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CEP932 Quantitative Methods in Educational Research I
Summer 2010

Homework #6

Due: August 4, 2010 10 PM
Total: 46 points

1. (15 points) Suppose a researcher is interested in whether teacher professional development in hours (the predictor) is related (or can predict) student achievement (the outcome). Suppose that the covariance between the two variables is 45 and the standard deviations of professional development hours and achievement are 6 and 15 respectively.

a. (2 points) Compute the correlation coefficient.

$$corr = r_{xy} = \frac{cov(x,y)}{s_x s_y}$$

$$corr = r_{xy} = 45/6(15) = 0.5$$

b. (2 points) Compute the regression coefficient (slope). Interpret the slope.

$$b = r(S_y / S_x)$$

$b = .5($15/6)= 1.25

c. (2 points) If the mean of professional development hours is 10 and the mean of achievement is 50 what is the intercept?

50 = a + .5(10)

a= 45

Megan Fedor 8/5/10 1:34 PM
Comment: A = 50=1.25*10=37.5

- 2 points

d. (2 points) Compute and interpret the coefficient of determination.

The coefficient of determination is r^2.

Thus $(.05)^2 = 0.25$

Explaining 25% of the variability generally means it is a good fit: this model is a good fit for predicting the outcome.

e. (2 points) Suppose the F test is 9? Is it significant (assume sample size is 1002)? Explain what the F test indicates.

The F-test is based on the ratio between the mean squares of the model (MSm) and the residual Mean squares (MSR). If the Mean squares of the model are larger than the residual mean squares than the F will be greater than 1. If the model is good, then we expect the improvement in prediction due to the model to be large (so MSM will be large) and the difference between the model and the observed data to be small (so MSR will be small). A good model will have an F-ratio greater than 1 and we use a table to assess the ratio based on the critical values for the degrees of freedom.

An F-test of 9 here indicates to a high degree that it is not only significant, but that model is a good predictive model. The critical value for significance at these degrees of freedom (1 in the numerator, N-2 in the denominator) for an $\alpha = .005$, is 7.88, and $\alpha = .001$, is 10.83. Our F-statistic is very significant, meaning that the model is a good predictive model.

g. (5 points) What is the t test of the slope (hours of professional development)? What is the standard error of the slope? Is the slope significant? What do you conclude about hours of professional development and achievement? What are the implications for policy makers?

The t-test of the slope would be the square root of the F-ratio, so t=3.

And using the t-test, we can find the standard error of the slope:

SE=b/t
SE=1.25/3=.417

With this many degrees of freedom, using statable, I get p=.002, which means that this test is significant at the .01 level.

What we can conclude from these tests is that the variables are correlated and that hours of professional development can predict student achievement. However, this does not mean that there exists a causal relationship. In terms of policy makers, I would tell them that the relationship needs to be further explored to ensure that there is not an effect by a third variable, but that hours of professional development can predict student achievement, that as hours of PD increase, so does student achievement.

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3. (21 points) Some researchers have argued that there is an important association between student achievement in mathematics and hours of computer use in school. The following Table summarizes the relationship between student achievement in mathematics and hours of computer use for a sample of 1002 elementary school students.

Predictor	Coefficient	SE	t	p
Constant	30	15		
Hours of Computer Use	6	2		

a. (2 points) What is the null hypothesis for the slope? What is the alternative or research hypothesis for the slope?

$H_o \; is \; b = 0$
$H_a \; is \; b \neq 0$

We want to see that if we input a variable, the result with be a change in another variable. If there is not a change in the outcome variable, than we don't have a prediction model. Under these circumstances, the b(correlation coefficient) would go to zero. This would mean that the change in outcome would be zero in the model.

b. (2 points) What is the regression equation?

$$y = a + bx + e$$

In this case, $y = 30 + 6(x)$

We pull 30 from the table as the coefficient of the constant, and 6 is the coefficient of the hours of computer use (the X: independent/predictor variable).

c. (2 points) What are the predicted values and residuals for the following students?

$$Student Acheivement = 30 + 6(Student\ Hours)$$

Residual = Observed value - Predicted value

Student	Achievement	Predicted Values	Hours	Residual Values
1	300	270	40	300-270= 30
2	200	210	30	200-210= -10
3	150	150	20	150-150= 0

d. (5 points) Compute the t values in the above Table.

$t = b / SE(b)$
$t = 30 / 15 = 2$
$t = 6 / 2 = 3$

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Comment: Missing the p values: .046 and .003

- 1 point

Is the slope (regression coefficient) statistically significant?
(note: used a table for the df of freedom of N-2)

For both t-tests, the regression coefficient is statistically significant at the .05 and the .01 level.

What are the p values associated with the t values observed (use excel or statable to compute the p values and assume a two tailed test)?
(note: used statatble at 500, found the left-tail, and subtracted from 1)

The p-values for this would be <0.01, so the t-test is significant at the most significant level possible.
1-left-tail
t=2, left-tail =0.97698, p=1-.96798=.03202

t=3, left-tail =0.998583; p = 1- .998583=.0014

What are the df for the t tests?
The degrees of freedom for the t-tests are N-2; so 1000.
(2 variables --> N-2)

What is the value of the F test in an ANOVA Table?

F-test = $\frac{MS_m}{MSr} = t^2$
F-test for the constant= 4 and for hours of use= 9.

What are the df of the F test?
The degrees of freedom for the F test are 1 numerator, N-2 in the denominator.

What information does the F test provide? Explain and discuss.

The F-test assumes the null hypothesis, reject if $F > F_\alpha$

(This is the same explanation as above: I couldn't think of another way to explain it). The F-test is based on the ratio between the mean squares of the model (MSm) and the residual Mean squares (MSR). If the Mean squares of the model are larger than the residual mean squares. If the model is good, then we expect the improvement in prediction due to the model to be large (so MSM will be large) and the difference between the model and the observed data to be small (so MSR will be small). A good model will have an F-ratio greater than 1 and we use a table to assess the ratio based on the critical values for the degrees of freedom.

e. (2 points) Given the value of the F test, which of the following is an accurate representation and why?

1. (2 points) SSreg < error variance
2. SSreg > error variance
3. SSreg = error variance.

#2, because the F-test is significant, the Sum of the Squares of Observed data is much higher than the error variance.

f. (2 points) Compute the 95% confidence interval for the slope. Is the slope significant? What are the smallest and largest bound for the slope? (assume n=1002). How is that result related to the t test for the slope?

Use the t-values, use the chart for the df and the critical value, plug that into the CI equation

$$b \pm t_{(0.025, df)}(s_b)$$

$$6 \pm 1.96(3) = .12, 11.88$$

g. (4 points) Interpret the constant and the slope in the above Table. Given the results reported in the above Table what is the substantive conclusion? Is the association between computer use and achievement important? What are the implications for policy makers?

All of the tests we've been computing give us information about the constant and the slope from the above table. What we know is that the model predicts the outcome with a great degree of certainty, given the significance of both the t-test and the F-ratio. Both tests were significant to the highest degree. While we know that the number of hours on the computer can predict achievement, this does not indicate causality, mostly because there could be unmeasured variables which affect the results. It could be that the more hours a students spends on the computer is due to their SES, which is the factor that is causing the increase in achievement. The implications for policy makers is to examine this in more detail to attempt to discover what might be causing the covariance.

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4. (4 points). Data analysis using SPSS. Use the self efficacy dataset to compute the correlation between self efficacy in mathematics and mathematics performance. Is the correlation significant? What do you conclude? Now compute the correlations among self efficacy, math anxiety and math performance. Are they significant? Discuss the results.

In running the analysis on the correlation between self-efficacy and mathematics performance, the SPSS output indicates that the Pearson correlation is .536 and it is significant at the .01 level for the one-tailed test (which I chose because there was no directionality indicated in the hypothesis). I can conclude that there is a positive correlation between those two variables. As self-efficacy increases, so does math performance.

In computing the correlations among self-efficacy, math anxiety and math performance, there was a statistically significant negative correlation between math performance and

anxiety (-.504) as well as between math anxiety and self-efficacy (-.577). Both of these correlations were significant at the .01 level for the one-tailed test. What we can conclude is that math anxiety increases, both performance and self-efficacy decrease.

5. (6 points). Data analysis using SPSS. Use the self efficacy dataset to predict math performance using self efficacy. Interpret the R square. Is the regression coefficient (slope) significant? Interpret the slope and discuss the result.

Now compute the gender gap in math performance. Use gender (variable female) as predictor and math performance as the outcome. Interpret the slope and the constant. Is the slope significant? What do you conclude?

In examining the gender gap in math performance, the slope =.440 and the constant is 11.040. ThLooking at the SPSS output when predicting math performance from self-efficacy, I find that the regression coefficient is not significant. In interpreting the R square, at .287, it is only accounting for 28% of the variation. This might be a good number in the social sciences, but it also tells us that a majority of the error can be accounted for by another variable. First of all, b is negative, less than zero at -2.827. This is different than the standard error, but it is in the wrong direction. To consider the regression coefficient to be significant, we would expect b to be much larger than the standard error. Finally, the t-test is not significant.e slope is not significant according to the SPSS output. Basically, for a person's gender can predict 11 points of achievement. Additionally, looking at R squared, gender only accounts for 3% of the variation, which is not very much. I can conclude that gender does not predict math performance very well.

Megan Fedor 8/5/10 5:13 PM
Comment: Great job!

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