Name: Answer Key Date: _____

AP STATISTICS: MIDTERM EXAM 2014

Part 1: MULTIPLE CHOICE SECTION- ANSWER SHEET

Directions: Please write answers to the 25 multiple choice questions on this sheet. Only this sheet will be graded for the multiple-choice section. Please be neat!

1.) D

2.) B

3.) B

4.) E

5.) E

6.) E

7.) C

8.) D

9.) B

10.) B

11.) C

12.) A

13.) C

14.) D

15.) E

16.) A

17.) A

18.) C

19.) D

20.) C

21.) D

22.) C

23.) C

24.) D

25.) C

AP® STATISTICS
2003 SCORING GUIDELINES

Question 1

Solution

Part (a):

For example, a deadline in the department where the group of volunteers works has been moved back, lowering the stress levels of those working in the department. If the volunteers from this department were all in the same treatment group, this change in stress level could mistakenly be attributed to the treatment.

Without random assignment of volunteers to the two programs, it is possible that the two treatment groups could differ in some way that affects the outcome of the experiment. Randomization "evens out" the possible effects of potentially confounding variables.

Part (b):

Without the control group, the company could compare the two treatments, but would not be able to say whether the observed reduction in stress was attributable to participation in the programs. For example, a change in the work environment during this period might have reduced the stress level of all employees. The addition of a control group would enable the company to assess the magnitude of the mean reduction attributable to each treatment, as opposed to just determining if the two programs differ.

Part (c):

It is not reasonable to generalize the findings of this study to all employees, because

the participants in this experiment were volunteers and volunteers may not be representative of the population
OR
the participants were not randomly selected from the company employees.

Question 4 (cont'd)

Scoring

Each component is scored as either essentially correct (E), partially correct (P), or incorrect (I).

Part (a) has two components: the example, and the randomization.

- The example is scored as essentially correct (E) if it contains each of the elements in the table below:

Elements	Sample statements
1. Identify a plausible example of a problem	"Because a deadline has been moved back..."
2. Relate the identified problem to the change in stress level (the response)	"...lowering the stress levels of those working in the department. This change in stress level..."
3. ...and state that the identified problem effects can not be distinguished from the difference in treatment effects	"...could mistakenly be attributed to the treatment." (Note: A construction such as "can't tell the difference" is OK here.)

The example is scored as partially correct (P) if the response contains 2 of the 3 components.

- The randomization is scored as essentially correct (E) if the student gives a reason for the necessity of random assignment. Possibilities include:

  clearly stating in context that randomization is relied upon to create comparable groups

  clearly stating in context that randomization controls for the effects of potentially confounding variables or reduces bias. (Both "Avoiding" bias and "Eliminating" bias are incorrect (I).)

The randomization is scored as partially correct (P) if the statement about randomization is not in context or is poorly communicated.

Note: Constructions such as "split up" and "divided into" can be interpreted to indicate randomization.

Question 4 (cont'd)

Part (b) is scored as essentially correct (E) if the student

1. indicates that a control group does provide additional information
   AND
2. explains that the control group allows the company to determine if either or both treatments are effective in reducing stress

   OR

   explains that the control group provides a baseline for comparison

Part (b) is scored as partially correct (P) if the student indicates there is additional information, even if the student's explanation is incorrect.

Note: Stating that the "passage of time" reduces stress is not sufficient; the student must specify that there is a confounding variable that operates through time.

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

1. indicates that it is not reasonable to generalize to all employees
   AND
2. gives an explanation that the participants were not randomly selected from the company employees

   OR

   gives an explanation tied to the use of volunteers

   Note: Simply using the word "volunteer" in the explanation is not sufficient.

Part (c) is scored as partially correct (P) if the student explicitly says that it is not reasonable to generalize to all employees, even if the student's explanation is incorrect.

Part (c) is scored as incorrect (I) if the student indicates that it is reasonable to generalize to all employees.

Question 4 (cont'd)

Scoring

4 **Complete Response (4E)**

All four "components" are essentially correct

3 **Substantial Response (3E 0P or 3E 1P or 2E 2P)**

Three components essentially correct and no components partially correct
OR
Three components essentially correct and 1 component partially correct
OR
Two components essentially correct and 2 components partially correct

2 **Developing Response (2E 0P or 2E 1 P or 1E 2P or 1E 3P or 4P)**

Two components essentially correct and no components partially correct
OR
Two components essentially correct and 1 component partially correct
OR
One component essentially correct and 2 components partially correct
OR
One component essentially correct and 3 components partially correct
OR
Four components partially correct

1 **Minimal Response (1E 1P or 1E 0P or 0E 2P or 0E 3P)**

One component essentially correct and 1 component partially correct
OR
One component essentially correct and no components partially correct
OR
No components essentially correct and 2 components partially correct
OR
No components essentially correct and 3 components partially correct

AP® STATISTICS
2010 SCORING GUIDELINES

Question # 2

Intent of Question

The primary goals of this question were to assess students' ability to (1) apply terminology related to designing experiments; (2) construct an appropriate plot that could be used to investigate the fit of a linear model; (3) decide, from a graphical display, whether a linear regression model is appropriate for a set of data.

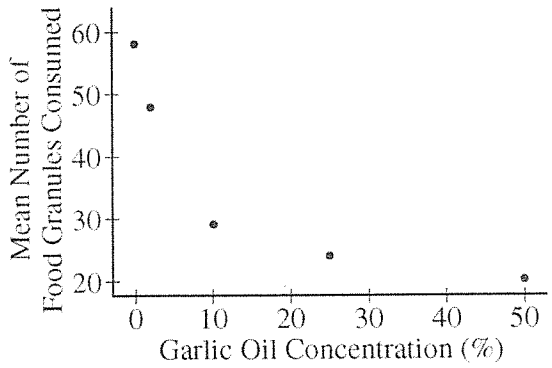
Solution

Part (a):

i. The treatments are the different concentrations of garlic in the food granules. Specifically, there are five treatments: 0 percent, 2 percent, 10 percent, 25 percent and 50 percent.
ii. The experimental units are the birds (starlings), each placed in an individual cage.
iii. The response is the number of food granules consumed by the bird.

Part (b):

i. The following scatterplot results from these data.



ii. The curved pattern in this scatterplot reveals that a linear regression model would not be appropriate for modeling the relationship between these variables.

Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the student correctly identifies all three subparts—the treatments, the experimental units and the response that will be measured.

Partially correct (P) if the student identifies two subparts correctly.

Incorrect (I) otherwise.

Question 1 (continued)

Notes
- In subpart ii, it is acceptable to identify the experimental units as the cages.
- In subpart iii, it is not correct to identify the response as the *mean* number of granules consumed.

Part (b) is scored as follows:

Essentially correct (E) if the student produces a correct graph (a reasonable scatterplot or residual plot with correct labels and scales) and then concludes, based on one or more features of the graph, that the pattern of the relationship does not appear to be linear.

Partially correct (P) if the student produces a correctly shaped graph but concludes that the data are linear *OR* if the student produces an incorrectly shaped graph but makes a reasonable conclusion based on one or more features of the graph.

Incorrect (I) if the student does not include a graph *OR* if the student produces an incorrect graph and does not make a reasonable conclusion based on one or more features of the graph.

Note: Any of the following will result in an incorrect graph.
- Incorrect scale
- Reversed axes
- Missing label(s)
- Other types of graph (histogram, bar graph, etc.)

4 **Complete Response**

Both parts essentially correct

3 **Substantial Response**

One part essentially correct and one part partially correct

2 **Developing Response**

One part essentially correct and one part incorrect

OR

Both parts partially correct

1 **Minimal Response**

One part partially correct and one part incorrect

Question 3

Solution

Part (a):

For runner 3

$$P(time < 4.2) = P\left(z < \frac{4.2 - 4.5}{.14}\right) = P(z < -2.14) = 0.0162 \quad (\textit{from table})$$

OR

$$P(time < 4.2) = 0.0160622279 \quad (\textit{from} \text{ Calculator})$$

It is possible but unlikely that runner 3 will run a mile in less than 4.2 minutes on the next race. Based on his running time distribution, we would expect that he would have times less than 4.2 minutes less than 2 times in 100 races in the long run.

OR

It is possible but unlikely that runner 3 will run a mile in less than 4.2 minutes on the next race because 4.2 is more than 2 standard deviations below the mean. Since the running time has a normal distribution, it is unlikely to be more than 2 standard deviations below the mean.

Part (b):

$$\mu_T = \mu_1 + \mu_2 + \mu_3 + \mu_4 = 4.9 + 4.7 + 4.5 + 4.8 = 18.9$$

The runners' times are independently distributed, therefore

$$\sigma_T^2 = \sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2 = (.15)^2 + (.16)^2 + (.14)^2 + (.15)^2 = 0.0902$$

$$\sigma_T = \sqrt{.0902} = 0.3003$$

Part (c):

$$P(team\ time < 18.4) = P\left(z < \frac{18.4 - 18.9}{.3003}\right) = P(z < -1.67) = 0.0475 \quad (\textit{from table})$$

OR

$$P(team\ time < 18.4) = 0.0479561904 \quad (\textit{from} \text{ Calculator})$$

Question 3 (cont'd.)

Scoring

Each part is scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is *essentially correct* if:

the probability is calculated correctly, it is correctly assessed as unlikely, and the justification is acceptable
OR
the student does not compute the probability, but appeals to the fact that a time of 4.2 minutes is more than 2 standard deviations below the mean of a normal distribution and then uses this information to reach a conclusion with appropriate communication.

Part (a) is *partially correct* if:

the probability computed is not correct (for example, $P(z > -2.14)$ or $P(z < +2.14)$ might be computed), but the given probability is correctly assessed
OR
an argument is based on the number of standard deviations from the mean without invoking normality.

Part (b) is *essentially correct* if both the mean and the standard deviation of the team time distribution are correctly computed (except for purely arithmetic mistakes).

Part (b) is *partially correct* if only one of these is correctly computed (except for purely arithmetic mistakes).

CAUTION: A standard deviation of .3 (numerically correct) can arise from this incorrect calculation: $\frac{(.15+.16+.14+.15)}{\sqrt{4}} = 0.3$

Part (c) is *essentially correct* if the probability is correctly calculated using a mean which is either correct or carried from (b) as well as a standard deviation which is either correct or carried from (b).

Part (c) is *partially correct* if:

both the mean and standard deviation are correct or carried from (b), but the computed probability is incorrect
OR
the mean or standard deviation is incorrectly derived from (b) but the subsequent probability calculation is correct.

Question 3 (cont'd.)

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
One part essentially correct and one part partially correct.
OR
Three parts partially correct.

1 **Minimal Response**

One part essentially correct and zero parts partially correct.
OR
No parts essentially correct and two parts partially correct.