

2002 AP[®] STATISTICS FREE-RESPONSE QUESTIONS

2. 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.
3. There are 4 runners on the New High School team. The team is planning to participate in a race in which each runner runs a mile. The team time is the sum of the individual times for the 4 runners. Assume that the individual times of the 4 runners are all independent of each other. The individual times, in minutes, of the runners in similar races are approximately normally distributed with the following means and standard deviations.

	Mean	Standard Deviation
Runner 1	4.9	0.15
Runner 2	4.7	0.16
Runner 3	4.5	0.14
Runner 4	4.8	0.15

- (a) Runner 3 thinks that he can run a mile in less than 4.2 minutes in the next race. Is this likely to happen? Explain.
- (b) The distribution of possible team times is approximately normal. What are the mean and standard deviation of this distribution?
- (c) Suppose the team's best time to date is 18.4 minutes. What is the probability that the team will beat its own best time in the next race?

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Question 2

Solution

Part (a):

A **paired design** is used in which each subject receives a pair of boots where one boot is treated with the new method and the other with the current method.

Subjects should be randomly assigned to one of two groups. Group 1 would have the new method applied to the right boot; group 2 would have the new method applied to the left boot.

OR

For each subject, whether the new method is applied to the right or left boot is determined at random.

OR

A **crossover design** is used in which each subject receives a pair of boots, both of which were treated with one treatment. The boots are used for three months and then exchanged for a second pair of boots, both of which were treated with the other treatment. These boots are then used for the next three months.

Subjects should be randomly assigned to one of two groups. One group receives boots with the new treatment first and the other group receives boots with the current method first.

NOTE: Additional appropriate blocking schemes are considered extraneous.

Part (b):

The design could be double blind, as long as both the *subjects* and the person *evaluating* the boots for water damage do not know which boots were treated with the new method and which were treated with the current method.

NOTE: If the student does something unexpected in part (a) and gives a design that actually cannot be double blind, then part (b) could be considered correct provided the response explains why the design could not be double blind.

Scoring

A student response is scored as **E** (essentially correct), **P** (partially correct), or **I** (incorrect) for each of the following key elements:

1. **Design**

- **E** - paired design (may be described as blocking on individual) or crossover design
- **P** - 2 or more groups (e.g., Completely Randomized Design)
- **I** - no grouping or grouping with no treatments specified

2. **Implementation:** Randomization appropriate to the design

- **E** - Written description of appropriate randomization
- **P** - Incomplete or incorrect description of randomization
- **I** - No description of randomization

NOTE: (1) Diagram alone can be scored at most a **P**.

(2) The randomization must apply to the allocation or assignment of subjects to the treatment groups or the allocation of treatments to the subjects.

(3) Randomization to select the 100 volunteers without assignment to the treatment groups is scored an **I**.

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Question 2 (cont'd.)

3. **Double blind:** Explanation in parts (a) and/or (b) that shows understanding of what it means for an experiment to be double blind.
- **E** - response indicates that blinding applies to both the evaluator and subjects.
 - **P** - response recognizes that blinding applies to the subjects and at least one other party, whether or not they think that this can be accomplished; the other party may not be correctly identified.
 - **I** - response fails to recognize that both the subject and another party must be blinded or is missing or irrelevant.

Score as Design - Randomization - Double Blind

4 Complete Response

E E E

3 Substantial Response

Any one of the following combinations:

E E P	P E E	P E P *
E E I		
E P E		

2 Developing Response

Any one of the following combinations:

E P P	P E I	I E E	P E P *
E P I	P P E	I P E	
E I E	P P P		
E I P	P I E		

1 Minimal Response

Any one of the following combinations:

E I I	P P I	I E P
I E I	P I P	
I I E	I P P	

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Question 2 (cont'd.)

0 No Credit

P I I	I I I
I P I	
I I P	

* **P E P** may be scored as either a **2** or a **3**:

- (1) If the description of the randomization *only* says, “Randomly allocate”, then score P E P a 2.
- (2) If the description of the randomization says, “Randomly allocate”, but also contains greater detail about the randomization or the inclusion of blocking in the design or other statistical thinking, then score P E P a 3.