

### 3.3 Completely Randomized Experiments

Objectives: 1. Use the 4 Key Concepts in Experimental Design  
2. Design a completely randomized experiment.

- The **design** of an experiment is the overall plan for conducting an experiment. A good design minimizes ambiguity in the interpretation of the results.

Ex1 We are interested in determining how student performance on a calculus exam is affected by room temperature. There are four calculus classes, taught by two different teachers, at the school where we are running the experiment. Two classrooms are set at 65° and two classrooms are set at 75°.

Design this experiment.

#### ★ Four Key Concepts in Experimental Design

##### ○ **Randomization**

Random assignment (of subjects to treatments or of treatments to trials) reduces bias by equalizing the effects of confounding variables.

➔ *Remember that random assignment – either **of subjects to treatments or of treatments to trials** – is a critical component of a good experiment.*

##### ○ **Blocking**

Using extraneous factors to create groups (blocks) that are similar. All experimental treatments are then tried in each block. Not required, but may improve your design. A **matched pairs design** is a type of blocking. We block to reduce variability.

##### ○ **Direct Control**

Holding extraneous factors constant so that their effects are not confounded with those of the experimental conditions.

##### ○ **Replication**

Ensuring that there is an adequate number of observations for each experimental condition.

### **Completely Randomized Design**

Ex2 (2009 Q3) Before beginning a unit on frog anatomy, a seventh-grade biology teacher gives each of the 24 students in the class a pretest to assess their knowledge of frog anatomy. The teacher wants to compare the effectiveness of an instructional program in which the students physically dissect frogs with the effectiveness of a different program in which students use computer software that only simulates the dissection of a frog. After completing one of the two programs, students will be given a posttest to assess their knowledge of frog anatomy. The teacher will then analyze the changes in the test scores (score on the posttest minus score on the pretest).

- (a) Describe a method for assigning the 24 students to two groups of equal size that allows for a statistically valid comparison of the two instructional programs.
  
- (b) Suppose the teacher decided to allow the students in the class to select which instructional program on frog anatomy (physical dissection or computer simulation) they prefer to take, and 11 students choose actual dissection and 13 students choose computer simulation. How might that self-selection process jeopardize a statistically valid comparison of the changes in the test scores for the two instructional programs? Provide a specific example to support your answer.

**Ex3** An experiment to test the effectiveness of four different medications is being designed. Four hundred subjects have volunteered to participate. Describe a completely randomized experiment to randomly select subjects so that each subject will be assigned to one of the four treatment groups.

**Checkpoint:**

**Multiple Choice Questions**

1. You are testing a new medication for relief of depression. You are going to give the new medication to subjects suffering from depression and see if their symptoms have lessened after a month. You have eight subjects available. Half of the subjects are to be given the new medication and the other half a placebo. The names of the eight subjects are given below.

- |               |             |              |         |
|---------------|-------------|--------------|---------|
| 1. Blumenthal | 2. Costello | 3. Duvall    | 4. Fan  |
| 5. House      | 6. Long     | 7. Pavlicova | 8. Tang |

Using the list of random digits 81507 27102 56027 55892 33063 41842 81868 71035 09001 43367 49497 starting at the beginning of this list and using single-digit labels, you assign the first four subjects selected to receive the new medication, while the remainder receive the placebo. The subjects assigned to the placebo are

- (a) Blumenthal, Costello, Duvall, and Fan
- (b) Blumenthal, House, Pavlicova, and Tang
- (c) House, Long, Pavlicova, and Tang
- (d) Costello, Duvall, Fan, and Long
- (e) None of the above

2. A statistics class is made up of 20 female and 16 male students. A committee of 8 students needs to be selected. Each student is given a number from 1 to 36. A random table is used to repeatedly select two-digit numbers until eight different numbers in the range of 1 to 36 are generated, thus forming a committee of 8 students. After the committee was formed, it was discovered that all 8 of the students were male. One of the female students in the class complained that this could not be random since only male students were selected. Which of the following statements is true?

- (a) A sample of size 8 is not large enough to produce random results.
- (b) The method used did produce a random sample, even though only males were selected.
- (c) It is so unlikely to have all 8 students be male that it is not a random sample.
- (d) Since the results do not reflect the composition of the class, it is not representative; therefore it is not random.
- (e) A random number table cannot be used in this type of selection.

3. Which of the following is the best description of replication?

- (a) Asking subjects the same question in different ways
- (b) A technique of increasing the number of treatments used in an experiment
- (c) A technique of increasing the number of subjects in an experiment to help decrease the variation caused by chance
- (d) A tendency for subjects to be influenced by knowing what group they are in
- (e) A technique of distributing the subjects into random groups

4. You are designing an experiment with one treatment and one control group. You are blocking for two different variables, gender (M, F) and blood type (A, B, AB, and O). The experiment will have

- (a) 2 factors, 6 levels, and 8 treatments
- (b) 2 factors, 8 levels, and 8 treatments
- (c) 2 factors, 4 levels, and 16 treatments
- (d) 3 factors, 6 levels, and 8 treatments
- (e) 3 factors, 8 levels, and 16 treatments

### **Free Response Question**

1. Use a completely randomized design to construct an experiment that studies whether taking a garlic supplement in tablet form can reduce the occurrence of colds during the winter.