

**Mr Murphy**  
**AP Statistics**  
**3.4 Block and Matched Pairs Experiments**  
**HW Worksheet**

- #Goals: 1. Use each of the 4 Key Concepts in Experimental Design.  
2. Design a block experiment or matched pairs experiment when appropriate.

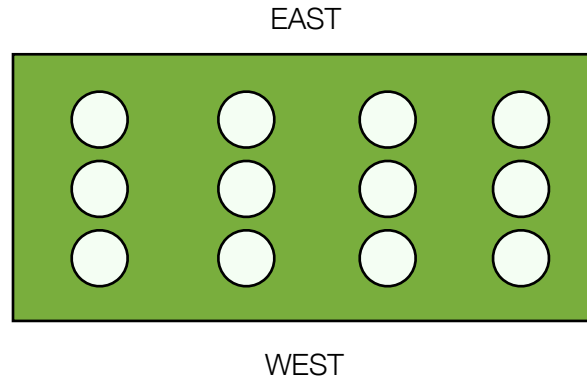
**Block Design**

Ex1 (2002B Q3) A preliminary study conducted at a medical center in St. Louis has shown that treatment with small, low-intensity magnets reduces the self-reported level of pain in polio patients. During each session, a patient rested on an examining table in the doctor's office while the magnets, embedded in soft pads, were strapped to the body at the site of pain. Sessions continued for several weeks, after which pain reduction was measured.

A new study is being designed to investigate whether magnets also reduce pain in patients suffering from herniated disks in the lower back. One hundred male patients are available for the new study.

- (a) Describe a completely randomized design for the new study. Discuss treatments used, methods of treatment assignment, and what variables would be measured.
- (b) How could you modify the design above if, instead of 100 male patients, there were 50 male and 50 female patients available for the study? Why might you choose to do this?

Ex2 A new type of fertilizer is being used that is meant to increase the mean overall weight of beans produced by bean plants over a six-week period. In order to test the efficacy of the fertilizer, the results need to be compared to bean plants grown with the previous fertilizer. The bean plants are to be grown in a garden as shown in the following diagram. However, it is believed that the direction of the sun will also have an effect on the way the bean plants grow.



Describe how an experiment may be constructed that compares the effectiveness of the new fertilizer with the old fertilizer and also accounts for the effect of the direction of the sun on the growth of the plant.

### **Matched Pairs Design**

A matched pairs design is a type of blocking. We will consider two types:

- **One Subject** - In this design one subject will receive both treatments. The order in which the subject receives the treatments is randomized.
- **Two Subjects** - In this design the two subjects are paired based on some common characteristic. One subject from the pair is randomly assigned a treatment, the other subject receives the other treatment.

Ex3 (2008B Q4) A researcher wants to conduct a study to test whether listening to soothing music for 20 minutes helps to reduce diastolic blood pressure in patients with high blood pressure, compared to simply sitting quietly in a noise-free environment for 20 minutes. One hundred patients with high blood pressure at a large medical clinic are available to participate in this study.

Propose a paired design for this study to compare these two treatments.

**Checkpoint:**  
**Multiple Choice Questions**

This scenario applies to Questions 1 and 2: One hundred volunteers who suffer from severe depression are available for a study. Fifty are selected at random and are given a new drug that is thought to be particularly effective in treating severe depression. The other 50 are given an existing drug for treating severe depression. A psychiatrist evaluates the symptoms of all volunteers after four weeks in order to determine if there has been substantial improvement in the severity of the depression.

1. The study is an example of

- (a) a completely randomized design.
- (b) confounding. The effects of gender will be mixed up with the effects of the drugs.
- (c) a block design.
- (d) a matched-pairs design.
- (e) an observational study.

2. Referring to the study described above, suppose volunteers were first divided into men and women, and then half of the men were randomly assigned to the new drug and half of the women were assigned to the new drug. The remaining volunteers received the other drug. This would be an example of

- (a) a completely randomized design.
- (b) confounding. The effects of gender will be mixed up with the effects of the drugs.
- (c) a block design.
- (d) a matched-pairs design.
- (e) an observational study.

3. Which of the following are true about the design of matched-pairs experiments?

- I. Each subject might receive both treatments.
- II. Each pair of subjects receives identical treatment, and differences in their responses are noted.
- III. Matched-pair design is one form of blocking.

- (a) I only      (b) II only      (c) III only      (d) I and III      (e) II and III

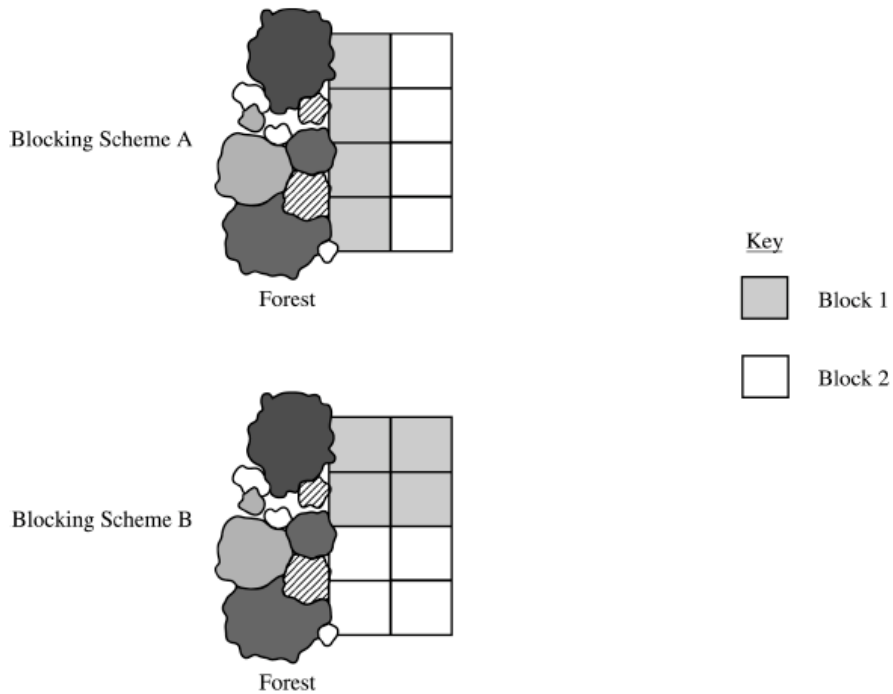
4. Will a fluoride mouthwash used after brushing reduce cavities? Twenty sets of twins were used to investigate this question. One member of each set of twins used the mouthwash after each brushing; the other did not. After six months, the difference in the number of cavities of those using the mouthwash was compared with the number of cavities of those who did not use the mouthwash. This experiment uses

- (a) random placebos.
- (b) double-blinding.
- (c) double replication.
- (d) a matched-pairs design.
- (e) randomization of treatments.

### Free Response

1. (2001 Q4) Students are designing an experiment to compare the productivity of two varieties of dwarf fruit trees. The site for experiment is a field that is bordered by a densely forested area on the west (left) side. The field has been divided into eight plots of approximately the same area. The students have decided that the test plots should be blocked. Four trees, two of each of the two varieties, will be assigned at random to the four plots within each block, with one tree planted in each plot.

The two blocking schemes shown below are under consideration. For each scheme, one block is indicated by the white region and the other block is indicated by the gray region in the figures.



- (a) Which of the blocking schemes, A or B, is better for this experiment? Explain your answer.
- (b) Even though the students have decided to block, they must randomly assign the varieties of trees to the plots within each block. What is the purpose of this randomization in the context of this experiment?

2. (2002 Q2) - CLASSIC example

A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.

- (a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented.
- (b) Could your design be double blind? Explain.