

AP[®] STATISTICS 2009 SCORING GUIDELINES

Question 1

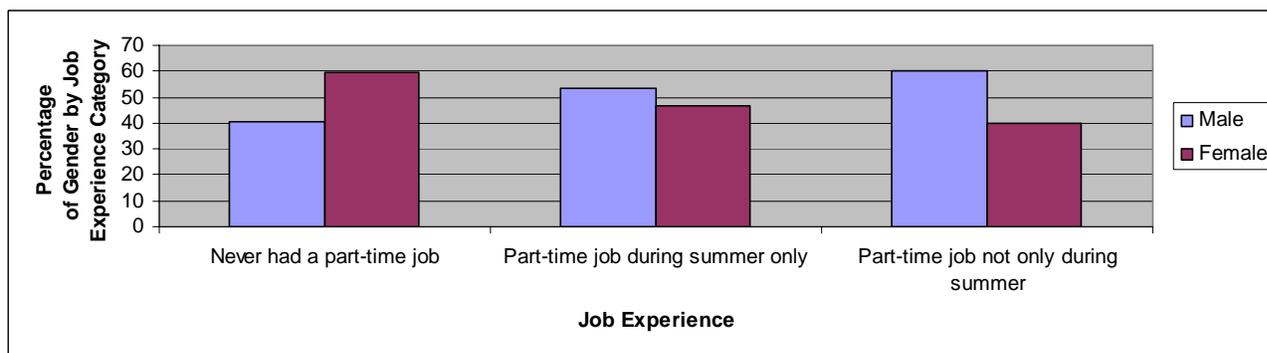
Intent of Question

The primary goals of this question were to assess a student's ability to (1) construct an appropriate graphical display for comparing the distributions of two categorical variables; (2) summarize from this graph the relationship of the two categorical variables; and (3) identify the appropriate statistical procedure to test if an association exists between two categorical variables and state appropriate hypotheses for the test.

Solution

Part (a):

A side-by-side bar graph of the data is shown below.



Part (b):

The females in the sample were more likely to have never had a part-time job than were the males. Females were less likely than males to have had a part-time job during summer only or to have had a part-time job not only during summer. If there is no association between the two variables, one would expect the heights of the bars for gender within each job-experience category to be about the same. Based on the sample data summarized in the graphical display, there appears to be an association between job experience and gender.

Part (c):

The appropriate test of significance is the chi-square test of association or independence.

The appropriate hypotheses are:

H_0 : There is no association between gender and job experience.

H_a : There is an association between gender and job experience.

OR

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Question 1 (continued)

H_0 : Gender and job experience are independent.

H_a : Gender and job experience are not independent.

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 an appropriate graph is drawn correctly and all labels are provided.

Partially correct (P) if the graphical display is drawn correctly but some labels are missing.

Incorrect (I) if a partial graph is drawn (such as for one job-experience category only) *OR* if the graphical display is incorrectly drawn or inappropriate.

Note: A segmented bar graph, a bar graph conditioning on gender, and pie charts are acceptable graphical displays.

Part (b) is scored as follows:

Essentially correct (E) if the student correctly discusses percentages for both genders within each category of job experience.

Partially correct (P) if the student correctly discusses percentages for both genders within only one or two of the job-experience categories.

Incorrect (I) otherwise.

Notes:

- Stating that there is no obvious gender difference for “Part-time job during summer only” is acceptable.
- If an incomplete graph is drawn in part (a), the student may receive an (E) for part (b) if a discussion of the percentages for both genders in all three job-experience categories is provided.

Part (c) is scored as follows:

Essentially correct (E) if the student recommends using the chi-square test of association or independence and states correct hypotheses in context.

Partially correct (P) if the student recommends using an incorrect test but states correct hypotheses in context for a chi-square test of association or independence *OR* if the student names the correct test but does not give correct hypotheses in context.

Incorrect (I) if the student recommends any incorrect statistical test and does not state correct hypotheses in context for a chi-square test of association or independence.

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Question 1 (continued)

Notes:

- If a student names merely the “chi-square test,” this will be accepted if the hypotheses for a chi-square test of association or independence are provided.
- If a student recommends the chi-square test of homogeneity but states correct hypotheses for that test in context, score part (c) as partially correct.

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 part partially correct

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 no parts partially correct

OR

No parts essentially correct and two parts partially correct

STATISTICS
SECTION II

1A1

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 graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

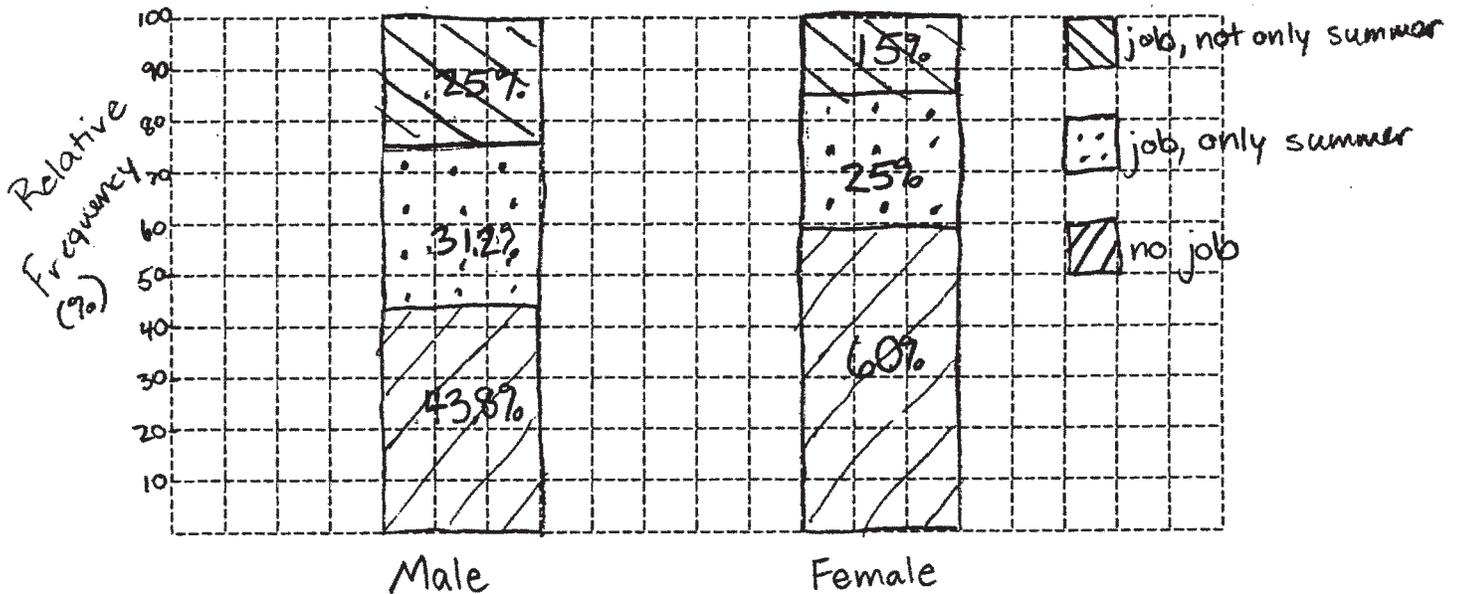
1. A simple random sample of 100 high school seniors was selected from a large school district. The gender of each student was recorded, and each student was asked the following questions.

1. Have you ever had a part-time job?
2. If you answered yes to the previous question, was your part-time job in the summer only?

The responses are summarized in the table below.

| Job Experience | Gender | | Total |
|--|--------|--------|-------|
| | Male | Female | |
| Never had a part-time job | 21 | 31 | 52 |
| Had a part-time job during summer only | 15 | 13 | 28 |
| Had a part-time job but not only during summer | 12 | 8 | 20 |
| Total | 48 | 52 | 100 |

- (a) On the grid below, construct a graphical display that represents the association between gender and job experience for the students in the sample.



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- (b) Write a few sentences summarizing what the display in part (a) reveals about the association between gender and job experience for the students in the sample.

1A2

The parallel, segmented bar charts show that females are more likely (60%) to have never had a part-time job than males (43.8%). Males are more likely to both have had a job only in summer (31.2% vs. 25% for females) and to have had a job not only in summer (25% vs. 15% for females).

- (c) Which test of significance should be used to test if there is an association between gender and job experience for the population of high school seniors in the district?

χ^2 test of independence

State the null and alternative hypotheses for the test, but do not perform the test.

H_0 : Job experience is independent of gender, so there is no association.
 H_A : Job experience is not independent of gender, so there is an association between job experience and gender.

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STATISTICS

SECTION II

Part A

Questions 1-5

Spend about 65 minutes on this part of the exam.

Percent of Section II score—75

181

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

1. A simple random sample of 100 high school seniors was selected from a large school district. The gender of each student was recorded, and each student was asked the following questions.

1. Have you ever had a part-time job?
2. If you answered yes to the previous question, was your part-time job in the summer only?

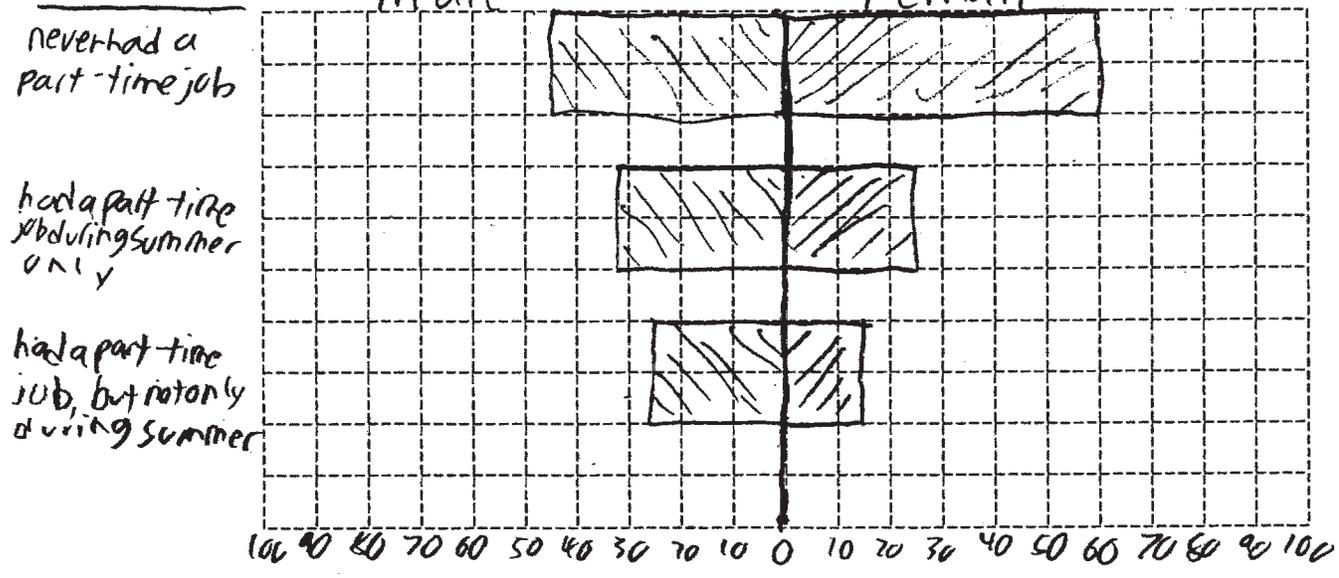
The responses are summarized in the table below.

| Job Experience | Gender | | Total |
|--|----------|----------|-------|
| | Male | Female | |
| Never had a part-time job | 44 21 | 60 31 | 52 |
| Had a part-time job during summer only | 31 15 | 25 13 | 28 |
| Had a part-time job but not only during summer | 25 12 | 15 8 | 20 |
| Total | 48 | 52 | 100 |

Job
experience

- (a) On the grid below, construct a graphical display that represents the association between gender and job experience for the students in the sample.

male female



percentage of gender

GO ON TO THE NEXT PAGE.

- (b) Write a few sentences summarizing what the display in part (a) reveals about the association between gender and job experience for the students in the sample.

The display shows that over 15% more females have never held jobs than males. Over 5% more males have held a part-time job in the summer only than females, and about 10% more males than females have held a part-time job, but not only during summer.

- (c) Which test of significance should be used to test if there is an association between gender and job experience for the population of high school seniors in the district?

State the null and alternative hypotheses for the test, but do not perform the test.

a χ^2 test for independence should be used to test if there is an association between gender and job experience for the population of high school seniors in the district.

Null hypothesis: there is no difference between genders with regards to job experience.

Alternative hypothesis: There is a difference between genders with regards to job experience.

Let P_1 = the proportion of males who have ever had a part-time job.

Let P_2 = the proportion of females who have ever had a part-time job.

$$H_0: P_1 = P_2$$

versus $H_A: P_1 \neq P_2$

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STATISTICS
SECTION II
Part A

101

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 graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

1. A simple random sample of 100 high school seniors was selected from a large school district. The gender of each student was recorded, and each student was asked the following questions.

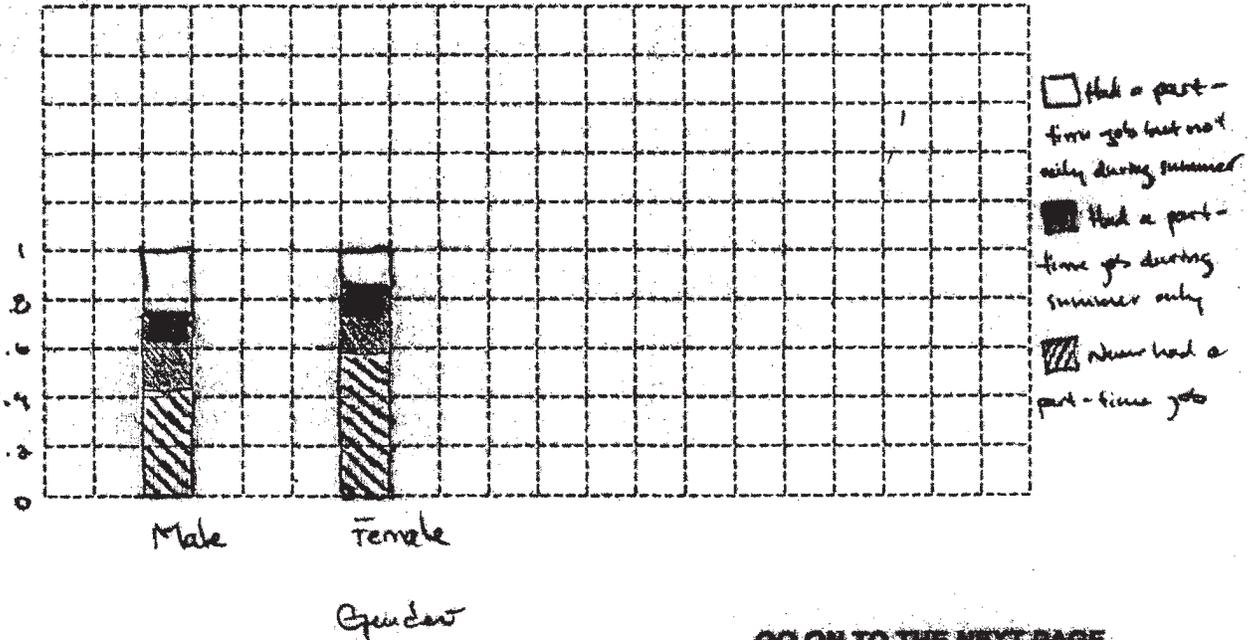
1. Have you ever had a part-time job?
2. If you answered yes to the previous question, was your part-time job in the summer only?

The responses are summarized in the table below.

| Job Experience | Gender | | Total |
|--|-----------|-----------|------------|
| | Male | Female | |
| Never had a part-time job | 21 | 31 | 52 |
| Had a part-time job during summer only | 15 | 13 | 28 |
| Had a part-time job but not only during summer | 12 | 8 | 20 |
| Total | 48 | 52 | 100 |

- (a) On the grid below, construct a graphical display that represents the association between gender and job experience for the students in the sample.

Proportion of job experience for the students



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- (b) Write a few sentences summarizing what the display in part (a) reveals about the association between gender and job experience for the students in the sample.

There is a higher proportion of females than males who "have never had a part-time job". But there is a higher proportion of males than females who have "had a part-time job during summer only" and who have "had a part-time job but not only during summer".
 For females, the proportions of job experience for the students seem to be skewed right, while for males it seems symmetrical.

- (c) Which test of significance should be used to test if there is an association between gender and job experience for the population of high school seniors in the district?

χ^2 test of homogeneity

State the null and alternative hypotheses for the test, but do not perform the test.

H_0 : There is an association between gender and job experience for the population of high school seniors in the district.

H_a : There isn't an association between gender and job experience for the population of high school seniors in the district.

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AP[®] STATISTICS

2009 SCORING COMMENTARY

Question 1

Overview

The primary goals of this question were to assess a student's ability to (1) construct an appropriate graphical display for comparing the distributions of two categorical variables; (2) summarize from this graph the relationship of the two categorical variables; and (3) identify the appropriate statistical procedure to test if an association exists between two categorical variables and state appropriate hypotheses for the test.

Sample: 1A

Score: 4

In part (a) the student provides well-labeled segmented bar graphs that accurately display the distributions of male and female responses. This part was scored as essentially correct. The student's response in part (b) includes a clear comparison of the percentages of males and females in each of the three job-experience categories. This part was scored as essentially correct. In part (c) the student correctly identifies the appropriate significance test as a chi-square test of independence and states a pair of correct hypotheses. This part was scored as essentially correct. The entire answer, based on all three parts, was judged a complete response and earned a score of 4 points.

Sample: 1B

Score: 3

In part (a) the student uses a comparative bar graph conditioned on gender to compare the distributions of job experience for males and females. Because the display is accurate and well-labeled, part (a) was scored as essentially correct. In part (b) the student effectively compares the percentages of males and females reporting each level of job experience. This part was scored as essentially correct. The student identifies the appropriate significance test in part (c) but does not state correct hypotheses for a chi-square test of independence. With a correct test but incorrect hypotheses, this part was scored as partially correct. With two parts essentially correct and one part partially correct, the entire answer was judged a substantial response and earned a score of 3 points.

Sample: 1C

Score: 2

In part (a) the student uses segmented bar graphs conditioned on gender to visually compare the distributions of job experience for males and females. Note that the student uses proportion on the vertical scale, so the height of each segmented bar is 1 (100 percent). Because the graph is well-labeled and accurate, this part was scored as essentially correct. The first two sentences of the student's response in part (b) include a complete discussion of how males and females compare in each of the three job-experience categories. If the student had stopped there, this part would have been scored as essentially correct. However, the student goes on to describe the shape of each graph, which is inappropriate for categorical data. Consequently, part (b) was scored as partially correct. The student identifies an incorrect test (" χ^2 test of homogeneity") in part (c) but goes on to state a correct pair of hypotheses for a chi-square test of association/independence. This part was scored as partially correct. With one part essentially correct and two parts partially correct, the entire answer was judged a developing response and earned a score of 2 points.