

Name Key  
 (Please ALSO write your name on the back of the last page.)

**Ag 400 - Quiz 5**  
**Fall 2006**

- A. The Tackey Toy Company plans to install special battery packs in its new line of Tackey robots. Three vendors can produce the battery packs with equal prices. To determine which brand of battery provides the longest life, a random sample of 5 battery packs is selected from each vendor and the useful life of each battery pack (in hours) is determined. The following data were compiled:

	Battery Brand		
	Lifelong	Neverstop	Everrun
	-----Number of Hours of Useful Life-----		
	144	157	170
	128	146	159
	143	138	154
	128	157	174
	<u>147</u>	<u>142</u>	<u>163</u>
Sum of the Scores	690	740	820
Sum of the Squares of the scores	95,562	109,822	134,742
Sum of the Squares of the deviations about the category means	342	302	262
	<b>Mean</b>	<b>138</b>	<b>148</b>
		<b>148</b>	<b>164</b>

- (12) 1. Test the statistical significance of the differences among the three battery brands by completing the following table. Assume that the figures on the table are correct. Use the .05 level to determine statistical significance.

AOV Table Sources of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2626	14		
Among brand categories	<u>1720</u>	<u>2</u>	<u>860</u>	<u>11.39</u>
Within brand categories	<u>906</u>	<u>12</u>	<u>75.5</u>	-

(16) 2. Answer the following in terms of the above analysis:

a. State the Null Hypothesis and the Alternative Hypothesis.

$H_0$  : there are no differences among the three brands  
in regard to useful life.

$H_1$  : there are differences . . .

b. Specify degrees of freedom for obtaining the critical F-value for this test.

$$df = 2 \text{ and } 12$$

c. Indicate the critical value of F at the .05 level.

$$F = 3.88$$

d. Reject or do not reject the Null Hypothesis.

Reject  $H_0$

e. What is the probability that you have made a Type I error in (d) above?

$$.001 < \alpha < .01$$

f. What is the probability that you have made a Type II error in (d) above?

$$\beta = 0.$$

g. State your conclusion precisely in terms of the problem.

- (6) 3. Test the statistical significance of the difference between the number of hours of useful life for the Lifelong and Neverstop batteries. Use the .05 level to determine statistical significance.

a. Show your work.

$$\text{Sig diff} = \sqrt{(75.5) \left(\frac{1}{5} + \frac{1}{5}\right)} \quad \sqrt{(3.88) (2)}$$

$$(5.49545267) \quad (2.782)$$

$$\text{Sig diff} = 15.309$$

$$\text{Actual diff} = 148 - 138 = 10$$

b. Make your conclusion.

n.s. .05 Cannot conc. that Lifelong + Neverstop batteries differ in length of useful life.

- (12) 4. Indicate whether each of the following statements is true (T) or false (F) in terms of these data. If any part of a statement is untrue, it should be marked false (F). Add comments, if you wish, to clarify your answers.

T a. The statistical unit here is a battery pack.

F b. The Null Hypothesis for the test in (1) above can be stated as follows:

$H_0$ : there are no significant differences among the three brands of batteries in number of hours of useful life.

T c. The sum of the squares of the deviations of the scores (number of hours) about 150 (the grand mean of the sample) equals 2626.

T d. Eta calculated for the above data is positive and less than 1.0. Eta is never negative and never greater than 1.00.

F e. The Analysis of Variance in the above table tests the statistical significance of the differences among the variances in useful life for the three brands of batteries.

F f. Based on this analysis, you should conclude that there is a statistical interaction between brand of battery and hours of useful life.

- B. You are given the following data concerning the relationships of Political Affiliation and Place of Residence to the Political conservatism of persons in Mugwump County. Conservatism is measured by an attitude scale which yields a score of between 10 and 30 such that the higher the score, the more conservative is the individual.

Political Affiliation	Place of Residence	
	Rural	Urban
	----- Mean Conservation Score -----	
Republican	22 (20) <sup>a</sup>	22 (20)
Democrat	20 (20)	16 (20)

<sup>a</sup>Numbers in parenthesis are the number of cases in the cell.

- (6) 1. Complete the following AOV Table.

Sources of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F
Total	2000	79		
Among 4 categories	480	3 <del>78</del>	160	8.0
Between political affiliations	320	1	320	
Between Residences	80	1	80	
Political affiliation x Residence	80	1	80	4.00 sig .05
Within 4 categories	1520	76	20	

- (4) 2. What can you conclude about the relationship between place of residence and Conservatism Scores.

*The relationship of residence to Cons Score differs for Reps + Dems  
For Dems, rural are more cons. than urban but, for Reps,  
residence is not related to Cons. Scores*

(10) 3. Indicate whether each of the following statements is true (T) or false (F) in terms of the above data. If any part of a statement is untrue, it should be marked false (F). Add comments, if you wish, to clarify your answers.

T a. The statistical unit is a person in Mugwump County.

T b. There is no interrelationship between Political Affiliation and Place of Residence in these data.

F c. The Null Hypothesis for the F-value of 8.0 reported on the above AOV Table can be stated as follows:

$H_0$ : the combined linear effect of Political Affiliation and Place of Residence is zero.

T d. The Null Hypothesis testing the statistical significance of the interactive effect of Political Affiliation and Place of Residence on Conservatism Scores can be stated as follows:

$H_0$ : the relationship of Place of residence to Conservatism Score is the same for Republicans and Democrats.

F e. The interaction of Political Affiliation and Place of Residence on Conservatism Scores can be described as follows:

Rural people are more conservative than are Urban people; and Republicans are more conservative than are Democrats.

- C. In an effort to increase the efficiency of their workforce in Factory A, the factory administrators developed two new training programs for their workers, and the number of minutes each worker needed to complete a specific task were recorded.

- Program A: Original training program. New workers were instructed individually by other workers on the job.
- Program B: Administrators provided formal group instruction on work procedures.
- Program C: Workers were provided with a film describing work procedures which they were permitted to view as often as they wished.

Participants in each of the training programs were tested by giving each a short task to perform and the time required by each person to complete the task was recorded. The attached output reports the results of analysis of these data.

- (34) Indicate whether each of the following statements is true (T) or false (F) in terms of the attached output. If any part of a statement is untrue, it should be marked false (F). Add comments, if you wish, to clarify your answers.

F 1. The independent variable here, time, is measured by an interval scale.

T 2. The statistical unit here is a worker.

T 3. In this sample, the variances in the times needed to complete the tasks was greatest for those in Program A and least for those in Program C, with the variance in times intermediate for those in Program B. However, these differences were not statistically significant at the .05 level.

F 4. Based on this analysis, you should reject the following Null Hypothesis ( $\alpha < .01$ ,  $\beta = 0.00$ )

$H_0$ : There is no relationship between Program Type and number of minutes needed to complete the task.

F 5. In these data, the interaction of Program Type and time is statistically significant at the .05 level.

F 6. Since Levene's Test has a "sig" value of .861, we should conclude that the variances in times for the three Programs are not significantly homogeneous.

T 7. Approximately 21.7% of the total variation among the 39 workers in time required to complete the task was associated with differences among the training programs.

- T 8. The sum of the squares of the times needed by individual workers about the mean time for their Program categories equals 3.705.
- T 9. The Null Hypothesis tested using the F-value of 4.995 on Page 1 of the output tests the following Null Hypothesis:

$$H_0: \mu_{\text{Program A}} = \mu_{\text{Program B}} = \mu_{\text{Program C}}$$

Where  $\mu$  = mean times required to complete the task for persons in the population in each of the three programs.

- F 10. Degrees of freedom for testing the statistical significance of the F-value on Page 1 equal 2 and 38.
- F 11. Since the relationship between Program Type and time needed to complete the task is linear in these data, it could have been tested for statistical significance using a Correlation-Regression analysis. Where Y = time required to complete the task and X = Program Type (A,B,C.)
- F 12. The grand mean of the sample equals the average of the Program category means, i.e.  $(5.045+4.3400+4.4127)/3 = 4.599$ .
- F 13. The "F" statistic is never negative and never greater than the sample size.
- T 14. In this problem, results of the Welch and Brown-Forsythe tests would result in rejecting the following Null Hypothesis ( $\alpha < .05$ ).
- $$H_0: \text{there are no differences among the times required to complete the task for subjects in Programs A, Program B, and Program C.}$$
- T 15. Approximately 21.7% of the total variation among the individual sample workers in the time needed to complete the task is associated with differences in type of training program.
- F 16. The mean time required to complete the task by those who participated in Program B did not differ significantly (.05 level) from the mean time required by participants in Program A but did differ significantly ( $p < .05$ ) from those in Program C.
- T 17. Both Program B and Program C were associated with significantly less time to complete the task than was needed by persons in the original program (Program A).

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ONEWAY
time BY program
/STATISTICS DESCRIPTIVES HOMOGENEITY BROWNFORSYTHE WELCH
/MISSING ANALYSIS
/POSTHOC = SCHEFFE ALPHA(.05).

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## Oneway

[DataSet0]

### Descriptives

time

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 ProgramA	12	5.0450	.65939	.19035	4.6260	5.4640	3.89	6.29
2 ProgramB	12	4.3400	.60706	.17524	3.9543	4.7257	3.29	5.36
3 ProgramC	15	4.4127	.56793	.14664	4.0982	4.7272	3.37	5.35
Total	39	4.5849	.66998	.10728	4.3677	4.8021	3.29	6.29

### Test of Homogeneity of Variances

time

Levene Statistic	df1	df2	Sig.
.151	2	36	.861

### ANOVA

time

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.705	2	1.852	4.995	.012
Within Groups	13.352	36	.371		
Total	17.057	38			

### Robust Tests of Equality of Means

time

	Statistic <sup>a</sup>	df1	df2	Sig.
Weich	4.408	2	22.880	.024
Brown-Forsythe	4.910	2	33.560	.013

a. Asymptotically F distributed.

## Post Hoc Tests

### Multiple Comparisons

Dependent Variable: time

Scheffe

(I) program	(J) program	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 ProgramA	2 ProgramB	.70500*	.24863	.027	.0702	1.3398
	3 ProgramC	.63233*	.23587	.038	.0301	1.2346
2 ProgramB	1 ProgramA	-.70500*	.24863	.027	-1.3398	-.0702
	3 ProgramC	-.07267	.23587	.954	-.6749	.5296
3 ProgramC	1 ProgramA	-.63233*	.23587	.038	-1.2346	-.0301
	2 ProgramB	.07267	.23587	.954	-.5296	.6749

\*. The mean difference is significant at the .05 level.

## Homogeneous Subsets

time

Scheffe<sup>a,b</sup>

program	N	Subset for alpha = .05	
		1	2
2 ProgramB	12	4.3400	
3 ProgramC	15	4.4127	
1 ProgramA	12		5.0450
Sig.		.955	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 12.857.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.