

Name: _____

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Assignment 10 Part I

The following item is selected from the textbook (Keppel & Wickens).

- (15.2 in textbook). Use the principles of the general linear model to test whether the slope β_1 of the regression line in Figure 15.1 is different from zero. First use the sums of squares in Table 15.2 to obtain $SS_{unexp}^{H_0}$ and $SS_{unexp}^{H_1}$ according to the two models in Equations 15.7 and 15.8. Then use Equations 14.4 and 14.8 to calculate the sum of squares for the regression effect and its degrees of freedom. With this information, complete the table

source	SS	df	MS	F
Regression error	34.571	1	34.571	15.45
total	48	7		

Solution:

$$H_0: \beta_1 = 0$$

$$H_1: \beta_1 \neq 0$$

From table 15.2, we can obtain $SS_{unexp}^{H_0}$ and $SS_{unexp}^{H_1}$

$$SS_{unexp}^{H_0} = \sum_{i=1}^N (Y_i - \bar{Y})^2 = 48.0$$

$$SS_{unexp}^{H_1} = \sum_{i=1}^N (Y_i - \hat{Y})^2 = 13.429$$

$$SS_{effect} = SS_{unexp}^{H_0} - SS_{unexp}^{H_1} = 48 - 13.429 = 34.571$$

$$df_{unexp}^{H_0} = 8 - 1 = 7$$

$$df_{unexp}^{H_1} = 8 - 2 = 6$$

$$df_{effect} = 7 - 6 = 1$$

$$F_{(1,6)} = 15.45$$

- Use the scenario below to answer questions 1)-4).

A cognitive psychologist is interested in examining the impact of technological programs designed to influence long-term memory. Prior to initiating the interventions, thirty subjects were instructed on novel academic material. Two weeks later, all subjects were tested on their retention of the lesson (the number of recall errors were tabulated). After the pre-test results were computed, ten subjects were randomly assigned to each of three groups. Over a two month period, Group 1 interacted with a software program thought to stimulate specific memory related regions of the

brain, Group 2 participated in a computer based instructional program that taught subjects to maximize their sensory input when attempting to store information, and Group 3 served as the control group (did not receive treatment). At the end of the intervention period, all subjects were again instructed on novel academic material and the number of recall errors were recorded (the pre and post lessons/assessments were of equal difficulty and the pre-test has a significant linear relationship with the post-test).

- 1) Briefly, interpret the result of the test below, describe the researcher's next step in his analysis, and state why this is a critical test with respect to the ANCOVA design.

"The within group regression slopes are equal across the memory intervention groups"

$F(2,24) = .864, p=.434$

The researcher has found a **non-significant** interaction between the covariate (pre-test) and group membership. This is an assumption of ANCOVA and it has not been violated.

Therefore, the researcher continues on with the ANCOVA analysis. It is necessary information due to the fact that the ANCOVA model utilizes the same slope across groups—the intercepts are different.

- 2) The researcher found: $SS_{unexp}^{Ho} = 103.32$ and $SS_{unexp}^{H1} = 48.59$

Calculate SS_A : $103.32 - 48.59 = 54.73$

MS_A : $54.73/2 = 27.36$

MS_{error} : $48.59/N-a-1 = 48.59/26 = 1.87$

You should check your calculations by obtaining the final F value of 14.6

- 3) The pooled within group regression slope = .516
- 4) Given the table below, provide the missing adjusted Y values that the researcher should obtain. Briefly describe why the estimated marginal or adjusted means are important when interpreting ANCOVA results.

Group	\bar{X}	\bar{Y}	Adj \bar{Y}
1	8.6	4.7	4.648
2	8.3	6.4	6.503
3	8.6	8.0	7.948
Grand Mean	8.5	6.4	

ANCOVA can be thought of as an ANOVA with the dependent variable being an adjusted variable.

Part II: SPSS

15.3 Suppose an instructor in a statistics class wants to evaluate the effectiveness of three teaching assistants. For one class session, the students are randomly divided into three groups, each of which receives a lecture on power and effect size from one of the assistants. At the next meeting of the class, the students are given a quiz on the material. The results of the quiz (Y_{ij}), together with scores from a statistical aptitude test administered at the beginning of the semester (X_{ij}), are located on page 345 of the textbook.

Use a computer program to investigate the following questions:

- a) Did the random assignment of the students to the three lectures result in reasonably equivalent groups on the statistical aptitude test?

Yes, the random assignment of the students resulted in reasonably equivalent groups on the statistical aptitude test ($F = 0.27$, $df = 2$, $p\text{-value} = 0.765$).

Tests of Between-Subjects Effects

Dependent Variable: X

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	110.056 ^a	2	55.028	.270	.765
Intercept	48693.778	1	48693.778	239.258	.000
Group	110.056	2	55.028	.270	.765
Error	6716.167	33	203.520		
Total	55520.000	36			
Corrected Total	6826.222	35			

a. R Squared = .016 (Adjusted R Squared = -.044)

- b) Does an analysis of variance reveal any systematic differences on the quiz administered following the lectures given by the teaching assistants?

Yes the analysis of variance revealed systematic differences on the quiz ($F = 4.284$, $df = 2$, $p\text{-value} = 0.022$).

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1194.000 ^a	2	597.000	4.284	.022
Intercept	29241.000	1	29241.000	209.818	.000
Group	1194.000	2	597.000	4.284	.022
Error	4599.000	33	139.364		

a. R Squared = .206 (Adjusted R Squared = .158)

- c) What does an analysis of covariance reveal? How do the adjusted means compare to those from the original analysis? In what ways is this analysis an improvement over the analysis of variance?

The ANCOVA revealed a more significant effect for Group on the quiz ($F = 8.556$, $df = 2$, $p\text{-value} = 0.001$) than the ANOVA did. The Error Sum of Squares is smaller in the ANCOVA (1369.136) than the ANOVA (4599) showing that the ANCOVA accounted for more of the variance in the scores than ANOVA did.

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4423.864 ^a	3	1474.621	34.465	.000
Intercept	39.154	1	39.154	.915	.346
X	3229.864	1	3229.864	75.490	.000
Group	732.159	2	366.080	8.556	.001
Error	1369.136	32	42.785		
Total	35034.000	36			
Corrected Total	5793.000	35			

a. R Squared = .764 (Adjusted R Squared = .741)