Experimenting with the Simpsons" Worksheet

p. 253-260, #45, 47, 49, 51, 55, 91

45.
(a) This was an observational study because no treatment was imposed on the mothers. The researchers simply asked them to report both their chocolate consumption and their babies' temperament.

(b) The explanatory variable is the mother's chocolate consumption and the response variable is the baby's temperament.

(c) No, this study is an observational study so we cannot make a conclusion of cause and effect. There could be a lurking variable that is actually causing the difference in temperament.

47.
(a) This was an experiment because students were randomly assigned to the different teaching methods.

(b) Since this was an experiment with proper randomization, the teacher can conclude that using the computer animation appears to result in higher increases in test scores.

49. One possible lurking variable would private versus public schools. Private schools tend to have smaller classes, and private school students might tend to earn higher scores. There might be something else about the private schools, however, that leads to that success other than the small class sizes. So final success could be dependent on either of these two variables.

51. Experimental units: pine seedlings. Explanatory variable: Light intensity. Treatments: full light, 25% light and 5% light. Response variable: dry weight at the end of the study.

55. Experimental units: fabric specimens. Explanatory variables: (1) roller type; (2) dyeing cycle time; (3) temperature. Treatments: (1) metal, 30 minutes, 150 degrees; (2) natural, 30 minutes, 150 degrees; (3) metal, 40 minutes, 150 degrees; (4) natural, 40 minutes, 150 degrees; (5) metal, 30 minutes, 175 degrees; (6) natural, 30 minutes, 175 degrees; (7) metal, 40 minutes, 175 degrees; (8) natural, 40 minutes, 175 degrees. Response variable: a quality measurement.

91. c

Characteristics of a Well-Designed Experiment

A well-designed comparative experiment has the following characteristics:

1. **Control**
2. **Randomization**
3. **Replication**

Characteristics of a Well-Designed Experiment

Control is the principle that potential sources of variation due to variables not under consideration must be reduced.

The other variables are often called lurking variables.

- Control is achieved by making the experimental conditions as identical as possible for all experimental units.

Characteristics of a Well-Designed Experiment

One form of control is creating a baseline group or control group.

A control group may be given no treatment like a placebo, or an accepted treatment that is to be compared to another.

In studies involving human subjects, controls are important to reduce a phenomenon known as the placebo effect, where subjects show a response to a treatment merely because the treatment is imposed regardless of its actual effect.

Characteristics of a Well-Designed Experiment

Another type of control is blinding.

Blinding is the practice of denying knowledge to subjects of which treatment is being imposed upon them.

- This reduces the chances that the subjects will alter their behavior and introduce unwanted variability into the response.

Characteristics of a Well-Designed Experiment

Sometimes, those collecting data in the experiment can introduce variability into the response, particularly when the response variable has a degree of subjectivity.

When both subjects and the evaluators are ignorant about which treatment a subject received, the study is called double-blind.

Characteristics of a Well-Designed Experiment

Randomization is the process by which treatments are assigned by a chance mechanism to experiential units.

- It "averages out" variation due to variables that cannot be controlled.

Replication is the practice of reducing chance by variation by assigning each treatment to many experimental units.

Characteristics of a Well-Designed Experiment

An experiment that does not include control, randomization and replication is subject to bias and confounding.

Confounding is the situation where the effects of two or more explanatory variables on the response variable cannot be separated.

- The placebo effect is an example of a confounding variable, because its effect on the response cannot be untangled from the effects of the treatment(s).
- Observational studies are also subject to confounding.

Example

A pharmaceutical company wishes to test new medication it thinks will reduce cholesterol. A group of 20 volunteers is formed and each has his or her cholesterol level measured. Half is randomly assigned to take the new drug and the other half is given a placebo. Neither group knows which pill it is taking. After 6 months the volunteers' cholesterol is measured again and any change from the beginning of the study recorded.

Explain where control, randomization and replication are present in the study.

Control: Control group, blinding

Randomization: half are randomly assigned

Replication: 20 volunteers

Example

A health studies research lab is interested in the effect of certain vegetables on cholesterol level. A group of 20 volunteers is formed and each keeps a diary of his food consumption for the next 6 months, after which time the diaries are collected and cholesterol level is measured. The researchers then examine the relationship between the rate of consumption of certain vegetables and cholesterol level.

What confounding variables could be present in this observational study?

Exercise, gender, stress, age, genetics, telling the truth.

Experiment Designs

There are two major types of experimental designs.

The first is a completely randomized design.

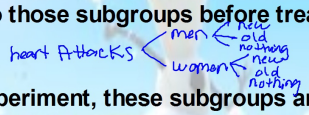
A completely randomized design is one in which experimental units are assigned treatments solely by chance.

- No grouping of experimental units is done prior to assignment of treatments.

Experiment Designs

The second major design is the randomized block design.

If a researcher has reason to believe that subgroups of the experimental units will respond differently to treatments because of some characteristic, the units are sorted into those subgroups before treatments are assigned.



- In an experiment, these subgroups are called blocks.
- Once units are assigned to blocks, treatments are randomly assigned to the units in each block.

Experiment Designs

Blocking is a form of control to reduce unwanted variability in the response variable due to some variable other than the treatment(s).

Experimental units may be sorted into blocks by one or more characteristics.

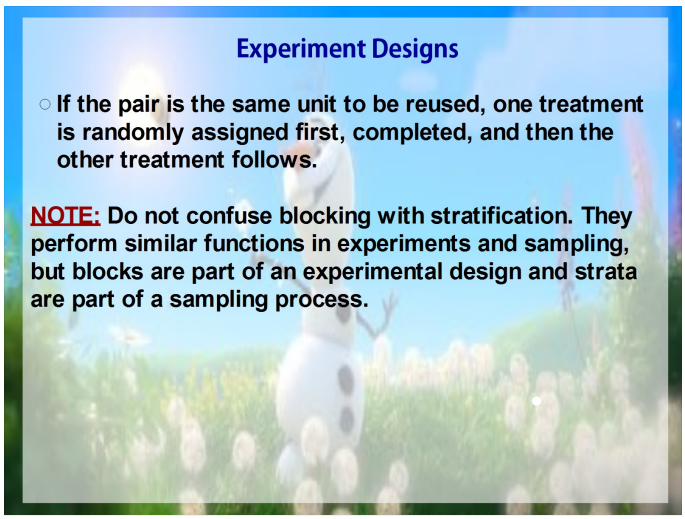
Experiment Designs

When only two treatments exist, experimental units are sometimes placed into pairs.

These pairs may be units related by some variable, or may be a single unit that receives each treatment at different times.

This is a form of block design called matched pairs.

- If the pairs consists of two experimental units, one is randomly assigned one of the two treatments with the second unit receiving the other.


Experiment Designs
If the pair is the same unit to be reused, one treatment is randomly assigned first, completed, and then the other treatment follows.
NOTE: Do not confuse blocking with stratification. They perform similar functions in experiments and sampling, but blocks are part of an experimental design and strata are part of a sampling process.