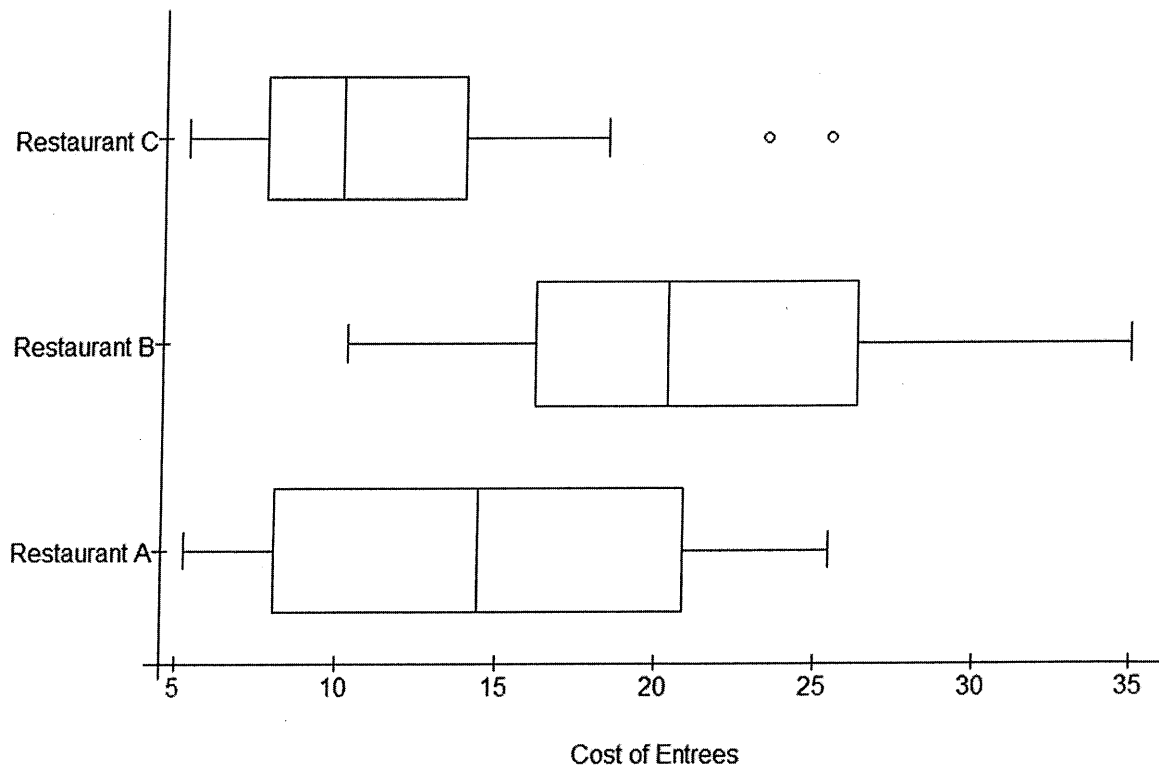


2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 1

1. Independent random samples of 20 entrée prices were taken from three different restaurants in a US city. Boxplots of entrée prices (in dollars) for the three restaurants are shown below.



- (a) Compare the distributions of entrée price for the three restaurants.
- (b) A worker at the city's visitor center is often asked to recommend a restaurant for visitors. For each of the following types of people, which one of the three restaurants should the worker recommend? Explain the logic behind each of your choices.
- i) A couple wanting a romantic formal dinner for their anniversary
 - ii) A family looking for a variety of moderately priced items
 - iii) A college student on a budget

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 1

Intent of Question

The primary goals of this question were to assess students' ability to (1) compare three distributions presented with boxplots; (2) apply the information provided in boxplots to a given situation.

Solution

Part (a):

Entrée costs tend to be larger in Restaurant B than either Restaurant A or C. The median entrée cost is largest for Restaurant B, the next largest median is Restaurant A followed by Restaurant C with the smallest median. Although the interquartile range is larger for Restaurant A than Restaurant C, both restaurants have similar ranges of entrée costs. The range of costs for Restaurants C and A is slightly smaller than the range for Restaurant B. Both distributions for Restaurants B and C appear to be skewed right, with Restaurant C having two outliers (one around \$22 and one around \$26) while Restaurant A has an approximately symmetric distribution.

Part (b):

- i) For the couple wanting a romantic formal dinner for their anniversary, the worker should recommend Restaurant B. Restaurant B has more expensive options for entrées, which typically indicates a more formal restaurant.
- ii) For the family looking for a variety of moderately priced items, the worker should recommend Restaurant A. The middle 50% of entrée costs at Restaurant A range from about \$8 to about \$21, which is not too expensive compared to the other two restaurants.
- iii) For the college student on a budget, the worker should recommend Restaurant C. Restaurant C tends to have the largest concentration of inexpensive entrees.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 1

Scoring

This question is scored in four sections. Part (a) has three components: (1) comparing the centers of the three distributions; (2) comparing variability for the three distributions; (3) identifying the shapes of all distributions and including context related to the variable of interest. Section 1 consists of part (a), component 1; section 2 consists of part (a), component 2; section 3 consists of part (a), component 3. Section 4 consists of part (b). Each of sections 1, 2, 3, and 4 are scored as essentially correct (E), partially correct (P), or incorrect (I).

Section 1 is scored as follows:

Essentially correct (E) if the response correctly compares center (or location) for all three distributions.

Partially correct (P) if the response correctly compares center (or location) for only two of the three distributions.

Incorrect (I) otherwise.

Section 2 is scored as follows:

Essentially correct (E) if the response correctly compares variability for all three distributions.

Partially correct (P) if the response correctly compares variability for only two of the three distributions.

Incorrect (I) otherwise.

Section 3 is scored as follows:

Essentially correct (E) if the response includes context related to the variable of interest (entrée cost) AND the response correctly identifies the shapes of all three distributions.

Partially correct (P) if the response correctly identifies the shapes of all three distributions BUT does NOT include context related to the variable of interest (entrée cost),

OR

if the response correctly identifies the shape of only two distributions AND includes context related to the variable of interest (entrée cost).

Incorrect (I) otherwise.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 1

Section 4 is scored as follows:

Essentially correct (E) if the response correctly chooses the restaurant for the three visitor restaurant types and explains the logic of choices using information from the boxplots.

Partially correct (P) if the response correctly states and explains the logic of the choices for only one or two of the three visitor restaurant types.

Incorrect (I) otherwise.

Each essentially correct (E) section counts as 1 point, and a partially correct (P) section counts as $\frac{1}{2}$ point.

4 Complete Response

3 Substantial Response

2 Developing Response

1 Minimal Response

If a response is between two scores (for example, $2\frac{1}{2}$ points), score down.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 2

2. Researchers at a weight loss clinic are conducting an experiment to determine whether weighing oneself daily does in fact lead to greater weight loss while on a diet, as is commonly assumed. They plan to compare the percentage of total body weight lost after twelve weeks on the clinic's diet plan for two groups of people, one weighing themselves every day and one not weighing themselves while on the diet. Eight volunteers that are just beginning the weight loss program are available to participate in this study. For each of these volunteers (numbered 1 through 8), the weight loss clinic collected information on the method by which the volunteer heard about the weight loss program and whether or not the volunteer is going to exercise while on the diet plan. This information is presented in the table below. Based upon this information, the researchers have decided to incorporate blocking into their experimental design.

Volunteer	Method	Exercise
1	TV commercial	Yes
2	On-line Ad	No
3	On-line Ad	Yes
4	TV commercial	Yes
5	On-line Ad	Yes
6	On-line Ad	No
7	TV commercial	No
8	TV commercial	No

- (a) Identify (by number) the volunteers that you would group into blocks. Justify your choice of blocks.
- (b) For the design in (a), describe an appropriate method for assigning treatments (weighing yourself every day or not) to each of the volunteers.
- (c) Can this experiment be carried out in a double blind manner? Explain.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 2

Intent of Question

The primary goals of this question are to assess a student's ability to: (1) use blocking in designing an experiment; (2) describe a mechanism for randomly assigning treatments to experimental units in the context of the selected blocking; and (3) explain how an experiment can be carried out in a double blind manner.

Solution

Part (a):

We want to create blocks that are as similar as possible with respect to factors that might influence the response variable. As regular exercise will have an impact on a person's ability to lose weight but the method by which the person heard about the weight loss program will not, the blocks were based upon the exercise variable. Those that do exercise (1, 3, 4, 5) should be grouped into one block and those that do not exercise (2, 6, 7, 8) should be grouped into a second block.

Part (b):

For each block we could select one of the volunteers and then flip a coin to determine whether they are assigned to weigh themselves every day over the twelve week period or not. For example, if the coin lands face up, the volunteer weighs themselves every day; otherwise they do not. Continue this process until half of the volunteers in the block are assigned to one weighing regimen, then assign the remaining volunteers to the other regimen.

Part (c):

If the experiment were double blind, then neither the researchers working at the weight loss clinic nor the volunteers participating in the study would know who is weighing themselves every day and who is not. Though it would be possible for the researchers to be unaware of which volunteers are weighing themselves every day, it would not be possible for the volunteers to be unaware of whether they are weighing themselves every day or not, and attempting to do so would defeat the purpose of the study.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 2

Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the response includes the following two components:

1. The two blocks are correctly identified by volunteer number or by exercise status.
2. The justification for the blocking scheme demonstrates an understanding that blocks should consist of people that are similar with respect to factors that affect weight loss.

Partially correct (P) if the response includes only 1 of the 2 components listed above.

Incorrect (I) if the response does not meet the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response describes an appropriate method for assigning treatments within each block, including a method of randomization that can be implemented by the reader.

Partially correct (P) if the response assigns treatments randomly within blocks but lacks a method of randomization,

OR

if the response assigns treatments within each block with no mention of randomization.

Incorrect (I) if the response does not meet the criteria for E or P.

Notes

- Simply saying “use a random number table” or “flip a coin” is not sufficient to get credit for the method of randomization.
- If in part (a) the student creates heterogeneous blocks, then randomly assigning blocks to treatments with an appropriate method of randomization can be essentially correct if it guarantees that within the two groups of volunteers of the same exercise status, half receive one treatment and half receive the other treatment. If no randomization is described, this situation is scored as partially correct. In this case, the student is confusing blocks with treatments, a misconception they have already been penalized for in part (a).
- If a student created four blocks based on both variables in part (a), their assignment of treatments should result in one person weighing themselves and one person not within each block.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 2

Part (c) is scored as follows:

Essentially correct (E) if it includes the following two components:

1. Clearly explains a double blind experiment with reference to both the researchers and the participants.
2. Correctly indicates that the experiment could not feasibly be carried out in a double blind manner or that doing so would defeat the purpose of the study.

Partially correct (P) if it correctly addresses component 1 above, but then attempts to describe how to double blind this experiment.

Incorrect (I) if “NO” is the only response or if “NO” is the response with incorrect reasoning.

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 one part incorrect

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect

OR

Two parts partially correct and one part incorrect

2104 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 3

3. A game is played with a pair of dice, die A which has four 9's and two 0's on its faces, and die B which has four 3's and two 11's on its faces. When either of these dice is rolled, each face has an equal chance of landing on top. The game is played with two players. The first player selects a die and rolls it, and the second player rolls the remaining die. The winner is the player whose die has the highest number on top.

(a) One player would like to determine if he is more likely to win the game by choosing die A or by choosing die B.

i) To make this determination, the player began by listing each of the four possible outcomes of the game and the probability of each. Complete the table below to show these outcomes and associated probabilities.

Die A	Die B	Winner	Probability – show calculations

ii) Based on your calculations in part i), what is the probability of winning the game if a player selects die A?

iii) What is the probability of winning the game if a player selects die B?

(b) Suppose now that if the player using die A wins, he receives 45 sheckles (their unit of currency) from the player using die B. If the player using die A loses, how many sheckles would he need to pay the player using die B in order for this to be a “fair” game? A fair game is one in which the expected gain for the player using die A (or, equivalently, the player using die B) is zero sheckles. Show all calculations.

~~\$~~ ~~\$~~

2104 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 3

Intent of Question

The primary goals of this question are to assess a student’s ability to: (1) determine the set of possible outcomes from a chance experiment and use the basic rules of probability to find the probability of each outcome; (2) set up and perform expected value calculations for a discrete probability distribution.

Solution

Part (a):

i)

Die A	Die B	Winner	Probability – show calculations
9	3	A	$\frac{2}{3} \cdot \frac{2}{3} = \frac{4}{9}$
9	11	B	$\frac{2}{3} \cdot \frac{1}{3} = \frac{2}{9}$
0	3	B	$\frac{1}{3} \cdot \frac{2}{3} = \frac{2}{9}$
0	11	B	$\frac{1}{3} \cdot \frac{1}{3} = \frac{1}{9}$

ii) There is only one outcome in which the player with die A can win, and the probability that this outcome occurs is $\frac{4}{9}$.

iii) The three outcomes in which the player with die B wins the game are mutually exclusive. Thus, the probability that player B wins the game is $\frac{2}{9} + \frac{2}{9} + \frac{1}{9} = \frac{5}{9}$.

Part (b):

Let X = gain for the player using die A. Then the probability distribution for X is given by:

x	45	c
$P(x)$	$\frac{4}{9}$	$\frac{5}{9}$

where c represents the amount that should be paid to the player using die B by the player using die A if he loses the game.

2104 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 3

To find c :

$$E(X) = 0$$

$$45\left(\frac{4}{9}\right) + c\left(\frac{5}{9}\right) = 0$$

$$20 = -\frac{5}{9}c$$

$$180 = -5c$$

$$c = -\frac{180}{5} = -36$$

Thus, in order for this to be a fair game, 36 shekles should be paid to the player using die B by the player using die A if he loses the game.

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 response includes the following three components:

1. The four possible outcomes and the winner in each outcome have been identified correctly.
2. The probability of each of the four outcomes has been correctly calculated.
3. The probability of winning with each die has been correctly calculated.

Partially correct (P) if the response correctly provides only two of the three components.

Incorrect (I) if the response correctly provides only one or none of the components.

Note: If the response does not earn credit for component (1) because the winner of an outcome was incorrectly identified or incorrectly calculates a probability in component (2), then the response can still earn credit for component (3) if the probability of winning with each die is calculated correctly from the identified winners in component (1) and the probabilities calculated in component (2).

2104 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 3

Part (b) is scored as follows:

Essentially correct (E) if the student sets up and performs a correct expected value calculation to find the loss (gain) for the player using die A (die B) needed to make the game fair.

Partially correct (P) if the student sets up the expected value calculation but does not carry it out correctly *OR* sets up an incorrect but plausible calculation but carries it through correctly.

Incorrect (I) if the student does not set up or perform the expected value calculation correctly.

Note: A response based on incorrect values in part (a) can still score an essentially correct (E).

4 **Complete Response**

Both parts essentially correct EE

3 **Substantial Response**

One part essentially correct and one part partially correct EP, PE

2 **Developing Response**

One part essentially correct and one part incorrect PP, EI, IE
OR
Both parts partially correct

1 **Minimal Response**

One part partially correct and one part incorrect ~~II~~ PI, IP

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 4

4. A fast food chain famous for its roast beef sandwiches is considering altering the recipe for its signature sauce, but only if the new recipe is favored by a majority of its customers. The restaurant randomly selected 50 of its customers to participate in a blind taste test where they were asked to taste two unmarked sandwiches in a random order, one prepared with the old sauce and one prepared with the new sauce, and then to select their favorite. In the 50 taste tests, 27 of the customers preferred the new sauce and 23 of the customers preferred the old sauce. Do these results provide convincing evidence that a majority of the restaurant's customers prefer the new recipe for their signature sauce over the old recipe?

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 4

Intent of Question

The primary goal of this question was to assess a student's ability to identify, set up, perform, and interpret the results of an appropriate hypothesis test to address a particular question. More specific goals were to assess a student's ability to: (1) state appropriate hypotheses; (2) identify the appropriate statistical test procedure and check appropriate conditions for inference; (3) calculate the appropriate test statistic and p -value; and (4) draw an appropriate conclusion, with justification, in the context of the study.

Solution

Step 1: State a correct pair of hypotheses.

- Let p represent the proportion of all of the fast food chain's customers who would prefer the new sauce recipe to the old recipe.
- The hypotheses to be tested are $H_0: p = 0.5$ versus $H_a: p > 0.5$.

— population not sample

Step 2: Identify a correct test procedure (by name or formula) and check appropriate conditions.

The appropriate procedure is a one-sample z test for a population proportion.

The first condition is that the data are obtained using randomization. As the data are the result of a designed experiment, the principles of blinding and randomly assigning treatments to subjects should be used. Furthermore, to generalize the results to the entire population, the sample of subjects participating in the experiment should be randomly selected from the population. All aspects of this condition are met, because we are told that the customers participating in the test taste were randomly selected, that the taste tests were blinded, and that the order of the tasting was randomized.

The second condition is that the sample size is large enough to expect at least 10 successes and at least 10 failures under the null hypothesis. This condition is met because $np_0 = 50(.5) = 25$ and $n(1 - p_0) = 50(.5) = 25$ are both at least 10.

Step 3: Correct mechanics, including the value of the test statistic and p -value (or rejection region).

The sample proportion is $\hat{p} = \frac{27}{50} = 0.54$.

— The test statistic is $z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}} = \frac{0.54 - 0.50}{\sqrt{\frac{0.5(0.5)}{50}}} \approx 0.57$.

— The p -value is $P(Z > 0.57) \approx 0.2843$.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 4

Step 4: State a correct conclusion in the context of the study, using the results of the statistical test.

- Because this p -value is larger than any common significance level such as $\alpha = 0.05$ or $\alpha = 0.10$ (or, because this p -value is so large), we fail to reject H_0 and conclude that the data do not provide convincing evidence (or, statistically significant evidence) that a majority of all of the fast food chain's customers who would prefer the new recipe for their signature sauce over the old recipe.

Scoring

Each of steps 1, 2, 3, and 4 are scored as essentially correct (E) or incorrect (I).

Step 1 is scored as essentially correct (E) if the response states a correct pair of hypotheses.

Notes:

- Standard notation for the proportion (p or π) need not be defined in the hypotheses.
- If the response contains language that suggests that the response refers to the sample data, Step 1 should be scored as incorrect.

Step 2 is scored as essentially correct (E) if the student identifies a correct test (by name or by formula) and checks for appropriate conditions.

Notes:

- In addressing the randomization component, the student must indicate that random allocation of treatments to subjects is a required condition.
- $np_o > 5$ and $n(1 - p_o) > 5$ are acceptable as long as appropriate values are used for n and p_o .
- $n\hat{p}$ and $n(1 - \hat{p})$ are not acceptable.
- Since students cannot check the actual population size, they do not need to mention it.
- If additional extraneous information is included, it must be correct.

Step 3 is scored as essentially correct if the student provides the value of the test statistic and p -value with no more than one of the following errors present in the student's work:

- The correct z -value = 0.57 is given with no setup for the calculation; OR
- The value of \hat{p} was used in the calculation of the standard error; OR
- The incorrect z -value is calculated because of a minor arithmetic error.

Step 4 is scored as essentially correct (E) if the student states a correct conclusion in the context of the problem, using the result of the statistical test.

Notes:

- If both an α value and a p -value are given, the linkage is implied.
- If no α is given, the solution must be explicit about the linkage by giving a correct interpretation of the p -value or explaining how the conclusion follows from the p -value.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 4

- If the p -value in part (c) is incorrect but the conclusion is consistent with the computed p -value, Step 4 can be considered as essentially correct (E).
- If a student accepts the null hypothesis and concludes the proportion really is 0.50, Step 4 is incorrect (I).
- If the response contains language that suggests that the response refers to the sample data, Step 4 should be scored as incorrect (I).

Each essentially correct (E) response counts as 1 point.

- 4 Complete Response**
- 3 Substantial Response**
- 2 Developing Response**
- 1 Minimal Response**

NOTE:

- Responses based on conducting a two-sample proportion z -test of the hypotheses $H_0 : p_{new} = p_{old}$ versus $H_A : p_{new} > p_{old}$ will be scored as incorrect for Steps 1 and 2.
- Such responses can be scored essentially correct for Step 3 if they use the correct mechanics for their incorrect test:

$$z = \frac{\hat{p}_{new} - \hat{p}_{old}}{\sqrt{\hat{p}_C(1 - \hat{p}_C)\left(\frac{1}{n_{new}} + \frac{1}{n_{old}}\right)}} = \frac{\frac{27}{50} - \frac{23}{50}}{\sqrt{\frac{50}{100}\left(1 - \frac{50}{100}\right)\left(\frac{1}{50} + \frac{1}{50}\right)}} = 0.8$$

The corresponding p -value is $P(Z > 0.8) \approx .2119$.

- Such responses can be scored essentially correct in Step 4 if they state a correct conclusion in the context of the problem, using the result of their incorrect statistical test.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 5

5. Allison is interested in the amount of time spent working/studying per week for students and faculty members at her university. Allison wants to perform a hypothesis test of

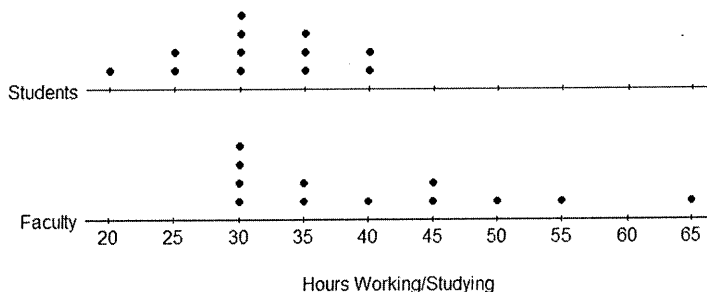
$$H_0: \mu_F - \mu_S = 0$$

$$H_A: \mu_F - \mu_S \neq 0$$

where μ_F is the average amount of working/studying time per week for all faculty members and μ_S is the average amount of working/studying time per week for students.

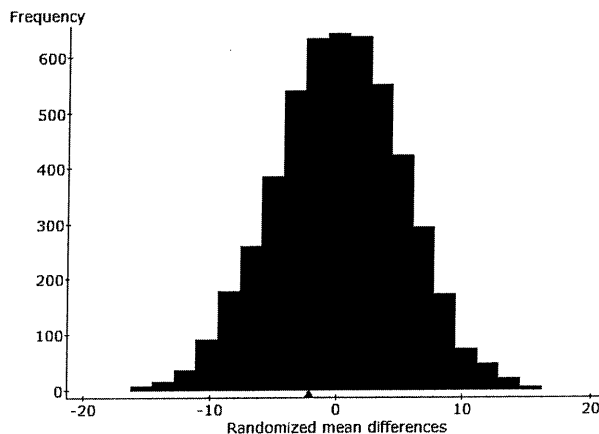
- (a) If the study were to provide insufficient evidence for H_A , would it be reasonable to conclude that the population mean working/studying time for all faculty and the population mean working/studying time for all students are actually equal?

Allison performed a study with a random sample of 12 faculty members and 12 students. The average amount of working/studying time per week for the faculty members was 40.83 (\bar{x}_F), and 31.25 (\bar{x}_S) was the average amount of working/studying time per week for the students. The following are dot plots of the two datasets.



- (b) Why is it not reasonable to use a standard two sample t -test to test Allison's hypotheses?

Although a standard two sample t -test cannot be used, it is possible to simulate the distribution of $\bar{x}_F - \bar{x}_S$. Under the assumption that the null hypothesis is true, 5,000 values of $\bar{x}_F - \bar{x}_S$ were simulated. The histogram below shows the results of the simulation.



- (c) Assume you obtained the raw data that created the histogram above. Based on the results of the simulation, explain how you would calculate a p -value for Allison's test.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 5

Intent of Question

The primary goals of this question are to assess a student's ability to (1) recognize the limited conclusions that can be drawn from an observational study; (2) determine whether a condition for applying a particular inference procedure is satisfied; and (3) calculate p-value from a simulation analysis.

Solution

Part (a):

No, it would not be reasonable to conclude that the population mean working/studying time for all faculty and all students are equivalent as a result of the study. Although the study concluded that there was not enough evidence to suggest the alternative hypothesis that not the same as concluded that the null hypothesis is definitely true. There is just not enough evidence from the sample chosen to conclude that the population mean working/studying times for faculty and students are different.

Part (b):

Based on the dot plot, the distribution of the sample for the Students data may indicate a normal approximation for the population of Student working/studying times per week is appropriate. However, the dot plot of the sample for the Faculty data indicates a population that is right skewed. Since both distributions cannot be assumed to be approximately normally distributed it is not appropriate to use the standard two sample t -test methods for this test.

Part (c):

From the raw data, count the number of simulations that created a value of $\bar{x}_F - \bar{x}_S$ greater than or equal to 9.58 and less than or equal to -9.58. This count divided by 5000 will result in a simulated p -value for this test.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 5

Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the response correctly claims that accepting the null hypothesis is not valid AND provides an explanation based on the study design.

Partially correct (P) if the response correctly claims that accepting the null conclusion is not valid AND provides a weak or incomplete explanation

Incorrect (I) if the response does not satisfy the criteria for E or P.

Part (b) is scored as follows:

Essentially correct (E) if the response indicates that at least one distribution may not be approximately normal AND clearly explains which distribution may not be approximately normal and why.

Partially correct (P) if the response indicates that at least one distribution is not approximately normally but does not clearly indicate which distribution or why.

Incorrect (I) if the response does not satisfy the criteria for E or P.

Part (c) is scored as follows:

Essentially correct (E) if the response provides clear explanation of how to correctly calculate the simulated p -value.

Partially correct (P) if the response provides

- A correct calculation of a one-tailed p -value
- A correct explanation of counting occurrences in both tails but does not divide by 5,000.

Incorrect (I) if the response does not satisfy the criteria for E or P.

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 5

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 one part incorrect

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

1 Minimal Response

One part essentially correct and two parts incorrect

OR

Two parts partially correct and one part incorrect

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 6

6. A teacher wanted to determine if her students' perception of their test results is lower than their actual grade. The teacher randomly selected ten of her students and had each of them complete a 50 item multiple-choice exam. At the end of the exam, the students were asked to state the grade they thought they earned. The teacher matched this information to their actual grades. The results are shown in the table below.

Student	Perceived Grade	Actual Grade	Difference (Perceived-Actual)
1	80	84	-4
2	60	54	6
3	74	78	-4
4	96	92	4
5	84	86	-2
6	70	76	-6
7	86	90	-4
8	50	54	-4
9	80	86	-6
10	90	88	2

- (a) Let μ_D represent the mean of the population of differences in the perceived and actual exam score for this teacher's students where $D = \text{perceived grade} - \text{actual grade}$. In terms of μ_D , state the hypotheses this teacher is interested in testing.
- (b) One might consider using a paired t -test to test the hypotheses in (a). Explain why this would not be a reasonable procedure for this sample.
- (c) Let the random variable X represent the number of pairs in a sample of ten students for which the perceived grade is lower than the actual grade. What is the value of X in this teacher's sample?
- (d) If we assume that there is no difference in a student's perceived and actual grade, then a student is equally likely to perceive their grade as being either higher or lower than their actual grade (ignoring the possibility of a tie). Use this information to find the probability for each possible value of X and record it in the table below.
- (e) Use your work in (c) and (d) to find an appropriate p -value for testing the hypotheses in (a).
- (f) Using the result from part (e), what can the teacher conclude about her students' perceptions of their own abilities on a multiple-choice exam?

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 6

Intent of Question

The primary goals of this question are to evaluate a student's ability to apply the concepts of significance testing to a new situation, in particular to: (1) state hypotheses for a parameter of interest given a research question; (2) recognize that the population of differences should be normally distributed in a paired t -test; (3) calculate the value of a new test statistic; (4) calculate the probability distribution of this new test statistic, assuming the null hypothesis is true; (5) use the probability distribution of the test statistic under the null hypothesis to determine the p -value of the test; and (6) draw an appropriate conclusion, with justification, in the context of the study.

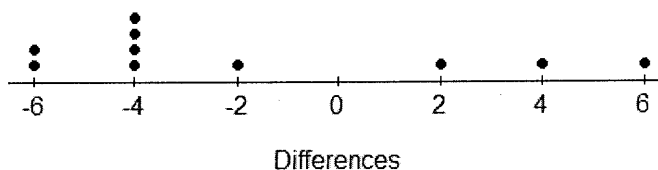
Solution

Part (a):

The hypotheses to be tested are $H_0 : \mu_D = 0$ versus $H_A : \mu_D < 0$.

Part (b):

The dot plot below shows that the sample of differences is clearly skewed to the right. Thus, it is not reasonable to assume that the population of differences is approximately normal.



Part (c):

In this teacher's sample, $X = 7$.

Part (d):

X will follow a binomial distribution with $n = 10$ and $p = 0.5$. The possible values of X and their corresponding probabilities are given in the table below.

x	$p(x)$
0	.00098
1	.00977
2	.04395
3	.11719
4	.20508
5	.24609
6	.20508
7	.11719
8	.04395
9	.00977
10	.00098

2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 6

Part (e):

If the null hypothesis were true, and there truly is no difference in a student's perceived and actual grade, then we would expect 5 out of the 10 students in this sample to perceive their grade as lower than their actual grade. However, if the alternative hypothesis were correct, and student's perceptions of their test grade is lower than their actual grade, then we would expect more than 5 of the differences (perceived – actual) to be negative. Hence, an appropriate p -value for this test is $P(X \geq 7) = .11719 + .04395 + .00977 + .00098 = .17189$.

Part (f):

As the p -value of .17189 is greater than any reasonable significance level, we would not reject the null hypothesis that $\mu_D = 0$. Hence, this teacher does not have statistically significant evidence to conclude that, on average, her students' perceptions of their own abilities are lower than their actual performance.

Scoring

Parts (a) and (b) are combined and scored as essentially correct (E), partially correct (P), or incorrect (I). Parts (c) and (d) are combined and scored as essentially correct (E), partially correct (P), or incorrect (I). Part (e) is scored as essentially correct (E), partially correct (P), or incorrect (I). Part (f) is scored as essentially correct (E), partially correct (P), or incorrect (I).

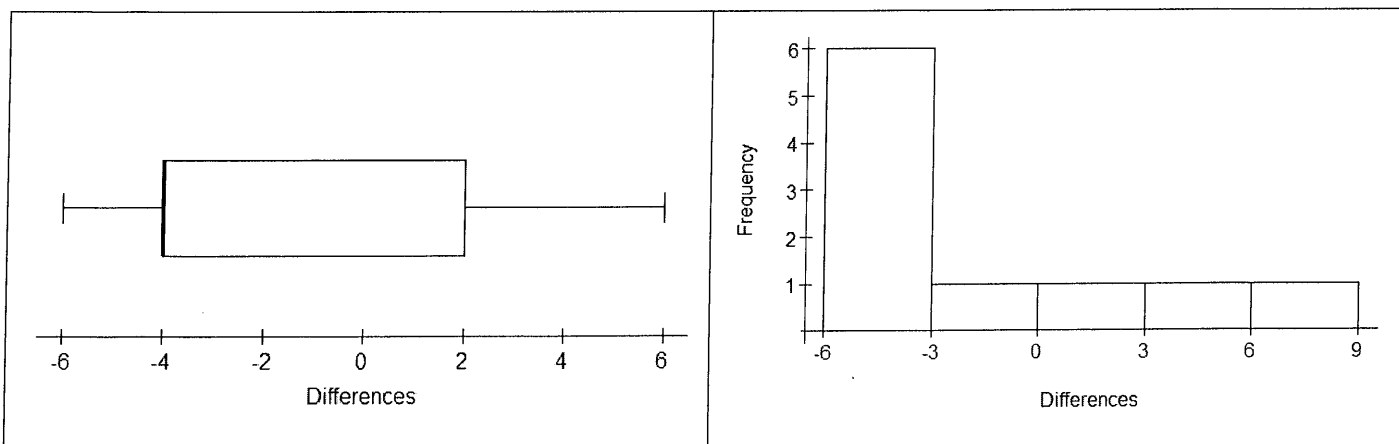
Parts (a) and (b) combined are scored as follows:

Essentially correct (E) if both parts (a) and (b) are correct.

Partially correct (P) if one of the two parts is correct.

Incorrect (I) if neither of the two parts is correct.

Note: A student may also provide a boxplot or histogram of the differences for part (b).



2014 Clemson AP Statistics Practice Exam – Scoring Guidelines
Question 6

Parts (c) and (d) combined are scored as follows:

Essentially correct (E) if both parts (c) and (d) are correct.

Partially correct (P) if one of the two parts is correct.

Incorrect (I) if neither of the two parts is correct.

Part (e) is scored as follows:

Essentially correct (E) if the student uses the information from part (d) to find the appropriate p -value.

Partially correct (P) if the student reverses the direction of the probability calculation.

Incorrect (I) otherwise.

Part (f) is scored as follows:

Essentially correct (E) if the student provides a correct conclusion in context, also providing justification based on linkage between the p -value and conclusion.

Partially correct (P) if the student provides a correct conclusion, with linkage to the p -value, but not in context *OR* provides a correct conclusion in context, but without justification based on linkage to the p -value.

Incorrect (I) otherwise.

Each essentially correct (E) counts as 1 point, and a partially correct (P) counts as $\frac{1}{2}$ point.

4 Complete Response

3 Substantial Response

2 Developing Response

1 Minimal Response

If a response is between two scores (for example, $2\frac{1}{2}$ points), score down.