Question 1

Intent of Question

The primary goals of this question were to assess a student's ability to (1) describe the distribution of a quantitative variable based on a histogram and (2) determine the effect of changing one data value on the mean and the median.

Solution

Part (a):

The distribution of Robin's tip amounts is skewed to the right. There is a gap between the largest tip amount (in the $20 to $22.50 interval) and the second largest tip amount (in the $12.50 to $15 interval), and the largest tip amount appears to be an outlier. The median tip amount is between $2.50 and $5.00. Robin's tip amounts vary from a minimum of between $0 and $2.50 to a maximum of between $20.00 and $22.50. About 78 percent of the tip amounts are between $0 and $5.

Part (b):

The mean: If the $8 tip had been $18, the mean would increase by $10 divided by 60, or $$\frac{1}{6}$$, or about 17 cents.

The median: If the $8 tip had been $18, the median would not change because the current median is between $2.50 and $5.00, and both $8 and $18 are greater than that.

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 reasonable comments on the following five components:
1. Shape (skewed right)
2. Outlier (at least one) *OR* gap (one tip amount greater than $20, next highest at most $15)
3. Center between $2.50 and $5.00 (median) or between $2.62 and $5.13 (mean)
4. Variability, by noting that the tip amounts vary from about $0 to at most $22.50, or that a majority of tip amounts are between $0 and a value greater than or equal to $5, or by providing a correct numerical approximation of a measure of variability
5. Context (tip amounts)

Partially correct (P) if the response includes only three or four of the five components.

Incorrect (I) if the response includes at most two of the five components.

Part (b) is scored as follows:

Essentially correct (E) if the response includes the following four components:
1. Comments that the mean will increase
2. Correctly justifies why the mean will increase
3. Comments that the median will not change
4. Correctly justifies why the median will not change

Partially correct (P) if the response includes only two or three of the four components.

Incorrect (I) if the response includes at most one of the four components.

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
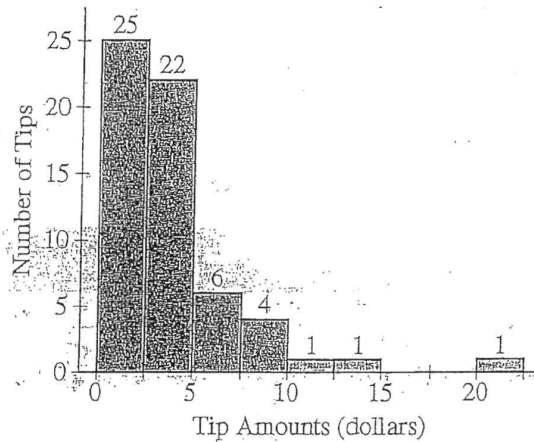
> One part partially correct and one part incorrect

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Robin works as a server in a small restaurant, where she can earn a tip (extra money) from each customer she serves. The histogram below shows the distribution of her 60 tip amounts for one day of work.

(a) Write a few sentences to describe the distribution of tip amounts for the day shown.

The distribution of tips is skewed to the right and is unimodal.

The largest tip is between 20 and 22.5 dollars and the lowest tip is between 0 and 2.5 dollars. The range of the tips is between 17.5 and 22.5 dollars.

The median tip is between 2.5 and 5 dollars.

There is a gap between 15 and 20 dollars, so no tips were received that were between 15 and 20 dollars.

Possible outlier at 22.5 dollars.

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(b) One of the tip amounts was $8. If the $8 tip had been $18, what effect would the increase have had on the following statistics? Justify your answers.

The mean:

If the 8 dollar tip was changed to $18, then the mean would increase, because the sum of all the tips is now higher.

The median:

If the 8 dollar tip was changed to $18, the the median would not change because both 8 and 18 dollars are above the median (center value) which is still between 2.5 and 5 dollars.

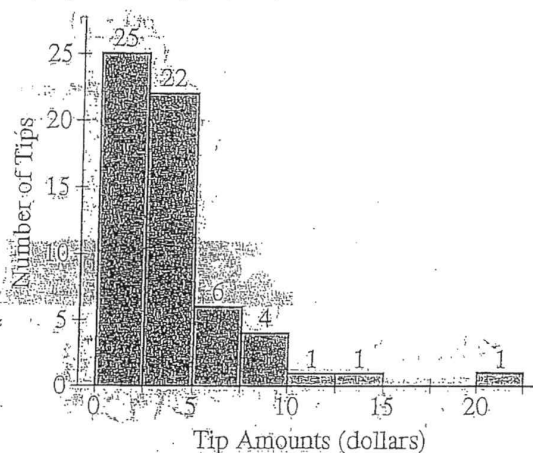GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part A
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Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Robin works as a server in a small restaurant, where she can earn a tip (extra money) from each customer she serves. The histogram below shows the distribution of her 60 tip amounts for one day of work.

(a) Write a few sentences to describe the distribution of tip amounts for the day shown.

> The shape of the distribution of trip amounts
> is heavily skewed right. The center (median)
> is ≈ 3 dollars. The range (spread) is ≈ 22.5 and
> there is one potential outlier of ≈ 20 dollars.

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(b) One of the tip amounts was $8. If the $8 tip had been $18, what effect would the increase have had on the following statistics? Justify your answers.

The mean:

This would cause the mean to increase because adding/subtracting affects the mean of a distribution. Since $18 is larger than $8, the mean would also be larger as the sum of the tips before dividing by # of tips to find the mean would be higher.

The median:

The median would not be affected. Because there were 60 tips, the median would still be in the (2.5, 5) range of the histogram as it would fall between the 30th and 31st tip.

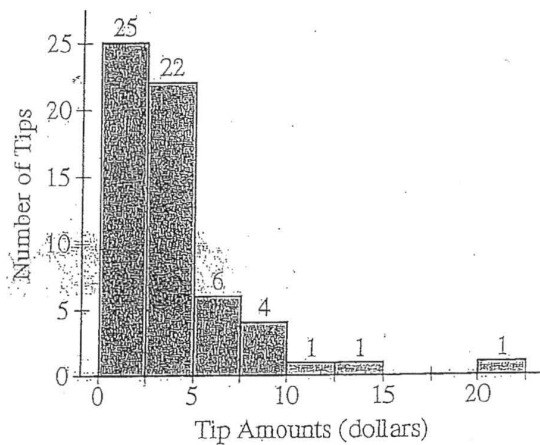GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. Robin works as a server in a small restaurant, where she can earn a tip (extra money) from each customer she serves. The histogram below shows the distribution of her 60 tip amounts for one day of work.

(a) Write a few sentences to describe the distribution of tip amounts for the day shown.

The center of the distribution is between 2.5 and 5 dollars.
The distribution is skewed right. It has a range of $25 and
a standard deviation near 2-3 dollars.

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(b) One of the tip amounts was $8. If the $8 tip had been $18, what effect would the increase have had on the following statistics? Justify your answers.

The mean:

The mean would increase by $.16, because the total amount of money would increase by $10, and the amount of tips is 60, and $\frac{10}{60}$ is .16

The median: The median would remain unchanged because both $8 and $18 are in the upper half of the distribution so increasing the value would have no effect on the median.

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AP® STATISTICS
2016 SCORING COMMENTARY

Question 1

Overview

The primary goals of this question were to assess a student's ability to (1) describe the distribution of a quantitative variable based on a histogram and (2) determine the effect of changing one data value on the mean and the median.

Sample: 1A
Score: 4

In part (a) the first sentence of the response includes a correct description of the shape of the distribution in context, which satisfies components 1 and 5. The next two sentences provide reasonable statements about the variability in tip amounts, satisfying component 4. The comment that "The median tip is between 2.5 and 5 dollars" satisfies component 3 (center). The response concludes with a statement about the gap and a marginal comment about a possible outlier, which satisfies component 2. With all five components satisfied, part (a) was scored as essentially correct. In part (b) the response correctly indicates that the mean would increase if the $8 tip had been $18 because "the sum of all the tips is now higher." This efficient comment satisfies components 1 and 2. The response goes on to address the fact that the median would not change "because both 8 and 18 dollars are above the median," which satisfies components 3 and 4. With all four components satisfied, part (b) was scored as essentially correct. Because both parts were scored as essentially correct, the response earned a score of 4.

Sample: 1B
Score: 3

The first sentence in part (a) satisfies components 1 (shape) and 5 (context). The second sentence about center — median is approximately $3 — satisfies component 3. The third sentence satisfies components 2 (outlier/gap) and 4 (variability). With all five components satisfied, part (a) was scored as essentially correct. Part (b) begins with a statement that the mean would increase, satisfying component 1. While the comment "adding/subtracting affects the mean" is not clear, the comment is followed by a correct justification of why the mean increases (sum increases), which satisfies component 2. The response clearly indicates that the median would not change, satisfying component 3. However, the final sentence does not give an adequate justification of why the median would still be "in the (2.5, 5) range" based on the fact that $8 and $18 are both above the median. Therefore component 4 is not satisfied. With three of four components satisfied, part (b) was scored as partially correct. Because one part was scored as essentially correct, and one part was scored as partially correct, the response earned a score of 3.

Sample: 1C
Score: 2

In part (a) the first sentence satisfies component 3 (center). The second sentence describes the shape of the distribution as skewed right, which satisfies component 1. The third sentence includes both a reasonable comment "standard deviation near 2-3 dollars" and an incorrect comment "range of $25" about variability. Therefore component 4 is not satisfied. No mention is made of the gap or outlier or of the context, so neither component 2 nor component 5 is satisfied. With only two of five components satisfied, part (a) was scored as incorrect. The response in part (b) satisfies components 1 and 2 by stating that the mean would increase by $10/60 (about 16 cents). Components 3 and 4 are satisfied by the statement "The median would remain unchanged because both $8 and $18 are in the upper half of the distribution." With all four components satisfied, part (b) was scored as essentially correct. Because one part was scored as essentially correct, and one part was scored as incorrect, the response earned a score of 2.