



“FRAPPY” {Free Response AP Problem...Yay! }

The following problem is taken from an actual Advanced Placement Statistics Examination. Your task is to generate a complete, concise statistical response in 15 minutes. You will be graded based on the AP rubric and will earn a score of 0-4. After grading, keep this problem in your binder for your AP Exam preparation.

As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog’s activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

Scoring:

(a) What would be an advantage to adding a control group in the design of this study?

E P I

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

E P I

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

E P I

Total: ___/4

Student Responses for Dogs' Hip Health Problem

(a) What would be an advantage to adding a control group in the design of this study?

P
Missing
Context

An advantage to adding a control group to this design would be that it gives the experiment something to compare its results to, to see how much of a difference the treatments make.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

E

For every dog that is chosen roll a die. IF the die is a 1 or 2 give the dog the glucosamine. IF the die is a 3 or 4 give the dog the chondroitin. IF the die is a 5 or 6 put the dog in the control group. This will completely randomize the design.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

P.
don't have
to pick
So why
choose breed
Need to
say more
signif than
clinic

I would decide to use the blocking on breed of dog. The clinic the dog is in should not affect the medicine the dog is given. However, different breeds of dogs might respond to the medicines differently. Therefore, the blocking on breed of dog should be used.

(a) What would be an advantage to adding a control group in the design of this study?

E The advantage to adding a control group in the design of this study would be to have something to compare the results to. This helps to reduce the effects of confounding variables. For example the weather which can affect joint pain.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

E To obtain a completely randomized design I would number each dog 1 to 300 and then using a random number generator I would select 100 numbers ignoring repeats the 100 dogs corresponding to those 100 numbers will be placed in the first treatment group and will receive glucosamine. I will repeat this process selecting 100 new numbers, these 100 dogs will be placed in the second treatment group and will receive chondroitin and the remaining 100 dogs will be the control group and will receive a placebo.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

E Which ever variable has more variation should be used as a block. I think breed of dog will cause more variation in the experiment because different kinds of dogs can respond differently to the treatment, but which clinic the dogs came from probably will have less effect on the experiment.

5/3

(a) What would be an advantage to adding a control group in the design of this study?

E It would be an advantage to add a control group to this study because then after 6 months, you have ~~some~~ a group to compare with the treated dogs in the study, to see if the treatments really had an impact in promoting joint and hip health and reducing the onset of canine osteoarthritis.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

E For a completely randomized design, I would assign each of the 300 dogs a number, 1-300, and then put all the numbers into a hat. Then draw 100 numbers out of the hat and assign them to group 1, the control group. Then pull out 100 more numbers and assign them to group 2, the glucosamine treatment. Then with the 100 left over dogs assign them to group 3, for the chondroitin treatment. That way, you will have three groups for a completely randomized design.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

P
No Rather than using a completely randomized design, I would incorporate blocking on the specific breed of dog, because the different treatments could possibly have a different effect on the different types of dogs, therefore I would use the blocking on breed of dog so it would eliminate any variables that could change the actual data. I would rather block on breed of dog than clinic, because breeds of dogs seem to be much more different than different clinics, therefore I would block on breeds of dogs.

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Question 2

Intent of Question

The three primary goals of this question are to assess a student's ability to: (1) clearly explain the importance of a control group in the context of an experiment; (2) describe the randomization process required for three groups; and (3) reduce variability by grouping experimental units as homogeneously as possible.

Solution

Part (a):

A control group gives the researchers a comparison group to be used to evaluate the effectiveness of the treatments. The control group allows the impact of the normal aging process on joint and hip health to be measured with appropriate response variables. The effects of glucosamine and chondroitin can be assessed by comparing the responses for these two treatment groups with those for the control group.

Part (b):

Each dog will be assigned a unique random number, 001–300, using a random number generator on a calculator, statistical software, or a random number table. The numbers will be sorted from smallest to largest. The dogs assigned the first 100 numbers in the ordered list will receive glucosamine. The dogs with the next 100 numbers in the ordered list will be assigned to the control group. Finally, the dogs with the numbers 201–300 will receive chondroitin.

Part (c):

The key question is which variable has the strongest association with joint and hip health. The goal of blocking is to create groups of homogeneous experimental units. It is reasonable to assume that most clinics will see all kinds and breeds of dogs so there is no reason to suspect that joint and hip health will be strongly associated with a clinic. On the other hand, different breeds of dogs tend to come in different sizes. The size of a dog is associated with joint and hip health, so it would be better to form homogeneous groups of dogs by blocking on breed.

Scoring

Parts (a), (b), and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as essentially correct (E) if an advantage of using a comparison group is described in the context of this study.

Part (a) is scored as partially correct (P) if an advantage of using a control group is described but not in the context of this study.

Part (a) is scored as incorrect (I) if the student says that control groups should always be used but gives no further explanation *OR* an incorrect explanation.

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Question 2 (continued)

Note: Since “treatment” and “control” are standard terms in design, a comparison of specific aspects of the study is needed to establish context.

Part (b) is scored as essentially correct (E) if randomization is used correctly, and the method of randomization can be implemented after reading the student response (so that two knowledgeable statistics users would use the same method to assign dogs to treatment groups).

Part (b) is scored as partially correct (P) if randomization or chance is used, but the method could not be implemented after reading the student response.

Part (b) is scored as incorrect (I) if randomization or chance is not used in a planned way *OR* the solution does not yield a completely randomized design.

Part (c) is scored as essentially correct (E) if:

the student argues that the variable with the stronger relationship to joint and hip health should be used as the blocking variable;

OR

the student states that the variable with the larger anticipated variability in the response measure should be used as the blocking variable so that units within blocks are as homogeneous as possible. A rationale is required, but a variable does not have to be selected.

Part (c) is scored as partially correct (P) if:

the student indicates that the purpose of blocking is to create groups of homogeneous experimental units but makes an error in the application to this experiment;

OR

the student does not acknowledge that there may be more variability associated in the response variable with one of the variables (breed or clinic) than the other;

OR

the student does not recognize that both variables are associated with variation in the response variable.

Part (c) is scored as incorrect (I) if the student does not exhibit an understanding of the purpose of blocking.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct, and no parts partially correct

OR

One part essentially correct and two parts partially correct

OR

Three parts partially correct

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Question 2 (continued)

1 Minimal Response

One part essentially correct and either zero or one part partially correct

OR

No parts essentially correct and two parts partially correct

