Answers to Questions from Reviewing Inferential Statistics

1. a. The Z score for a marriage of 10 years (or 120 months) is

$$Z = \frac{120 - 205}{181} = -.470$$

The area between the mean and this value is .1808.

Z score for 20 years, or 240 months, is

$$Z = \frac{240 - 205}{181} = .193$$

Area between the mean and this value is about .0753, so the total proportion of marriages is about .256.

b. A marriage that lasts 50 years is at the 98.5th percentile. This is certainly a rare value, so it justifies the exceptional nature of such marriages.

$$Z = \frac{600 - 205}{181} = 2.182$$

Area beyond this Z score is about .0146.

c.

$$Z = \frac{360 - 205}{181} = .856$$

Area above this Z value is about .1949 or .195, which is also the probability.

d. Yes, length of marriage is probably not normally distributed because there can be no cases less than about 1.13 standard deviations below the mean (less than zero years in length). This would not be true if length was normally distributed.

2. a. Republicans and Other party members were least likely to support President Clinton's handling of the economy. About 31% from each group indicated that they "approve strongly." In contrast, the Democrats in the sample indicated the highest level of support, with 80% approving strongly of the President's handling of the economy.

b. There are (5 – 1)(4 – 1) = 12 degrees of freedom. The value of chi-square, 236.140, is significant at .0000 level. We conclude that political preference and support for Clinton's handling of the economy are related.

c. Three cells out of 15, or 20% of the cells, have an expected value less than 5. All of these cells are in the column for respondents of "Other Party" or "No Preference." This is on the border of being acceptable per most authorities. However, given the clear nature of the relationship between party preference and support for President Clinton, it is very likely that the 10 respondents from other parties are not greatly affecting the chi-square result. Some may suggest removing them from the table (or combining the two categories) and recalculating chi-square. The key point is to get students to think about what to do when statistical assumptions are just barely violated or met.

3. a. For both tables, the calculated chi-squares are significant. For those with a high school education or less, the chi-square is 95.14 (p=.0000). For respondents with some college education or more, the chi-square is larger at 153.22 (p=.000). We would reject the null hypothesis in both cases. Our results are consistent for both educational groups. The relationship appears to be stronger in the table for individuals with some college or more.

   b. The educational groups help specify the relationship between political preference and support of Clinton's handling of the economy. If education were a control variable, we would find some differences between the two cross tabulations. For example, there may be a significant relationship in the first table, but not in the second. However, based on our calculations, we know that there is a significant relationship in both tables.

   c. The main problem comes about because of the small number of people who say they prefer a third, or other, party, especially for those with a high school education or less. Combine the "Other Party" category with the "Independent" and "No Preference" group. These categories are not exactly comparable, but this strategy groups political preference into Republican, Democrat, and Other. In the table for high school graduates (or less than high school), the relationship remains significant (chi-square 86.50). In the table for those with some college or more, the relationship remains significant (chi-square 143.30). Neither table has too few cells with an expected value below 5.

4. a. There are a total of 90,000 members spread across the three sizes of firms. A proportionate sample would take the following number from each:

Size			Sample Size
Small	(5,000/90,000)*100	≅	56
Medium	(35,000/90,000)*100	≅	389
Large	(50,000/90,000)*100	≅	556

   Due to rounding, the total is 1,001, not 1,000. This is not a concern.

   b. The probability of picking a member from a small firm is 5,000/90,000, or .056.

   c. With a sample size of 900, 300 will be chosen from small firms (and medium and large firms).

5. a. Standard error $= \sqrt{\frac{(59.5)(40.5)}{400}} = 2.454$

   Confidence Interval $= 59.5\% \pm 1.96(2.454)$

   $= 59.5\% \pm 4.81$

   $= 54.69\%$ to 64.31%

   b. The 99% confidence interval

Confidence Interval $= 59.5\% \pm 2.58\ (2.454)$

$= 59.5\% \pm 6.33$

$= 53.17\%$ to 65.83%

6. a. The exercise doesn't mention whether we should assume that the variances are equal or not. The safest strategy is to assume they are unequal (but students could do the calculation assuming the variances are equal because they are so similar). We then have:

$$s_{\bar{Y}_1-\bar{Y}_2} = \sqrt{\frac{2.58^2}{961}+\frac{2.48^2}{302}} = .17$$

$$t = \frac{13.28-13.85}{.17} = -3.35$$

The number of degrees of freedom is $N_1 + N_2 - 2 = 961+302-2 = 1{,}261$. The probability of –3.35 (two-tailed test) is less than .001. Based on our alpha of .05, we reject the null hypothesis. It appears that those for whom religion is important have slightly less education.

b. Based on alpha = .01, we would fail to reject the null hypothesis.

Neither test is better (or worse) than the other. The level of significance chosen to test a null hypothesis is a central element of inferential statistics, and it is perfectly possible for two different researchers to arrive at different conclusions with the exact same data depending on the level of significance chosen.

7. a. ^{2} = 5.793. At the .05 alpha level, we would reject the null hypothesis. The probability of our obtained chi-square falls somewhere between .02 and .01, both less than our alpha level. Those with higher levels of education (some college or more) are more likely to favor a school voucher program.

b. Proportion of high school graduates disapproving is .55 (279/510); for the group of college-educated respondents, it is .48 (328/688). Obtained Z is 2.33, with a probability of .0198 (.0099 x 2), so we reject the null hypothesis. There is a difference between high school and college graduates in their disapproval of school voucher programs.

$$Z = \frac{.55-.48}{\sqrt{\frac{.55(1-.55)}{510}+\frac{.48(1-.48)}{688}}} = 2.33$$

c. The proportion who disapprove is

$$\frac{279+328}{1198} = .51$$

Confidence Interval

$$.51 \pm 1.96\sqrt{\frac{.51(.49)}{1198}} = .51 \pm .028$$

Or in terms of percentages, 51% ± 2.8%

d. The conclusions are similar.

8. a. H_o: $\mu_1 = \mu_2$. The research hypothesis is $\mu_1 > \mu_2$.

We know that the variances are unequal. To calculate the estimated standard error, we'll have to use Formula 13.1.1. The number of degrees of freedom is 122+ 814 – 2 = 934. Our obtained t-test statistic is .889. The probability of t for a one-tailed test is somewhere greater than .05. This is greater than our alpha level of .05. We fail to reject the null hypothesis.

b. We are not given a population value for the standard deviation of hours worked for those not self-employed, so we must use the sample value of 12.87. The obtained t statistic of 3.43 has a probability less than .0005 (the t statistic doesn't even appear on the chart). The P value is below our alpha level of .01. We can conclude that Americans not self-employed work more than 40 hours per week. Of course, they don't work much more, just 1.44 hours.

$$t = \frac{41.44 - 40}{\frac{12.87}{\sqrt{934}}} = 3.43$$

9. a. This is a difficult (some would say unfair) question designed to see whether students really understand the logic of testing hypotheses about two samples. When we do a two sample test, two groups of unrelated individuals answer the same question. But in this problem, two groups of people answered different questions. Two samples and two questions is not a situation discussed in the text. And we can't do a one-sample test because both the results come from samples. Although there are methods to test whether the percentage of "approve" responses to these two questions differs, it is well beyond the scope of this text.

Therefore, the correct answer to this question is that, given what the students have learned, they cannot test whether there is any difference in the two approval ratings. Just recognizing that, and explaining why, is an important lesson.

Nevertheless, one can approximate such a test by constructing 99% confidence intervals for each proportion and seeing whether they overlap.

Confidence Interval for approval of Congress is

$$.40 \pm 2.58\sqrt{\frac{(.40)(.60)}{716}} = .40 \pm .047$$

Confidence Interval for approval of their own representative is

$$.70 \pm 2.58\sqrt{\frac{(.70)(.30)}{1,398}} = .70 \pm .032$$

These intervals clearly do not overlap, and so it is reasonable to conclude that people have a higher approval of their individual representative than of Congress as a whole. This assumes both samples are representative of the same population, which is a reasonable assumption in this instance.

b. Answers should be judged on logic and thoughtfulness.

10. a. The Z score for a Paranoia scale score of 70 is

$$Z = \frac{70 - 50}{10} = 2.00$$

About 2.28% of the population should have a score this high or higher.

It seems reasonable that a score of 70 is considered abnormal because it is at about the 97.8th percentile. Very few people have a score of 70 or above.

b. A score of 45 corresponds to a Z score of

$$Z = \frac{45 - 50}{10} = -.50$$

The area below this value is .3085, so the percentile rank is 30.85.

c. If the range of scores is to be centered around the mean, 37.5% should be on either side of the mean of 50. From the Normal Table, a Z value of 1.15 has about that much area between it and the mean. Thus

$$1.15 = \frac{(\text{Score Above}) - 50}{10} \quad \text{and} \quad \text{Score Above} = 61.5$$

Since the distribution is symmetrical, the score below is 50 – 11.5 = 38.5.

The range of scores is then 23.

11. a. People who are divorced, separated, or widowed say they are worse off than a year ago between 27-39%). People who are married are the least likely to say this (19%). However, singles (58%) and those married (53%) are the most likely to say they are better off than they were last year. Forty one percent of those widowed say that they are "about the same." More separated people either think they are better off or worse off, less think that they are about the same.

b. The chi-square for this table is 35.138 with 8 degrees of freedom. The probability of our chi-square is less than .000. We can confidently reject the null hypothesis and conclude that marital status and whether one is better off (or not) are related. No cells have an expected value less than 5.

12. The chi-square for the table is 141.49. With 6 degrees of freedom, we determine that our obtained chi-square does not appear on the chi-square probability table. It exceeds the largest chi-square value for 6 df, 22.457. We estimate that the probability of our obtained chi-square is less than .001. Since P is less than alpha, we

reject the null hypothesis. We can conclude that there is a relationship between smoking and school performance.

13. The chi-square for the first table is 9.39. With 3 degrees of freedom, we estimate its probability to be between .02 and .05. We reject the null hypothesis. We conclude that we have evidence that suggests a relationship between a person's age and the use of alternative medicine. The chi-square for the second table is 13.03. With 4 degrees of freedom, the probability of our obtained chi-square is between .01 and .02. The range is less than our alpha of .05; thus, we reject the null hypothesis and conclude that a relationship also exists between a person's level of income and the use of alternative medicine. How would you describe the relationship between age and use of alternative medicine? income and use of alternative medicine?

SPSS PROBLEMS

1. All variables are ordinal measurements. The only appropriate inferential test is chi-square. [What would be a non-inferential test appropriate for two ordinal variables?]

   Students should review each cross-tabulation and assess the number of small expected frequencies. Refer to Chapter 14, section on The Limitations of the Chi-Square Test, for more information. Students could recode degree categories (combining bachelor and graduate categories.)

Crosstab

			DEGREE RS HIGHEST DEGREE				
			0 LT HIGH SCHOOL	1 HIGH SCHOOL	2 JUNIOR COLLEGE	3 BACHELOR	4 GRADUATE
CONARMY CONFIDENCE IN MILITARY	1 A GREAT DEAL	Count	79	181	27	49	18
		% within DEGREE RS HIGHEST DEGREE	55.6%	35.4%	40.3%	29.7%	28.6%
	2 ONLY SOME	Count	48	263	32	93	37
		% within DEGREE RS HIGHEST DEGREE	33.8%	51.5%	47.8%	56.4%	58.7%
	3 HARDLY ANY	Count	15	67	8	23	8
		% within DEGREE RS HIGHEST DEGREE	10.6%	13.1%	11.9%	13.9%	12.7%
Total		Count	142	511	67	165	63
		% within DEGREE RS HIGHEST DEGREE	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.121[a]	8	.000
Likelihood Ratio	27.626	8	.001
Linear-by-Linear Association	9.603	1	.002
N of Valid Cases	948		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.04.

Crosstab

			DEGREE RS HIGHEST DEGREE				
			0 LT HIGH SCHOOL	1 HIGH SCHOOL	2 JUNIOR COLLEGE	3 BACHELOR	4 GRADUATE
CONFED CONFID IN EXEC BRANCH OF FED GOVT	1 A GREAT DEAL	Count	35	66	10	19	14
		% within DEGREE RS HIGHEST DEGREE	24.8%	13.0%	14.5%	11.4%	22.2%
	2 ONLY SOME	Count	63	249	30	97	32
		% within DEGREE RS HIGHEST DEGREE	44.7%	48.9%	43.5%	58.4%	50.8%
	3 HARDLY ANY	Count	43	194	29	50	17
		% within DEGREE RS HIGHEST DEGREE	30.5%	38.1%	42.0%	30.1%	27.0%
Total		Count	141	509	69	166	63
		% within DEGREE RS HIGHEST DEGREE	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.216[a]	8	.003
Likelihood Ratio	21.816	8	.005
Linear-by-Linear Association	.099	1	.753
N of Valid Cases	948		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.57.

2. Students will need to recode the variable ATTEND into two categories, those who attend religious services and those who do not. Students could recode various combinations—those that never attend versus those who attend at least once a month or more, or those who never attend versus those who attend at least once a week or more.

   For illustration, we present results for those who never attend religious services (ATTEND=0; NATTNED=0) and those who attend at least once a month or more (ATTEND=4-8; NATTEND=1). We calculated a t-test to determine the difference in education between the two ATTEND groups.

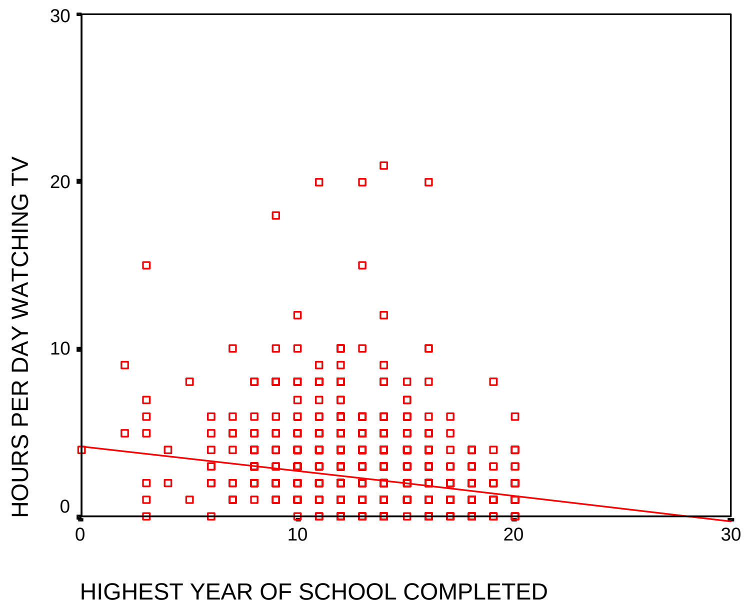
Group Statistics

	NATTEND new	N	Mean	Std. Deviation	Std. Error Mean
EDUC HIGHEST YEAR OF SCHOOL COMPLETED	.00	272	12.88	2.74	.17
	1.00	678	13.44	3.02	.12

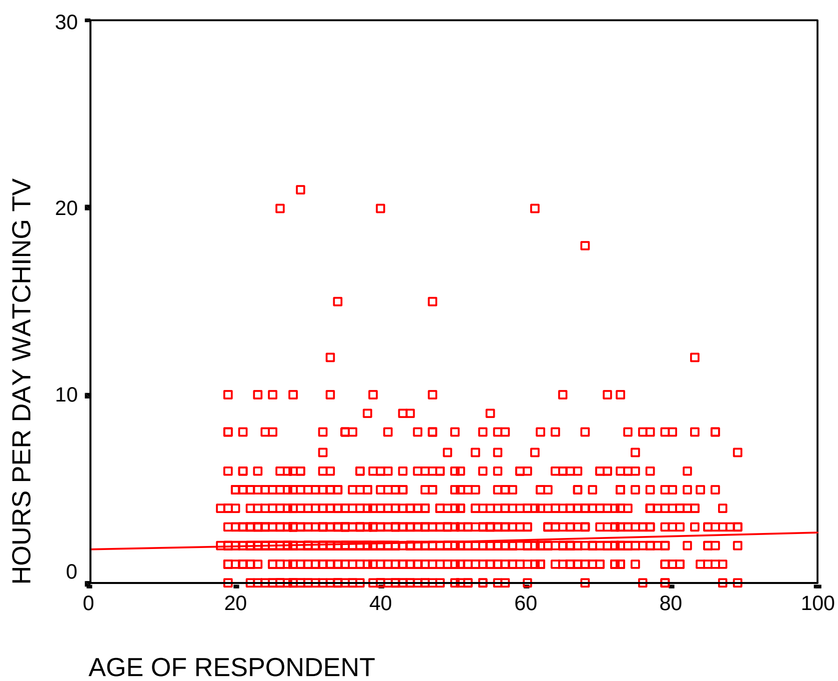
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equali			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diffe
EDUC HIGHEST YEAR OF SCHOOL COMPLETED	Equal variances assumed	2.300	.130	-2.643	948	.008	
	Equal variances not assumed			-2.752	545.964	.006	

3. a. There is a negative relationship between educational attainment and hours watching television per day. As education increases, the hours of television watching appear to decrease.



As indicated by the scatterplot below, there appears to be a slight positive relationship between the two variables. As respondent’s age increases, there is an increase in hours of television viewing – though the relationship is very slight.



b. The correlation coefficient for EDUC and TVHOURS is –.171; for AGE and TVHOURS, it is .065. As indicated by the coefficients, the relationship between age and television viewing is less than the relationship between educational attainment and television viewing.

The coefficient of determination for the first pair of variables is .029; for the second pair, .004. Both independent variables do not account for much of the variance in explaining TVHOURS, between .4% and 2.9%.

c. TVHOURS = 4.142+-.147 (EDUC)
TVHOURS = 1.752 + .010 (AGE)

As discussed in (a), education has a negative relationship with television viewing. For each year increase in educational attainment, hours of television viewing will decrease by .147. Age has a slight positive relationship with television viewing. For each increase in age, television viewing hours will increase by .010 hours per day. However, as indicated in (b), both of the variables do not explain much of the variance in predicting TVHOURS. Both are rather poor predictor variables.

4. a. The proportion of men who responded to the "good idea" category is 46% (N=442). The proportion of women who responded to the same category is 44% (N=526). The obtained Z is .67, with a probability of .5028 (.2514 x 2), so we fail to reject the null hypothesis.

$$Z = \frac{.46 - .44}{\sqrt{\frac{.46(1-.46)}{442} + \frac{.44(1-.44)}{526}}} = .67$$

b. SPSS output. T-test comparison between white and black respondents.

Group Statistics

	RACE RACE OF	N	Mean	Std. Deviation	Std. Error Mean
EDUC HIGHEST YEAR OF SCHOOL COMPLETED	1 WHITE	1109	13.46	3.00	9.02E-02
	2 BLACK	202	12.57	2.70	.19

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	
EDUC HIGHEST YEAR OF SCHOOL COMPLETED	Equal variances assumed	7.988	.005	3.925	1309	.000	.89	.23	
	Equal variances not assumed			4.220	298.694	.000	.89	.21	

We can reject the null hypothesis. Based on the t-test of 3.925 (significant at .000 level), we know that the difference between whites and blacks is significant. On average, whites have a higher level of educational attainment than blacks in our sample, a difference of .89 years (13.46-12.57 yrs.). This difference is significant at the .000 level.