Possible responses to the 2016 AP Statistics Free Resposne questions, draft #1.

You can access the questions here.

Note: I construct these as a service for both students and teachers to start discussions. There is nothing "official" about these solutions. I certainly can't even guarantee that they are correct. They probably have typos and errors. If you catch some, let me know! But if they generate discussion and help others, then I've succeeded.

1. Tip Amounts for Robin

a. Robin's tip amounts appear to be skewed to the right. The median tip amount appears to be between $2.50 and $5.00. Without precise values for the minimum, q1, median, q3, and maximum, it becomes tough to compute the range or IQR exactly. But, the range of tip amounts appears to be about $20-21 dollars. (about ($21? - $0?) . This range includes one unusually high tip amount over $20. 59 of the sixty tip amounts were under $15.

b. i. Since we are adding $10 to the entire sum of all the 60 tip amounts, the mean will increase by 10/60 = about $0.167.

ii. Since $8 is above the median tip amount, increasing that tip's value to $18 will not change the location of the 50th percentile. The median will remain the same.

2. Ads and snack choice

a)

We'll do a chi-squared test for homogeneity

Setup:

Ho: Snack choice distributions are the same for those like our volunteers regardless of whether they watch the Choco – only ads, the Appl-only adds, or no ads.

Ha: Snack choice distribution is different for students like our volunteers who watch Choco only ads, Apple Only Ads, or No Ads.

alpha level: 0.05.

Conditions:
-Random: The 75 students were assigned by random draw into one of the three treatment groups, so we pass this condition.
-Large counts: Notice that all of the expected counts are greater than 5, so we meet the large counts condition, and can trust that the statistic $\sum_{cells}\left(\frac{(\text{observed-expected})^2}{\text{expected}}\right)$ follows, roughly, a chi-squared distribution with (3-1)(2-1) = 2 degrees of freedom.

Ad Type	# choco	# apple	Total
Choc only	18.67	6.33	25
Apple only	18.67	6.33	25
neither	18.67	6.33	25
Total	56	19	75

Mechanics:

$\sum_{cells}\left(\frac{(\text{observed-expected})^2}{\text{expected}}\right)$ = 10.291. df = 2. p value = about 0.008.

Conclusion: Since our pvalue 0.008 < 0.05, we can reject the null hypothesis at the 5% level. We have convincing evidence that changing the type of ad influences the distribution of snack choice for children like those in our experiment.

c. When no ads were shown, students in the sample showed a strong preference for Choco-Zuties over Apple Zuties (88% vs 12%) . This strong preference was maintained when students saw ads for Choco Zuties (84% vs 16%). But when Apple Zuties ads were shown, students preference for Apple Zuties increased (52% for Choco, 48% for Apple).

Smoking and Alzheimer's Disease:

3.

a.

Explanatory Variable: Did the person smoke more than 2 packs a day, or were they a non-smoker? (2+ packs / Non-smoker)
Repsonse Variable: - did they develop Alzheimer's Disease? (yes/no)

b.

This is an observational study. No treatments were imposed on each person in the tudy. Their behaviors and the potential onset of Alzheimer's was simply observed.

c.

It is possible that those in the non-smoking group tended to exercise more than those in the smoking group. It is also possible that more exercise reduces the onset of Alzheimer's and that smoking is unrelated to developing Alzheimer's. But because individuals were not randomly assigned to smoke/ not smoke in this study, the effect of exercise is not distributed equally across the two comparison groups (smokers/ non-smokers). Therefore there was no way to determine if smoking or exercise was responsible for the difference in rates of developing Alzheimer's disease. For this reason, the effects exercise may be confounded with the effects of smoking.

4. Igniters and rockets

a) $P(30 \text{ successful ignitions in a row})$
$= 0.85^{30}$
≈ 0.00763

b) (0.15) + (0.85)(0.15) = 0.2775.

c) If the failure rate really is 0.15, then it would be VERY unusual to see all of the first 30 ignitions succeed. If we conducted 1000 runs of 30 ignition attempts, we'd see a perfect run only 7 or 8 times (less than 1 % of the time). For this reason, we can reject the assumption that the failure rate of 0.15 is accurate, and claim that the failure rate is something lower.

5. Economy vs. environment poll

a) 95% confidence interval for p = the proportion of all adults in the US who would choose the economy statement.

$$\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \approx (0.37) \pm 1.96 \sqrt{\frac{(0.37)(0.63)}{1048}}$$

(0.3318, 0.4086)

We estimate, with 95% confidence, that between 33.2% and 40.9% of all US adults would choose the economy statement (over the environment statement or no preference) in the question posed by the pollsters.

b) If the number who chose/didn't choose the economy statement are both >10, then we pass the "normal" condition for a one-proportion z-test. This means that we can believe that the underlying sampling distribution for $\hat{p}$ = the sample proportion is approximately normal.

c) A two-sample z test for a difference in proportions is NOT appropriate because we do not have two independent samples. We have a single sample of 1048 adults, and "environment" and "economy" are simply two possible outcomes of the question being asked. The proportions of responders who pick each response are NOT independent values.

6.

a) If taken as a single group the overall association between salary and number of semesters in the scatterplot is moderate, positive, and roughly linear. So there does appear to be a positive association between number of semesters and starting salary in this sample. The paper is justified in saying that this might be true. However, I see three distinct clumps of data, and I am curious if thee clumps suggest a more complex association.

b) The slope = 1.1594. For every additional semester of schooling, the regression model predicts an increase of about $1159.40 Euros in starting salary.

c) There appears to be a strong, negative, linear association between "# semesters" and starting salary for business majors.

d) Estimated median starting salary, the lowest earners appear to be the business students, with a median starting salary of about €38,000. In the middle, and comfortably ahead of the business majors, were the physics majors, (median near €48,000). The highest earners seemed to be chemistry majors (median near €55,000).

e) The researcher should look at the association within each subgroup of majors. When not controlling for type of degree, the overall association between #hours and starting salary was positive. But then we separated the data by major: business, chemistry, and physics. Within each subgroup, there was a strong negative association between # hours and salary. Why did we see the positive association overall? Well, business majors, who tended to earn the least overall, also tended to have the shortest number of semesters of study in our sample. Chemistry majors, who tended to earn the most, had the highest number of semesters. But when looking only at chemistry majors, the overall relationship between semesters and earning was negative. This negative association was also found within the physics and within the business majors.