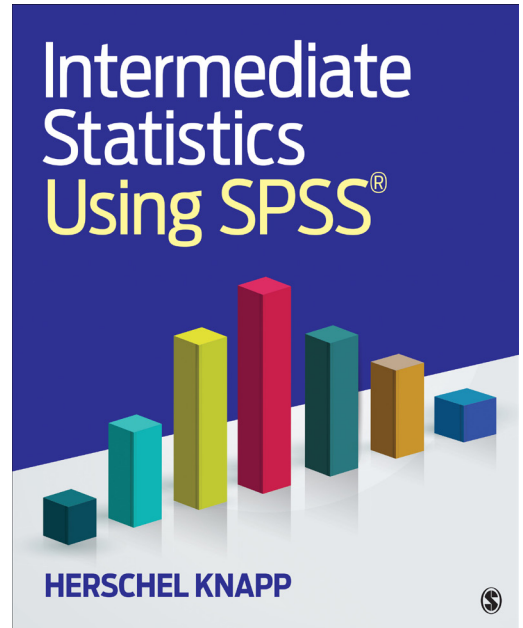


C H A P T E R 7

MANOVA

Solutions to Odd-Numbered Exercises



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EXERCISE 7.1A

Data set: Ch 07 – Exercise 01A.sav

(a)

H_0 : The number of students in a tutoring group has no effect on student satisfaction or number of homework errors.

H_1 : The number of students in a tutoring group has an effect on student satisfaction.

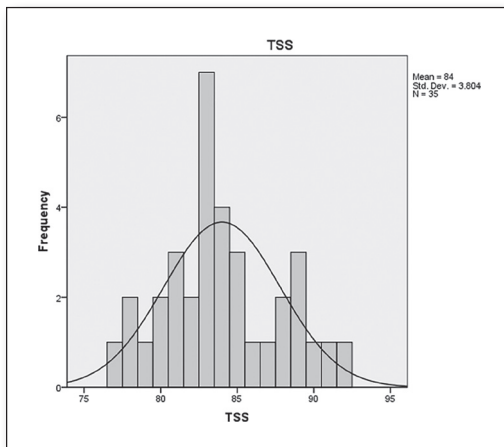
H_2 : The number of students in a tutoring group has an effect on the number of homework errors.

(b)

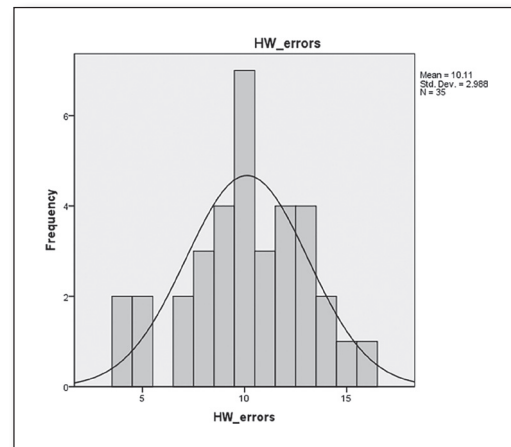
		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One-to-one	35	33.3	33.3	33.3
	Two-to-one	35	33.3	33.3	66.7
	Five-to-one	35	33.3	33.3	100.0
	Total	105	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

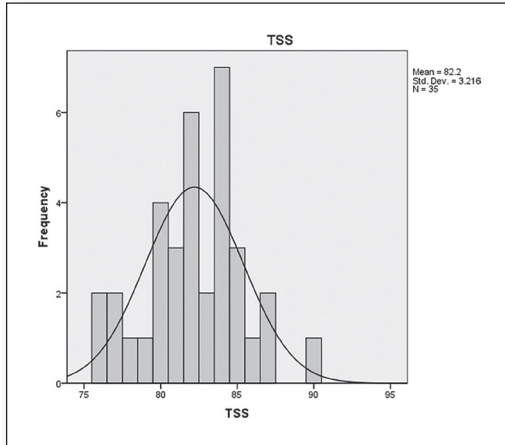
Histogram of *TSS*
for *One-to-one* (Group 1)



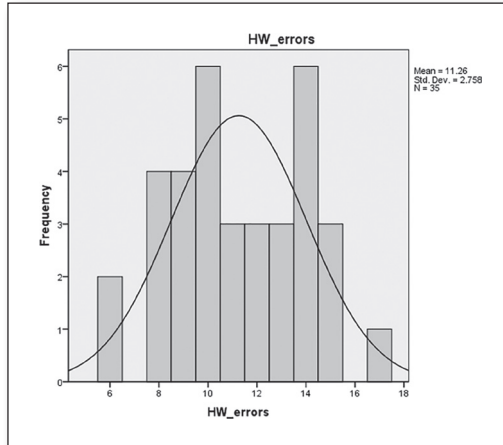
Histogram of *HW_errors*
for *One-to-one* (Group 1)



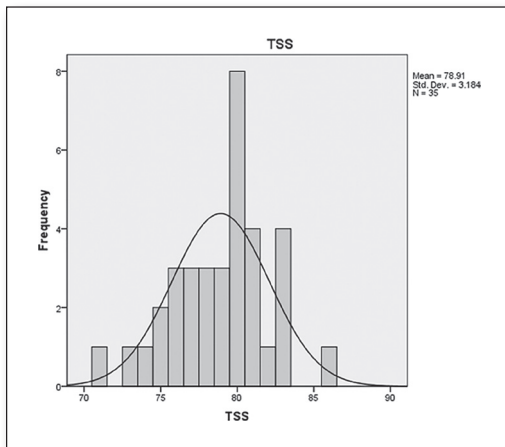
Histogram of *TSS*
for *Two-to-one* (Group 2)



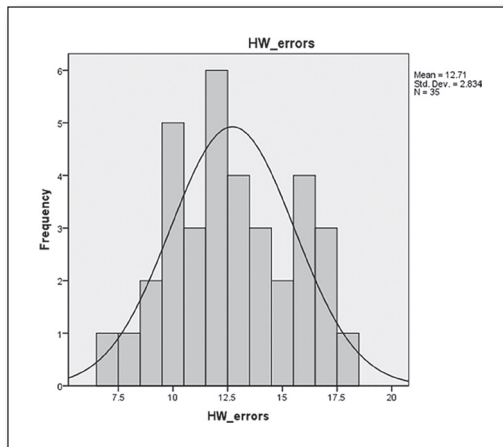
Histogram of *HW_errors*
for *Two-to-one* (Group 2)



Histogram of *TSS*
for *Five-to-one* (Group 3)



Histogram of *HW_errors*
for *Five-to-one* (Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations			
		TSS	HW_errors
TSS	Pearson Correlation	1	-.409**
	Sig. (2-tailed)		.000
	N	105	105
HW_errors	Pearson Correlation	-.409**	1
	Sig. (2-tailed)	.000	
	N	105	105

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is $-.409$; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices ^a	
Box's M	3.638
F	.589
df1	6
df2	259299.692
Sig.	.739

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of $.739$; since this is greater than $.001$, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TSS	.593	2	102	.555
HW_errors	.005	2	102	.995

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test):

Levene's Test produced Sig. (p) values of .555 and .995; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	36234.981 ^a	2.000	101.000	.000
	Wilks' Lambda	.001	36234.981 ^a	2.000	101.000	.000
	Hotelling's Trace	717.524	36234.981 ^a	2.000	101.000	.000
	Roy's Largest Root	717.524	36234.981 ^a	2.000	101.000	.000
Group	Pillai's Trace	.305	9.161 ^a	4.000	204.000	.000
	Wilks' Lambda	.696	10.039 ^a	4.000	202.000	.000
	Hotelling's Trace	.437	10.913	4.000	200.000	.000
	Roy's Largest Root	.435	22.195 ^a	2.000	102.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Group					
Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
TSS	One-to-one	84.000	.577	82.856	85.144
	Two-to-one	82.200	.577	81.056	83.344
	Five-to-one	78.914	.577	77.770	80.059
HW_errors	One-to-one	10.114	.484	9.155	11.074
	Two-to-one	11.257	.484	10.298	12.217
	Five-to-one	12.714	.484	11.755	13.674

Multiple Comparisons								
Bonferroni								
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		
						Lower Bound	Upper Bound	
TSS	One-to-one	Two-to-one	1.80	.816	.089	-.19	3.79	
		Five-to-one	5.09	.816	.000	3.10	7.07	
		Two-to-one	-1.80	.816	.089	-3.79	.19	
	Five-to-one	Five-to-one	3.29	.816	.000	1.30	5.27	
		One-to-one	-5.09	.816	.000	-7.07	-3.10	
HW_errors	One-to-one	Two-to-one	-1.14	.684	.294	-2.81	.52	
		Five-to-one	-2.60	.684	.001	-4.27	-.93	
	Two-to-one	One-to-one	1.14	.684	.294	-.52	2.81	
		Five-to-one	-1.46	.684	.107	-3.12	.21	
	Five-to-one	One-to-one	2.60	.684	.001	.93	4.27	
		Two-to-one	1.46	.684	.107	-.21	3.12	

Based on observed means.

The error term is Mean Square(Error) = 8.190.

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

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons		<i>p</i>
TSS	M(One-to-one) = 84.00 : M(Two-to-one) = 82.20	.089
TSS	M(One-to-one) = 84.00 : M(Five-to-one) = 78.91	.000*
TSS	M(Two-to-one) = 82.20 : M(Five-to-one) = 78.91	.000*
HW_errors	M(One-to-one) = 10.11 : M(Two-to-one) = 11.26	.294
HW_errors	M(One-to-one) = 10.11 : M(Five-to-one) = 12.71	.001*
HW_errors	M(Two-to-one) = 11.26 : M(Five-to-one) = 12.71	.107

*Statistically significant ($p < .05$).

Based on these results, I would reject H_0 and accept H_1 and H_2 .

- (d) NOTE: For clarity, the first paragraph discusses the overall test procedure, paragraph 2 discusses the first outcome (dependent) variable – *TSS* (Tutor Satisfaction Score), and paragraph 3 discusses the second outcome (dependent) variable – *HW_errors* (the number of homework errors or incomplete questions).

This study analyzed the effects that tutor group size had on student satisfaction scores. We recruited 105 students and randomly assigned them to one of three tutoring conditions: 1:1, 2:1, or 5:1. At the end of the term, each student completed the Tutor Satisfaction Survey (0 = very unsatisfied . . . 100 = very satisfied). We also gathered the mean number of homework errors or incomplete homework questions of each participant.

The highest tutor satisfaction was found among the participants who received 1:1 tutoring ($M = 84.00$), followed by those who received 2:1 tutoring $M = 82.20$, however using an α level of .05, there was no statistically significant difference detected between these two groups ($p = .089$). Both the 1:1 and 2:1 groups statistically significantly outperformed the 5:1 group $M = 78.91$ ($p < .001$). Based on these findings, we reject H_0 and accept H_1 .

We noted similar findings among these groups with respect to overall mean homework errors. Students who received 1:1 tutoring had the fewest homework errors ($M = 10.11$), followed by the 2:1 group ($M = 11.26$), and finally the 5:1 group ($M = 12.71$). We detected no statistically significant difference between the 1:1 group and the 2:1 group ($p = .294$) or the 2:1 and the 5:1 group ($p = .107$), however, the 1:1 group had statistically significantly fewer homework errors than the students in the 5:1 group ($p = .001$). Based on these findings, we reject H_0 and accept H_2 . Overall, it appears that smaller size tutor groups are optimal.

EXERCISE 7.1B

Data set: Ch 07 – Exercise 01B.sav

(a)

H_0 : The number of students in a tutoring group has no effect on student satisfaction or number of homework errors.

H_1 : The number of students in a tutoring group has an effect on student satisfaction.

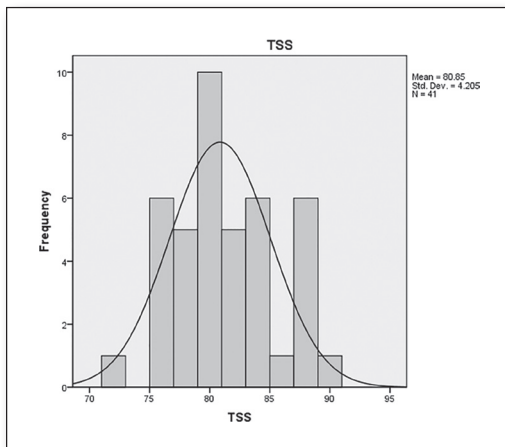
H_2 : The number of students in a tutoring group has an effect on the number of homework errors.

(b)

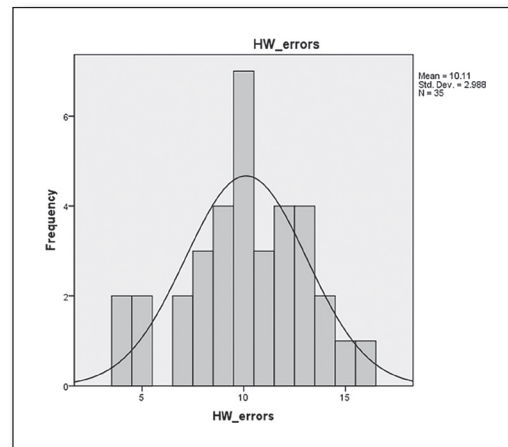
		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One-to-one	41	33.9	33.9	33.9
	Two-to-one	37	30.6	30.6	64.5
	Five-to-one	43	35.5	35.5	100.0
	Total	121	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

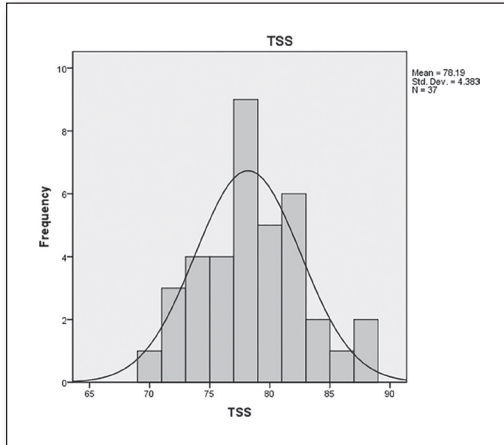
Histogram of *TSS*
for *One-to-one* (Group 1)



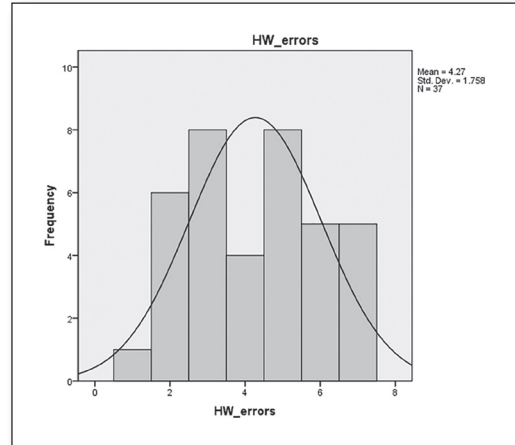
Histogram of *HW_errors*
for *One-to-one* (Group 1)



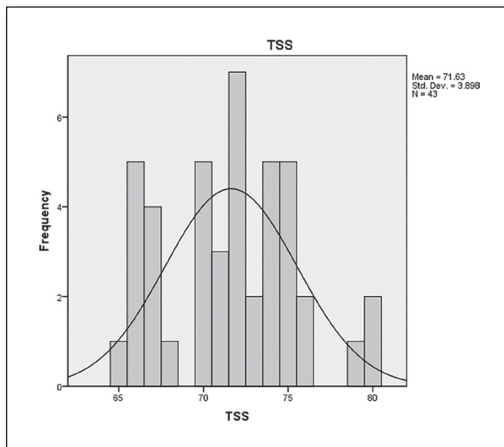
Histogram of *TSS*
for *Two-to-one* (Group 2)



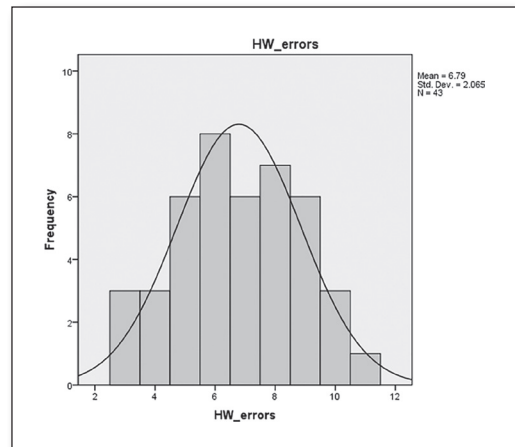
Histogram of *HW_errors*
for *Two-to-one* (Group 2)



Histogram of *TSS*
for *Five-to-one* (Group 3)



Histogram of *HW_errors*
for *Five-to-one* (Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		TSS	HW_errors
TSS	Pearson Correlation	1	-.424**
	Sig. (2-tailed)		.000
	N	121	121
HW_errors	Pearson Correlation	-.424**	1
	Sig. (2-tailed)	.000	
	N	121	121

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is $-.424$; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	4.697
F	.764
df1	6
df2	312696.991
Sig.	.599

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of $.599$; since this is greater than $.001$, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
TSS	.238	2	118	.789
HW_errors	.630	2	118	.534

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test):

Levene's Test produced Sig. (p) values of .789 and .534; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.998	24275.403 ^a	2.000	117.000	.000
	Wilks' Lambda	.002	24275.403 ^a	2.000	117.000	.000
	Hotelling's Trace	414.964	24275.403 ^a	2.000	117.000	.000
	Roy's Largest Root	414.964	24275.403 ^a	2.000	117.000	.000
Group	Pillai's Trace	.581	24.172	4.000	236.000	.000
	Wilks' Lambda	.464	27.367 ^a	4.000	234.000	.000
	Hotelling's Trace	1.057	30.643	4.000	232.000	.000
	Roy's Largest Root	.954	56.295 ^b	2.000	118.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Group					
Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
TSS	One-to-one	80.854	.649	79.569	82.139
	Two-to-one	78.189	.683	76.837	79.542
	Five-to-one	71.628	.634	70.373	72.883
HW_errors	One-to-one	5.244	.322	4.606	5.882
	Two-to-one	4.270	.339	3.599	4.942
	Five-to-one	6.791	.315	6.168	7.414

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
TSS	One-to-one	Two-to-one	2.66	.942	.017	.38	4.95
		Five-to-one	9.23	.907	.000	7.02	11.43
	Two-to-one	One-to-one	-2.66	.942	.017	-4.95	-.38
		Five-to-one	6.56	.932	.000	4.30	8.82
	Five-to-one	One-to-one	-9.23	.907	.000	-11.43	-7.02
		Two-to-one	-6.56	.932	.000	-8.82	-4.30
HW_errors	One-to-one	Two-to-one	.97	.468	.119	-.16	2.11
		Five-to-one	-1.55	.450	.002	-2.64	-.45
	Two-to-one	One-to-one	-.97	.468	.119	-2.11	.16
		Five-to-one	-2.52	.462	.000	-3.64	-1.40
	Five-to-one	One-to-one	1.55	.450	.002	.45	2.64
		Two-to-one	2.52	.462	.000	1.40	3.64

Based on observed means.

The error term is Mean Square(Error) = 4.254.

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

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

	Group Comparisons	<i>p</i>
TSS	M(One-to-one) = 80.85 : M(Two-to-one) = 78.19	.017*
TSS	M(One-to-one) = 80.85 : M(Five-to-one) = 71.63	.000*
TSS	M(Two-to-one) = 78.19 : M(Five-to-one) = 71.63	.000*
HW_errors	M(One-to-one) = 5.24 : M(Two-to-one) = 4.27	.119
HW_errors	M(One-to-one) = 5.24 : M(Five-to-one) = 6.79	.000*
HW_errors	M(Two-to-one) = 4.27 : M(Five-to-one) = 6.79	.002*

*Statistically significant ($p < .05$).

Based on these results, I would reject H_0 and accept H_1 and H_2 .

- (d) NOTE: For clarity, the first paragraph discusses the overall test procedure, paragraph 2 discusses the first outcome (dependent) variable – *TSS* (Tutor Satisfaction Score), and paragraph 3 discusses the second outcome (dependent) variable – *HW_errors* (the number of homework errors or incomplete questions).

This study analyzed the effects that tutor group size had on student satisfaction scores. We recruited 121 students and randomly assigned them to one of three tutoring conditions: 1:1, 2:1, or 5:1. At the end of the term, each student completed the Tutor Satisfaction Survey (0 = very unsatisfied . . . 100 = very satisfied). We also gathered the mean number of homework errors or incomplete homework questions of each participant.

The highest tutor satisfaction was found among the participants who received 1:1 tutoring ($M = 80.85$), followed by those who received 2:1 tutoring ($M = 78.19$), and finally those who received 5:1 tutoring ($M = 71.63$). Each of the pairwise comparisons among these groups revealed statistically significant differences using an α level of .05; 1:1 vs. 2:1 ($p = .017$), 2:1 vs. 5:1 ($p < .001$), and 1:1 vs. 5:1 ($p < .001$). Based on these findings, we reject H_0 and accept H_1 ; smaller tutor groups significantly outperform larger groups when it comes to student satisfaction.

We noted a different pattern among these groups with respect to overall mean homework errors. Students who received 2:1 tutoring had the fewest homework errors ($M = 4.27$), followed by the 1:1 group ($M = 5.24$), and finally the 5:1 group ($M = 6.79$). There was no statistically significant difference between the 1:1 group and the 2:1 group ($p = .119$), however the 1:1 had significantly fewer homework errors compared to the 5:1 group ($p < .001$); the 2:1 group also had significantly fewer homework errors than the 5:1 group ($p = .002$). Based on these findings, we reject H_0 and accept H_2 . One possible explanation for the fewest homework errors being detected in the 2:1 group may be that the students work in partnership, thereby offering the opportunity to collaboratively check the quality of their homework.

EXERCISE 7.3A

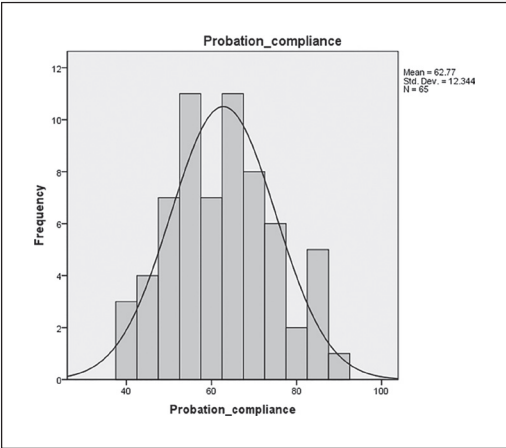
Data set: Ch 07 – Exercise 03A.sav

- (a)
- H_0 : Having a mentor will have no effect on probation compliance or on truancy.
- H_1 : Having a mentor will have an effect on probation compliance.
- H_2 : Having a mentor will have an effect on truancy.
- (b)

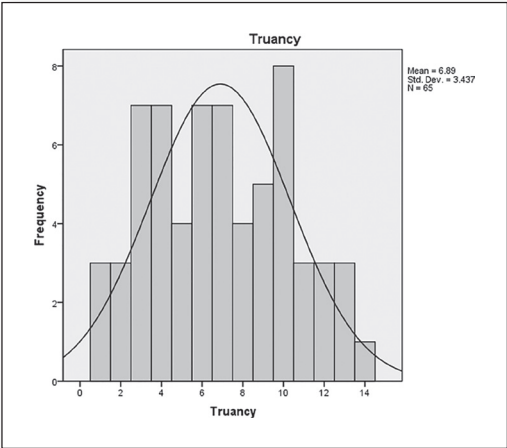
		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No mentor	65	34.6	34.6	34.6
	Peer mentor	65	34.6	34.6	69.1
	Adult mentor	58	30.9	30.9	100.0
	Total	188	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

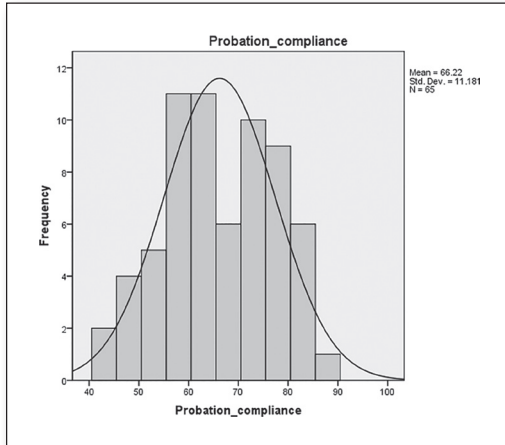
Histogram of *Probation_compliance* for *No mentor* (Group 1)



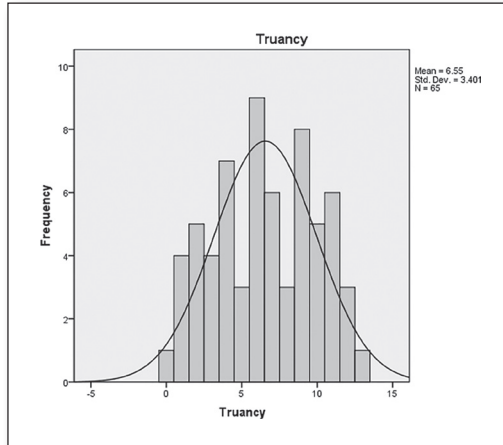
Histogram of *Truancy* for *No mentor* (Group 1)



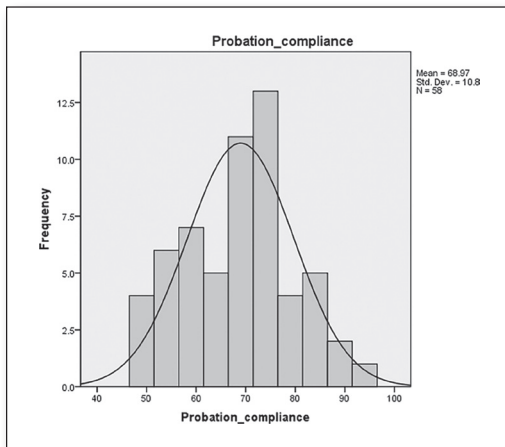
Histogram of *Probation_compliance* for
Peer mentor (Group 2)



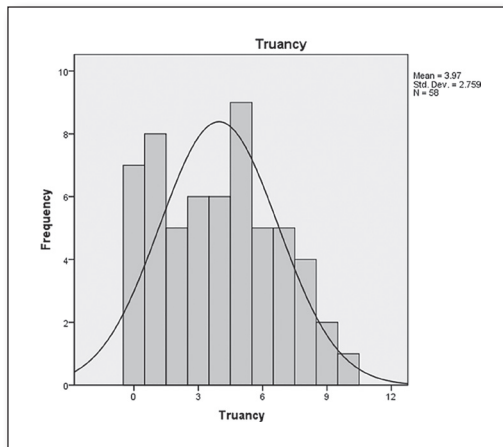
Histogram of *Truancy* for *Peer mentor*
(Group 2)



Histogram of *Probation_compliance* for
Adult mentor (Group 3)



Histogram of *Truancy* for *Adult mentor*
(Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations			
		Probation_compliance	Truancy
Probation_compliance	Pearson Correlation	1	-.405**
	Sig. (2-tailed)		.000
	N	188	188
Truancy	Pearson Correlation	-.405**	1
	Sig. (2-tailed)	.000	
	N	188	188

** . Correlation is significant at the 0.01 level (2 -tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is $-.405$; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices ^a	
Box's M	11.520
F	1.890
df1	6
df2	789832.051
Sig.	.078

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of $.078$; since this is greater than $.001$, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
Probation_compliance	.685	2	185	.505
Truancy	2.153	2	185	.119

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene’s test): Levene’s Test produced Sig. (p) values of .505 and .119; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.981	4732.937 ^a	2.000	184.000	.000
	Wilks' Lambda	.019	4732.937 ^a	2.000	184.000	.000
	Hotelling's Trace	51.445	4732.937 ^a	2.000	184.000	.000
	Roy's Largest Root	51.445	4732.937 ^a	2.000	184.000	.000
Group	Pillai's Trace	.152	7.625	4.000	370.000	.000
	Wilks' Lambda	.849	7.822 ^a	4.000	368.000	.000
	Hotelling's Trace	.175	8.016	4.000	366.000	.000
	Roy's Largest Root	.163	15.045 ^b	2.000	185.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

		Group			
Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Probation_compliance	No mentor	62.769	1.424	59.959	65.580
	Peer mentor	66.215	1.424	63.405	69.026
	Adult mentor	68.966	1.508	65.990	71.941
Truancy	No mentor	6.892	.401	6.102	7.683
	Peer mentor	6.554	.401	5.763	7.344
	Adult mentor	3.966	.424	3.129	4.802

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Probation_compliance	No mentor	Peer mentor	-3.45	2.015	.266	-8.31	1.42
		Adult mentor	-6.20 [*]	2.074	.010	-11.21	-1.18
	Peer mentor	No mentor	3.45	2.015	.266	-1.42	8.31
		Adult mentor	-2.75	2.074	.560	-7.76	2.26
Truancy	Adult mentor	No mentor	6.20	2.074	.010	1.18	11.21
		Peer mentor	2.75	2.074	.560	-2.26	7.76
	No mentor	Peer mentor	-.34	.567	1.000	-1.03	1.71
		Adult mentor	2.93 [*]	.583	.000	1.52	4.34
	Peer mentor	No mentor	-.34	.567	1.000	-1.71	1.03
		Adult mentor	2.59 [*]	.583	.000	1.18	4.00
	Adult mentor	No mentor	-2.93 [*]	.583	.000	-4.34	-1.52
		Peer mentor	-2.59	.583	.000	-4.00	-1.18

Based on observed means.

The error term is Mean Square(Error) = 10.434.

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

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons		<i>p</i>
Probation compliance	No mentor (M = 62.77) : Peer mentor (M = 66.22)	.266
Probation compliance	No mentor (M = 62.77) : Adult mentor (M = 68.97)	.010*
Probation compliance	Peer mentor (M = 66.22) : Adult mentor (M = 68.97)	.560
Truancy	No mentor (M = 6.89) : Peer mentor (M = 6.55)	1.000
Truancy	No mentor (M = 6.89) : Adult mentor (M = 3.97)	.000*
Truancy	Peer mentor (M = 6.55) : Adult mentor (M = 3.97)	.000*

*Statistically significant ($p < .05$).

Based on these results, I would reject H_0 and accept H_1 and H_2 .

(d)

A judge appointed us to evaluate the effectiveness of a new mentorship program for juvenile offenders with priors. The 188 juveniles were randomly assigned to one of three groups: no mentor, a trained peer mentor who is 3 to 5 years older than the offender, or a trained adult mentor.

Those paired with an adult mentor had the highest average level of probation compliance (M = 68.97), statistically significantly outperforming those who had no mentor (M = 62.77) ($p = .010$, $\alpha = .05$). No statistically significant differences in probation compliance were detected between those in no mentor group (M = 62.77) and the peer mentor group (M = 66.22) ($p = .266$, $\alpha = .05$), or the peer mentor (M = 66.22) and the adult mentor (M = 68.97) ($p = .560$, $\alpha = .05$). Based on these findings, we reject H_0 and accept H_1 .

The group with the lowest level of truancy per term were those who were assigned an adult mentor (M = 3.97), followed by peer mentor (M = 6.55), and finally no mentor (M = 6.89). Youths assigned to an adult mentor had significantly fewer truanies than those assigned to a peer mentor or no mentor ($p < .001$, $\alpha = .05$). Additionally, we detected no statistically difference in truancy, comparing youths who had a peer mentor and those who had no mentor ($p = 1.000$, $\alpha = .05$). Based on these findings, we reject H_0 and accept H_2 . These results suggest that adult mentors are the optimal choice for enhancing probation compliance and reducing truancy for this population.

EXERCISE 7.3B

Data set: Ch 07 – Exercise 03B.sav

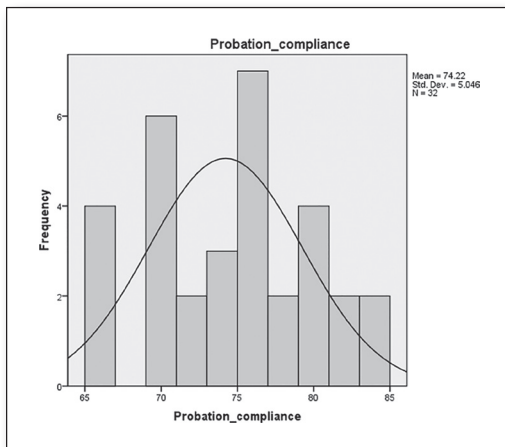
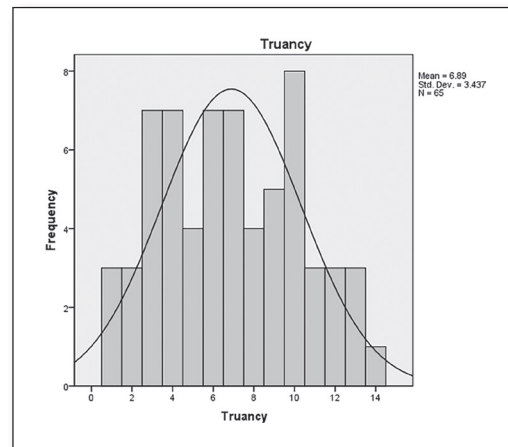
(a)

 H_0 : Having a mentor will have no effect on probation compliance or on truancy. H_1 : Having a mentor will have an effect on probation compliance. H_2 : Having a mentor will have an effect on truancy.

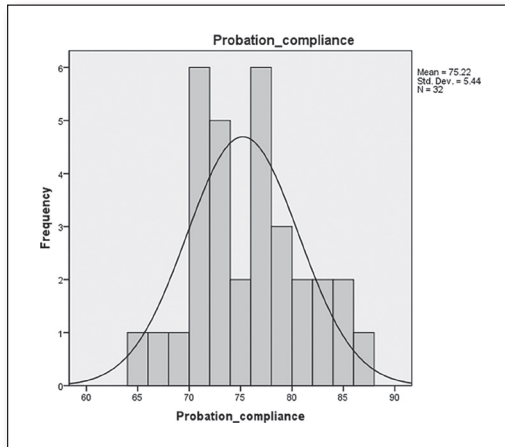
(b)

		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No mentor	32	33.3	33.3	33.3
	Peer mentor	32	33.3	33.3	66.7
	Adult mentor	32	33.3	33.3	100.0
	Total	96	100.0	100.0	

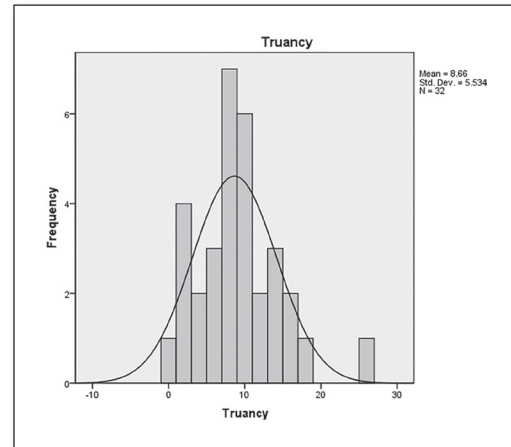
Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

Histogram of *Probation_compliance* for
No mentor (Group 1)Histogram of *Truancy* for *No mentor*
(Group 1)

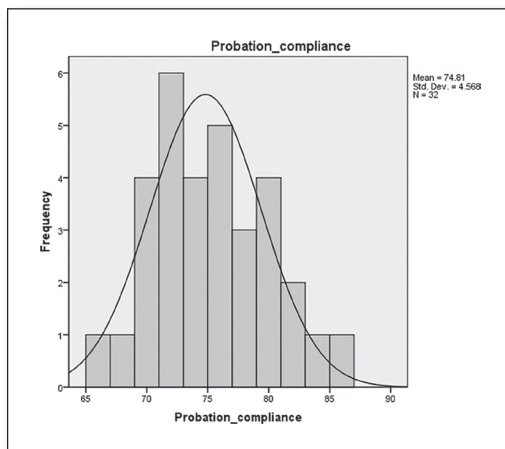
Histogram of *Probation_compliance* for
Peer mentor (Group 2)



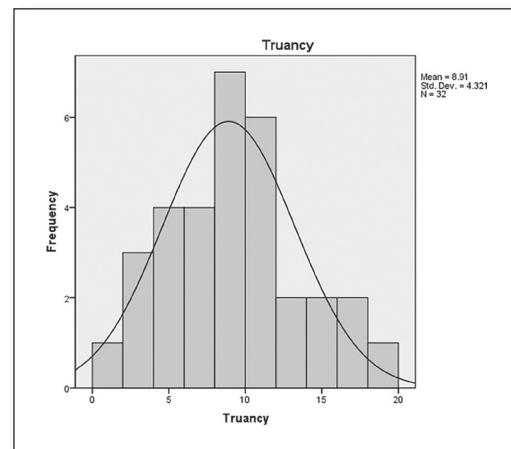
Histogram of *Truancy* for *Peer mentor*
(Group 2)



Histogram of *Probation_compliance* for
Adult mentor (Group 3)



Histogram of *Truancy* for *Adult mentor*
(Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		Probation_compliance	Truancy
Probation_compliance	Pearson Correlation	1	-.896**
	Sig. (2-tailed)		.000
	N	96	96
Truancy	Pearson Correlation	-.896**	1
	Sig. (2-tailed)	.000	
	N	96	96

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is -.896; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	3.972
F	.641
df1	6
df2	215559.692
Sig.	.697

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of .697; since this is greater than .001, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Probation_compliance	.475	2	93	.623
Truancy	.751	2	93	.475

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test): Levene's Test produced Sig. (p) values of .623 and .475; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.999	65134.313 ^a	2.000	92.000	.000
	Wilks' Lambda	.001	65134.313 ^a	2.000	92.000	.000
	Hotelling's Trace	1415.963	65134.313 ^a	2.000	92.000	.000
	Roy's Largest Root	1415.963	65134.313 ^a	2.000	92.000	.000
Group	Pillai's Trace	.011	.258	4.000	186.000	.904
	Wilks' Lambda	.989	.256 ^a	4.000	184.000	.906
	Hotelling's Trace	.011	.253	4.000	182.000	.907
	Roy's Largest Root	.010	.454 ^b	2.000	93.000	.636

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .904 for *Group*; since this is greater than .05, this indicates that no statistically significant differences have been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Dependent Variable	Group	Group			
		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Probation_compliance	No mentor	74.219	.889	72.453	75.985
	Peer mentor	75.219	.889	73.453	76.985
	Adult mentor	74.813	.889	73.046	76.579
Truancy	No mentor	9.781	.887	8.020	11.543
	Peer mentor	8.656	.887	6.895	10.418
	Adult mentor	8.906	.887	7.145	10.668

Multiple Comparisons								
Bonferroni								
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval		
						Lower Bound	Upper Bound	
Probation_compliance	No mentor	Peer mentor	-1.00	1.258	1.000	-4.07	2.07	
		Adult mentor	-.59	1.258	1.000	-3.66	2.47	
	Peer mentor	No mentor	1.00	1.258	1.000	-2.07	4.07	
		Adult mentor	.41	1.258	1.000	-2.66	3.47	
Truancy	Adult mentor	No mentor	.59	1.258	1.000	-2.47	3.66	
		Peer mentor	-.41	1.258	1.000	-3.47	2.66	
	No mentor	Peer mentor	1.13	1.254	1.000	-1.93	4.18	
		Adult mentor	.87	1.254	1.000	-2.18	3.93	
	Peer mentor	No mentor	-1.13	1.254	1.000	-4.18	1.93	
		Adult mentor	-.25	1.254	1.000	-3.31	2.81	
	Adult mentor	No mentor	-.87	1.254	1.000	-3.93	2.18	
		Peer mentor	.25	1.254	1.000	-2.81	3.31	

Based on observed means.
The error term is Mean Square(Error) = 25.176.

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons		<i>p</i>
Probation compliance	No mentor (M = 74.22) : Peer mentor (M = 75.22)	1.000
Probation compliance	No mentor (M = 74.22) : Adult mentor (M = 74.81)	1.000
Probation compliance	Peer mentor (M = 75.22) : Adult mentor (M = 74.81)	1.000
Truancy	No mentor (M = 9.78) : Peer mentor (M = 8.66)	1.000
Truancy	No mentor (M = 9.78) : Adult mentor (M = 8.91)	1.000
Truancy	Peer mentor (M = 8.66) : Adult mentor (M = 8.91)	1.000

*Statistically significant ($p < .05$).

Based on these results, I would accept H_0 and reject H_1 and H_2 .

(d)

A judge appointed us to evaluate the effectiveness of a new mentorship program for juvenile offenders with priors. The 96 juveniles were randomly assigned to one of three groups: no mentor, a trained peer mentor who is 3 to 5 years older than the offender, or a trained adult mentor.

Those paired with a peer mentor had the highest average level of probation compliance ($M = 75.22$), followed by those assigned to an adult mentor ($M = 74.81$), and finally, those who were not assigned to a mentor ($M = 74.22$). We detected no statistically significant differences in probation compliance among these groups ($p = 1.000$, $\alpha = .05$), hence we accept H_0 and reject H_1 .

We observed a slightly different pattern with respect to truancy; those assigned to a peer mentor had the lowest mean truancy per term ($M = 8.66$), followed by the adult mentor group ($M = 8.91$), and finally, those who had no mentor ($M = 9.78$). Once again, no statistically significant differences were detected among these pairs of groups ($p = 1.000$, $\alpha = .05$), hence we accept H_0 and reject H_1 . Per these results, we will review and revise our mentorship training and consider modifying our mentor recruitment protocol.

EXERCISE 7.5A

Data set: Ch 07 – Exercise 05A.sav

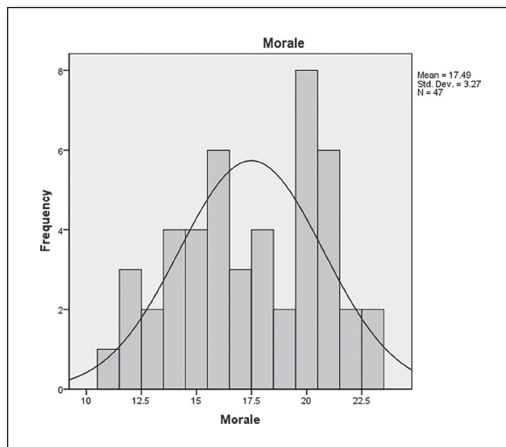
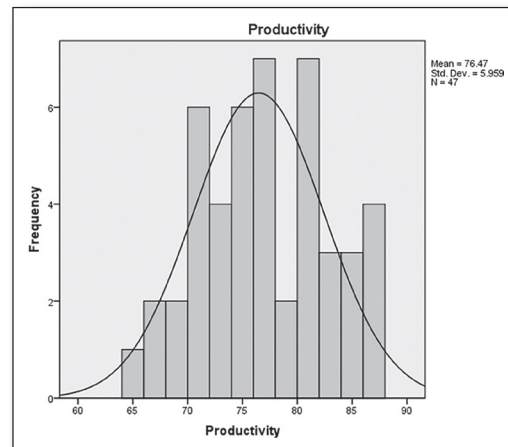
(a)

 H_0 : Increasing paid time off will not affect employee morale or productivity. H_1 : Increasing paid time off will affect employee morale. H_1 : Increasing paid time off will affect employee productivity.

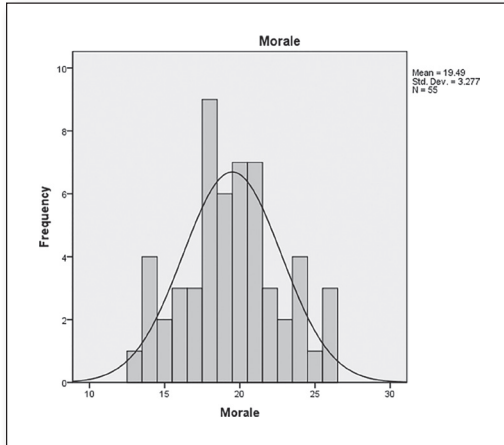
(b)

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

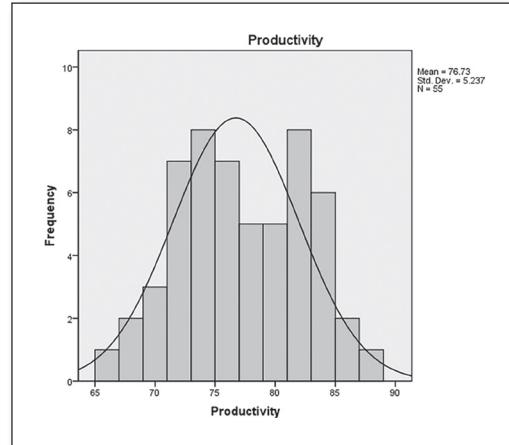
		Site			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 Weeks PTO	47	32.9	32.9	32.9
	2 Weeks PTO + 4th Fridays off	55	38.5	38.5	71.3
	3 Weeks PTO	41	28.7	28.7	100.0
	Total	143	100.0	100.0	

Histogram of *Morale* for 2 Weeks PTO (Group 1)Histogram of *Productivity* for 2 Weeks PTO (Group 1)

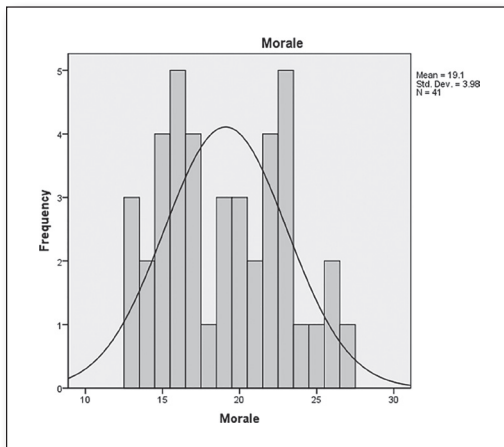
Histogram of *Morale* for 2 Weeks
PTO + 4th Fridays off (Group 2)



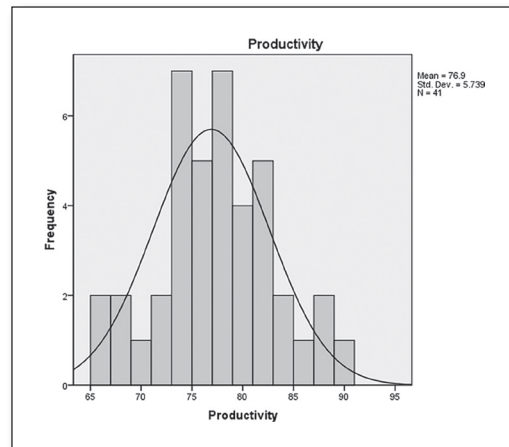
Histogram of *Productivity* for 2 Weeks
PTO + 4th Fridays off (Group 2)



Histogram of *Morale* for 3 Weeks
PTO (Group 3)



Histogram of *Productivity* for 3 Weeks
PTO (Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		Morale	Productivity
Morale	Pearson Correlation	1	.403**
	Sig. (2-tailed)		.000
	N	143	143
Productivity	Pearson Correlation	.403**	1
	Sig. (2-tailed)	.000	
	N	143	143

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is .403; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	7.013
F	1.144
df1	6
df2	351487.219
Sig.	.333

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a. Design: Intercept + Site

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of .333; since this is greater than .001, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Morale	2.364	2	140	.098
Productivity	.306	2	140	.737

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + Site

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene’s test): Levene’s Test produced Sig. (*p*) values of .098 and .737; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.995	13007.126 ^a	2.000	139.000	.000
	Wilks' Lambda	.005	13007.126 ^a	2.000	139.000	.000
	Hotelling's Trace	187.153	13007.126 ^a	2.000	139.000	.000
	Roy's Largest Root	187.153	13007.126 ^a	2.000	139.000	.000
Site	Pillai's Trace	.067	2.438	4.000	280.000	.047
	Wilks' Lambda	.933	2.463 ^a	4.000	278.000	.045
	Hotelling's Trace	.072	2.488	4.000	276.000	.044
	Roy's Largest Root	.072	5.025 ^b	2.000	140.000	.008

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Site

Pillai’s Trace produced a Sig. (*p*) of .047 for *Site*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

		Site			
Dependent Variable	Site	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Morale	2 Weeks PTO	17.489	.509	16.483	18.496
	2 Weeks PTO + 4th Fridays off	19.491	.471	18.561	20.421
	3 Weeks PTO	19.098	.545	18.020	20.175
Productivity	2 Weeks PTO	76.468	.821	74.845	78.091
	2 Weeks PTO + 4th Fridays off	76.727	.759	75.227	78.227
	3 Weeks PTO	76.902	.879	75.165	78.640

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Site	(J) Site	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Morale	2 Weeks PTO	2 Weeks PTO + 4th Fridays off	-2.00	.693	.014	-3.68	-.32
		3 Weeks PTO	-1.61	.746	.098	-3.42	.20
		2 Weeks PTO	2.00	.693	.014	.32	3.68
	2 Weeks PTO + 4th Fridays off	3 Weeks PTO	.39	.720	1.000	-1.35	2.14
		2 Weeks PTO	1.61	.746	.098	-.20	3.42
	3 Weeks PTO	2 Weeks PTO + 4th Fridays off	-.39	.720	1.000	-2.14	1.35
Productivity	2 Weeks PTO	2 Weeks PTO + 4th Fridays off	-.26	1.118	1.000	-2.97	2.45
		3 Weeks PTO	-.43	1.202	1.000	-3.35	2.48
		2 Weeks PTO	.26	1.118	1.000	-2.45	2.97
	2 Weeks PTO + 4th Fridays off	3 Weeks PTO	-.18	1.161	1.000	-2.99	2.64
		2 Weeks PTO	.43	1.202	1.000	-2.48	3.35
	3 Weeks PTO	2 Weeks PTO + 4th Fridays off	.18	1.161	1.000	-2.64	2.99
		2 Weeks PTO					
		3 Weeks PTO					

Based on observed means.

The error term is Mean Square(Error) = 31.659.

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

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons		<i>p</i>
Morale	M(2 Wks. PTO) = 17.49 : M(2 Wks. PTO + 4th Fri. off) = 19.49	.014*
Morale	M(2 Wks. PTO) = 17.49 : M(3 Wks. PTO) = 19.10	.098
Morale	M(2 Wks. PTO + 4th Fri. off) = 19.49 : M(3 Wks. PTO) = 19.10	1.000
Productivity	M(2 Wks. PTO) = 76.47 : M(2 Wks. PTO + 4th Fri. off) = 76.73	1.000
Productivity	M(2 Wks. PTO) = 76.47 : M(3 Wks. PTO) = 76.90	1.000
Productivity	M(2 Wks. PTO + 4th Fri. off) = 76.73 : M(3 Wks. PTO) = 76.90	1.000

*Statistically significant ($p < .05$).

Based on these results, I would reject null and accept H_1 but reject H_2 .

(d)

In order to assess methods of improving employee morale, we conducted a study of our 143 employees distributed over three sites statistically controlling for employment seniority: The employees at site 1 received the usual 2 weeks of PTO (Paid Time Off) per year, the employees at site 2 received the same 2 weeks of PTO per year plus the last Friday of each month off (with pay), and the employees at site 3, were granted 3 weeks of PTO per year.

We administered the Acme Morale Scale, wherein 1 = extremely low morale, and 25 = extremely high morale, to all of our employees.

Employee morale was found to be highest at the site that received 2 weeks PTO plus the last Friday of the month off with pay ($M = 19.49$), followed by the site that received 3 weeks ($M = 19.10$), and finally, the site that received 2 weeks ($M = 17.49$). The site that received 2 weeks plus the 4th Fridays off had significantly higher mean morale score than those who received only 2 weeks off ($p = .014$, $\alpha = .05$). No statistically significant differences were detected between those who received 2 weeks off and 3 weeks off ($p = .098$) or those who received 2 weeks plus the 4th Fridays off compared to those who received 3 weeks off ($p = 1.000$). Based on these findings, we reject H_0 and accept H_1 .

We also assessed employee productivity at each site. The site that provided 3 weeks of PTO had the highest mean productivity (with the highest mean productivity ($M = 76.90$), followed by the site that provided 2 weeks off plus every 4th Friday off ($M = 76.73$), and finally, the site that granted 2 weeks off ($M = 76.47$). Each of the pairwise comparisons produced a *p* value of 1.000. Based on these findings, we reject H_2 . These results suggest that productivity is not effected by PTO benefits, however with respect to morale, PTO does appear to be an influential factor.

EXERCISE 7.5B

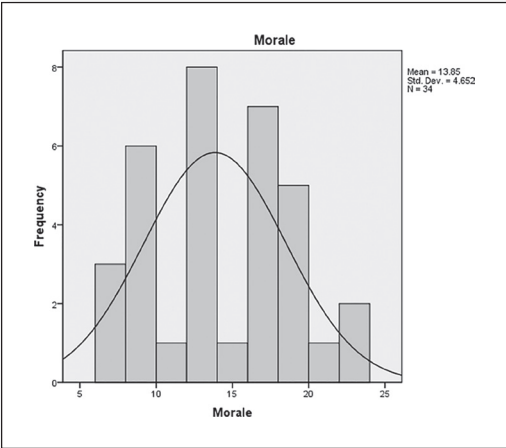
Data set: Ch 07 – Exercise 05B.sav

- (a)
- H_0 : Increasing paid time off will not affect employee morale or productivity.
- H_1 : Increasing paid time off will affect employee morale.
- H_1 : Increasing paid time off will affect employee productivity.
- (b)

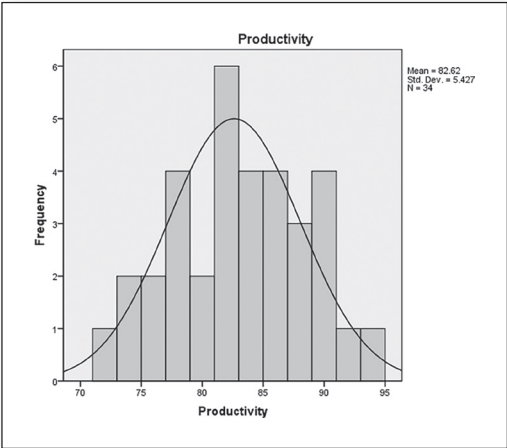
		Site			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 Weeks PTO	34	30.1	30.1	30.1
	2 Weeks PTO + 4th Fridays off	40	35.4	35.4	65.5
	3 Weeks PTO	39	34.5	34.5	100.0
	Total	113	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

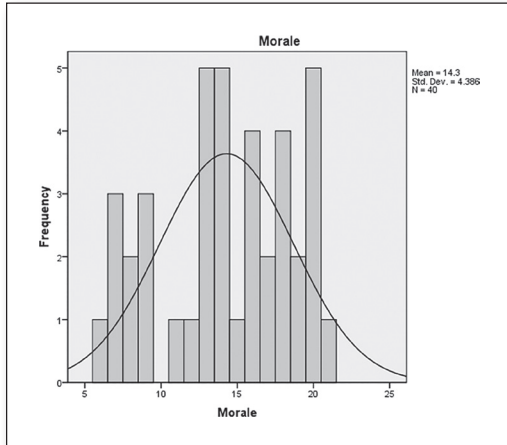
Histogram of *Morale* for 2 Weeks PTO (Group 1)



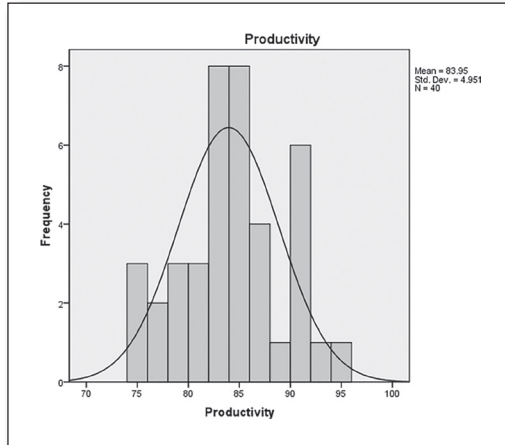
Histogram of *Productivity* for 2 Weeks PTO (Group 1)



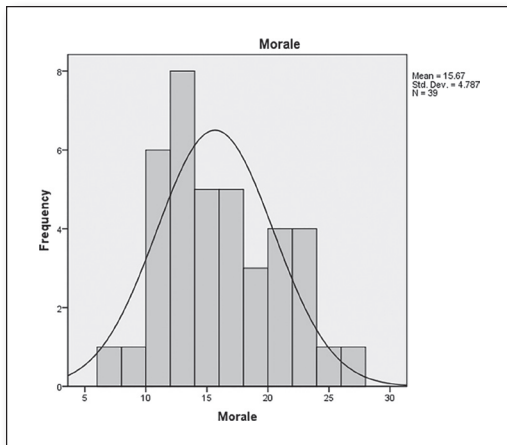
Histogram of *Morale* for 2 Weeks
PTO + 4th Fridays off (Group 2)



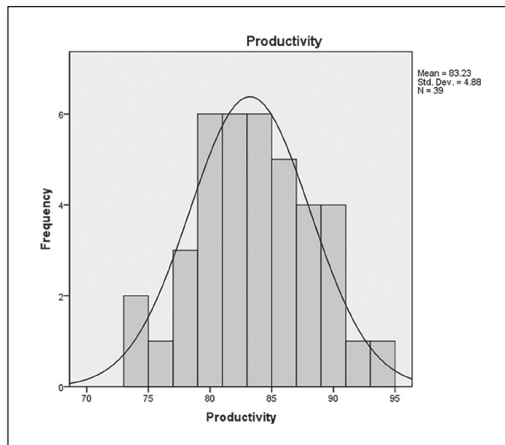
Histogram of *Productivity* for 2 Weeks
PTO + 4th Fridays off (Group 2)



Histogram of *Morale* for 3 Weeks
PTO (Group 3)



Histogram of *Productivity* for 3 Weeks
PTO (Group 3)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations			
		Morale	Productivity
Morale	Pearson Correlation	1	.792**
	Sig. (2-tailed)		.000
	N	113	113
Productivity	Pearson Correlation	.792**	1
	Sig. (2-tailed)	.000	
	N	113	113

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is .792; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices ^a	
Box's M	12.868
F	2.088
df1	6
df2	263078.960
Sig.	.051

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Site

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of .051; since this is greater than .001, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Morale	.259	2	110	.772
Productivity	.295	2	110	.745

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Site

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test): Levene's Test produced Sig. (p) values of .772 and .745; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests^c

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.998	30999.232 ^a	2.000	109.000	.000
	Wilks' Lambda	.002	30999.232 ^a	2.000	109.000	.000
	Hotelling's Trace	568.793	30999.232 ^a	2.000	109.000	.000
	Roy's Largest Root	568.793	30999.232 ^a	2.000	109.000	.000
Site	Pillai's Trace	.095	2.734	4.000	220.000	.030
	Wilks' Lambda	.906	2.753 ^a	4.000	218.000	.029
	Hotelling's Trace	.103	2.772	4.000	216.000	.028
	Roy's Largest Root	.093	5.096 ^b	2.000	110.000	.008

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Site

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Morale	66.793 ^a	2	33.396	1.573	.212
	Productivity	32.917 ^b	2	16.459	.639	.530
Intercept	Morale	23986.147	1	23986.147	1129.808	.000
	Productivity	779476.249	1	779476.249	30267.156	.000
Site	Morale	66.793	2	33.396	1.573	.212
	Productivity	32.917	2	16.459	.639	.530
Error	Morale	2335.331	110	21.230		
	Productivity	2832.852	110	25.753		
Total	Morale	26612.000	113			
	Productivity	786977.000	113			
Corrected Total	Morale	2402.124	112			
	Productivity	2865.770	112			

a. R Squared = .028 (Adjusted R Squared = .010)

b. R Squared = .011 (Adjusted R Squared = -.006)

Pillai's Trace produced a Sig. (p) of .030 for *Site*; since this is less than .05, this indicates that statistically significant differences have been detected among the groups; for specifics, we look to the Multiple Comparisons table.

Dependent Variable	Site	Site			
		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Morale	2 Weeks PTO	13.853	.790	12.287	15.419
	2 Weeks PTO + 4th Fridays off	14.300	.729	12.856	15.744
	3 Weeks PTO	15.667	.738	14.204	17.129
Productivity	2 Weeks PTO	82.618	.870	80.893	84.342
	2 Weeks PTO + 4th Fridays off	83.950	.802	82.360	85.540
	3 Weeks PTO	83.231	.813	81.620	84.841

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Site	(J) Site	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Morale	2 Weeks PTO	2 Weeks PTO + 4th Fridays off	-.45	1.075	1.000	-3.06	2.17
		3 Weeks PTO	-1.81	1.081	.289	-4.44	.81
		2 Weeks PTO + 4th Fridays off	.45	1.075	1.000	-2.17	3.06
	2 Weeks PTO + 4th Fridays off	3 Weeks PTO	-1.37	1.037	.571	-3.89	1.15
		2 Weeks PTO	1.81	1.081	.289	-.81	4.44
		2 Weeks PTO + 4th Fridays off	1.37	1.037	.571	-1.15	3.89
Productivity	2 Weeks PTO	2 Weeks PTO + 4th Fridays off	-1.33	1.184	.788	-4.21	1.55
		3 Weeks PTO	-.61	1.191	1.000	-3.51	2.28
		2 Weeks PTO + 4th Fridays off	1.33	1.184	.788	-1.55	4.21
	2 Weeks PTO + 4th Fridays off	3 Weeks PTO	.72	1.142	1.000	-2.06	3.50
		2 Weeks PTO	.61	1.191	1.000	-2.28	3.51
		2 Weeks PTO + 4th Fridays off	-.72	1.142	1.000	-3.50	2.06

Based on observed means.
The error term is Mean Square(Error) = 25.753.

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons			<i>p</i>
Morale	M(2 Wks. PTO) = 13.85 : M(2 Wks. PTO + 4th Fri. off) = 14.30		1.000
Morale	M(2 Wks. PTO) = 13.85 : M(3 Wks. PTO) = 15.67		.289
Morale	M(2 Wks. PTO + 4th Fri. off) = 14.30 : M(3 Wks. PTO) = 15.67		.571
Productivity	M(2 Wks. PTO) = 82.62 : M(2 Wks. PTO + 4th Fri. off) = 83.95		.788
Productivity	M(2 Wks. PTO) = 82.62 : M(3 Wks. PTO) = 83.23		1.000
Productivity	M(2 Wks. PTO + 4th Fri. off) = 83.95 : M(3 Wks. PTO) = 83.23		1.000

*Statistically significant ($p < .05$).

Based on these results, I would accept H_0 , and reject H_1 & H_2 .

(d)

In order to assess methods of improving employee morale, we conducted study of our 113 employees distributed over three sites statistically controlling for employment seniority: The employees at site 1 received the usual 2 weeks of PTO (Paid Time Off) per year, the employees at site 2 received the same 2 weeks of PTO per year plus the last Friday of each month off (with pay), and the employees at site 3, were granted 3 weeks of PTO per year.

We administered the Acme Morale Scale, wherein 1 = extremely low morale, and 25 = extremely high morale, to all of our employees. Employee morale was found to be highest at the site that received 3 weeks PTO ($M = 15.67$), followed by the site that received 2 weeks plus the last Friday of the month off (with pay) ($M = 14.30$), and finally, the site that received 2 weeks ($M = 13.85$). No statistically significant differences were detected among these groups; p values ranged from .289 to 1.000 ($\alpha = .05$). Based on these findings, we reject H_1 .

We also assessed employee productivity at each site. The site that provided 2 weeks of PTO plus the every 4th Friday off had the highest mean productivity ($M = 83.95$), followed by the site that provided 3 weeks off ($M = 83.23$), and finally, the site that granted 2 weeks off ($M = 82.62$). Each of the pairwise comparisons produced a p values ranging from .788 to 1.000 ($\alpha = .05$). Based on these findings, we accept reject H_2 and accept H_0 . These results suggest that neither morale nor productivity are significantly affected by PTO benefits among these sites.

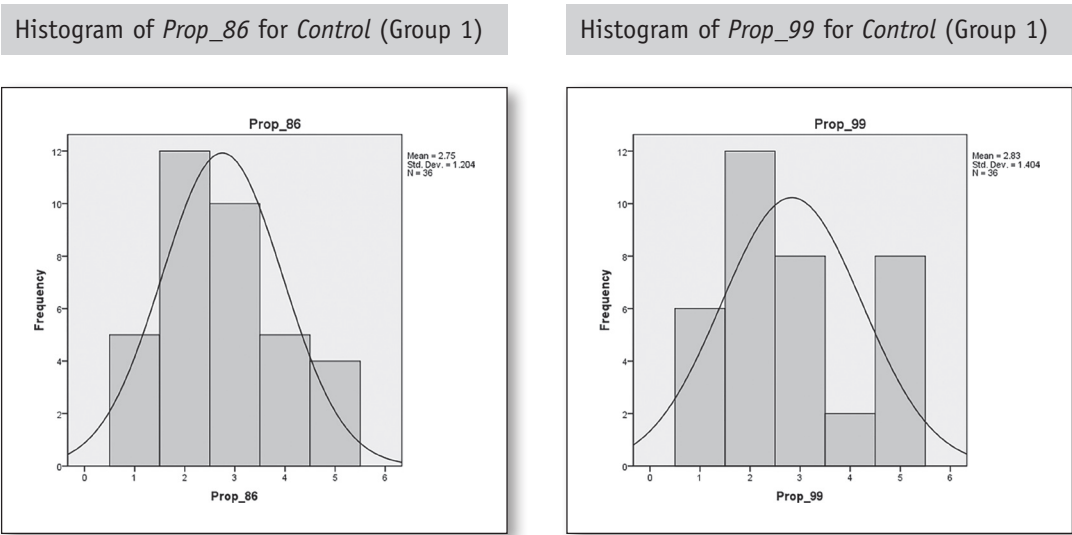
EXERCISE 7.7A

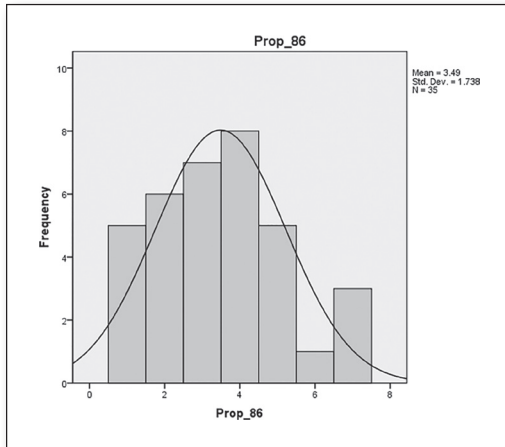
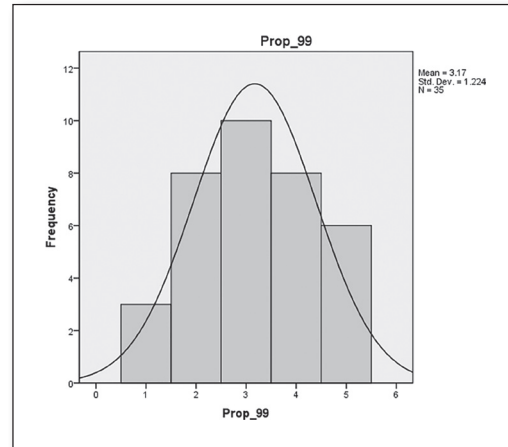
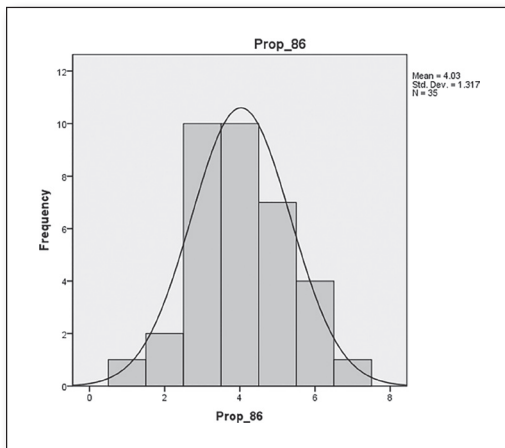
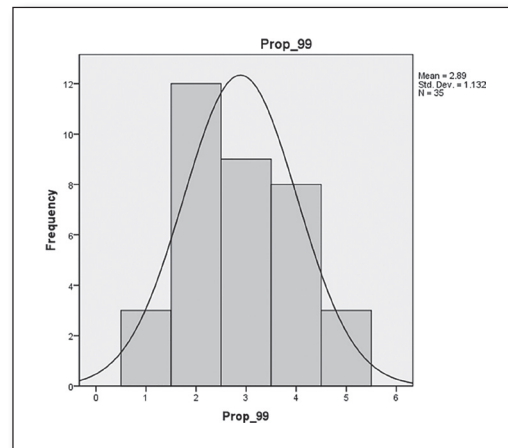
Data set: Ch 07 – Exercise 07A.sav

- (a)
- H_0 : Advertising media will not influence voter choice.
- H_1 : Advertising media will influence voter choice for Proposition 86.
- H_2 : Advertising media will influence voter choice for Proposition 99.
- (b)

		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control	36	34.0	34.0	34.0
	Print	35	33.0	33.0	67.0
	Video	35	33.0	33.0	100.0
	Total	106	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.



Histogram of *Prop_86* for *Print* (Group 2)Histogram of *Prop_99* for *Print* (Group 2)Histogram of *Prop_86* for *Video* (Group 3)Histogram of *Prop_99* for *Video* (Group 3)

Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		Prop_86	Prop_99
Prop_86	Pearson Correlation	1	-.341**
	Sig. (2-tailed)		.000
	N	106	106
Prop_99	Pearson Correlation	-.341**	1
	Sig. (2-tailed)	.000	
	N	106	106

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is $-.341$; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	18.147
F	2.940
df1	6
df2	263163.134
Sig.	.007

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of $.007$; since this is greater than $.001$, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Prop_86	2.921	2	103	.058
Prop_99	1.093	2	103	.339

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene’s test): Levene’s Test produced Sig. (p) values of .058 and .339; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.949	944.223 ^a	2.000	102.000	.000
	Wilks' Lambda	.051	944.223 ^a	2.000	102.000	.000
	Hotelling's Trace	18.514	944.223 ^a	2.000	102.000	.000
	Roy's Largest Root	18.514	944.223 ^a	2.000	102.000	.000
Group	Pillai's Trace	.161	4.495	4.000	206.000	.002
	Wilks' Lambda	.841	4.604 ^a	4.000	204.000	.001
	Hotelling's Trace	.187	4.710	4.000	202.000	.001
	Roy's Largest Root	.174	8.965 ^b	2.000	103.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .002 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Group					
Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Prop_86	Control	2.750	.239	2.275	3.225
	Print	3.486	.243	3.004	3.967
	Video	4.029	.243	3.547	4.510
Prop_99	Control	2.833	.210	2.417	3.250
	Print	3.171	.213	2.749	3.594
	Video	2.886	.213	2.463	3.308

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Prop_86	Control	Print	-.74	.341	.100	-1.57	.09
		Video	-1.28*	.341	.001	-2.11	-.45
	Print	Control	.74	.341	.100	-.09	1.57
		Video	-.54	.343	.351	-1.38	.29
	Video	Control	1.28*	.341	.001	.45	2.11
		Print	.54	.343	.351	-.29	1.38
Prop_99	Control	Print	-.34	.299	.783	-1.07	.39
		Video	-.05	.299	1.000	-.78	.68
	Print	Control	.34	.299	.783	-.39	1.07
		Video	.29	.301	1.000	-.45	1.02
	Video	Control	.05	.299	1.000	-.68	.78
		Print	-.29	.301	1.000	-1.02	.45

Based on observed means.

The error term is Mean Square(Error) = 1.588.

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

Drawing the means from the *Groups* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

	Group Comparisons	<i>p</i>
Prop 86	M(Control) = 2.75 : M(Print) = 3.49	.100
Prop 86	M(Control) = 2.75 : M(Video) = 4.03	.001*
Prop 86	M(Print) = 3.49: M(Video) = 4.03	.351
Prop 99	M(Control) = 2.83 : M(Print) = 3.17	.783
Prop 99	M(Control) = 2.83 : M(Video) = 2.89	1.000
Prop 99	M(Print) = 3.17 : M(Video) = 2.89	1.000

*Statistically significant ($p < .05$).

The only statistically significant difference is between the *control* group and the *video* group for Prop 86. Based on these results, I would reject H_0 & H_2 , and accept H_1 .

(d)

In order to determine the most persuasive form of advertisement to encourage people to vote *yes* on Propositions 86 and 99, we convened focus groups consisting of registered voters. We recruited 106 participants and randomly assigned them to one of three media groups control (no media), print advertisement, and video advertisement. Prior to dismissing the participants, each was asked to indicate the likelihood that they would vote *yes* on Proposition 86 using a 1 to 7 scale (1 = Will definitely vote *no* . . . 7 = Will definitely vote *yes*). We then asked the participants to use the same scale to rate their voting intentions for Proposition 99.

For Proposition 86, the video group ($M = 4.03$) had the highest score, significantly outperforming the control group ($M = 2.75$) ($p = .001$, $\alpha = .05$). The remaining pairwise comparisons were statistically insignificant: Control ($M = 2.75$) : Print ($M = 3.49$) ($p = .100$, $\alpha = .05$); Print ($M = 3.49$) : Video ($M = 4.03$) ($p = .351$, $\alpha = .05$). Based on these findings, we reject H_0 and accept H_1 .

No statistically significant differences emerged among the groups for Proposition 99; the scores from each group were relatively similar: Print ($M = 3.17$), Video ($M = 2.89$), Control ($M = 2.83$). Comparing the Control group to the Video group produced a *p* value of .783; all other pairwise comparisons rendered a *p* value of 1.00. Based on these findings, we reject H_2 . These findings may suggest that these voters' opinions are relatively inflexible regarding Proposition 99, or we may need to adjust our advertising approach.

EXERCISE 7.7B

Data set: Ch 07 – Exercise 07B.sav

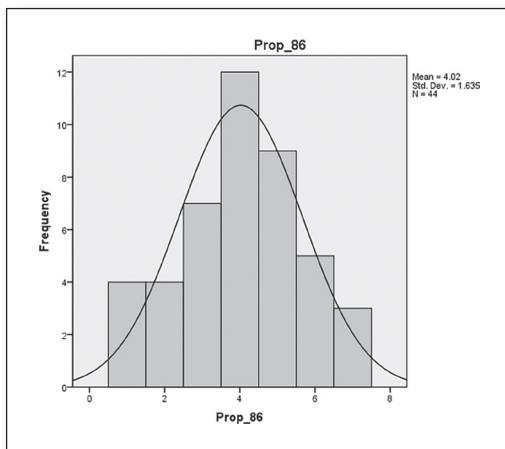
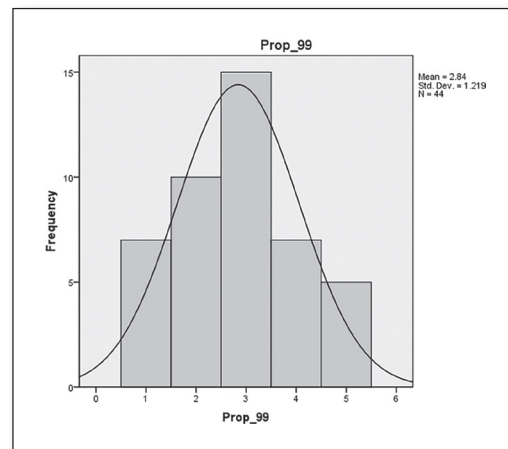
(a)

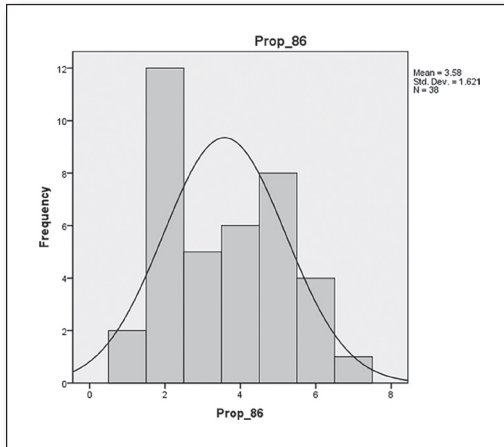
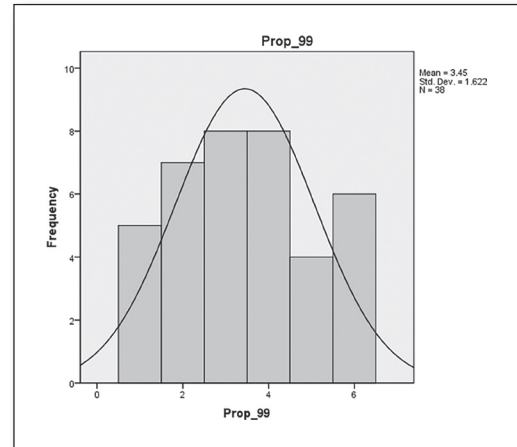
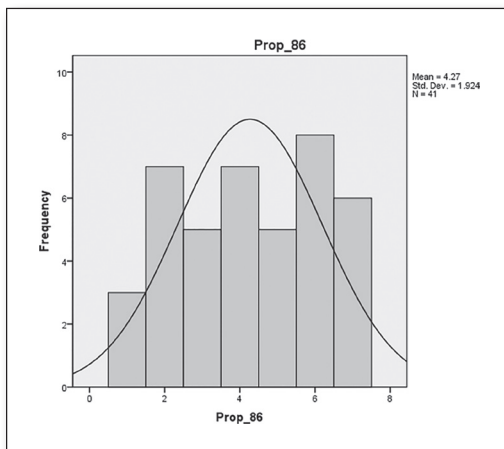
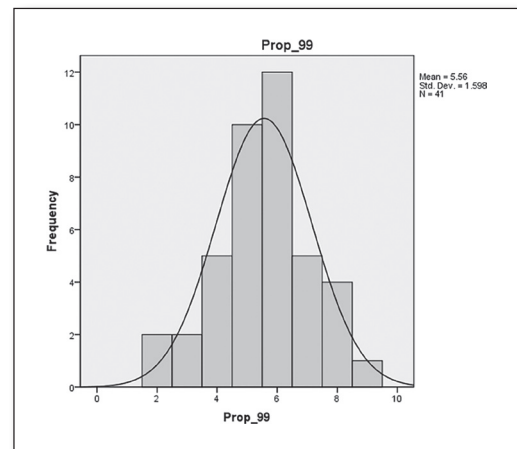
 H_0 : Advertising media will not influence voter choice. H_1 : Advertising media will influence voter choice for Proposition 86. H_2 : Advertising media will influence voter choice for Proposition 99.

(b)

		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control	44	35.8	35.8	35.8
	Print	38	30.9	30.9	66.7
	Video	41	33.3	33.3	100.0
	Total	123	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are at least 30 per groups; hence, the sample size criterion is satisfied.

Histogram of *Prop_86* for Control (Group 1)Histogram of *Prop_99* for Control (Group 1)

Histogram of *Prop_86* for *Print* (Group 2)Histogram of *Prop_99* for *Print* (Group 2)Histogram of *Prop_86* for *Video* (Group 3)Histogram of *Prop_99* for *Video* (Group 3)

Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		Prop_86	Prop_99
Prop_86	Pearson Correlation	1	.504**
	Sig. (2-tailed)		.000
	N	123	123
Prop_99	Pearson Correlation	.504**	1
	Sig. (2-tailed)	.000	
	N	123	123

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is .504; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	24.243
F	3.943
df1	6
df2	327059.784
Sig.	.001

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (*p*) of .001; since this is (greater than or) equal to .001, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Prop_86	1.992	2	120	.141
Prop_99	2.409	2	120	.094

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene’s test): Levene’s Test produced Sig. (p) values of .141 and .094; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.890	483.056 ^a	2.000	119.000	.000
	Wilks' Lambda	.110	483.056 ^a	2.000	119.000	.000
	Hotelling's Trace	8.119	483.056 ^a	2.000	119.000	.000
	Roy's Largest Root	8.119	483.056 ^a	2.000	119.000	.000
Group	Pillai's Trace	.478	18.827	4.000	240.000	.000
	Wilks' Lambda	.531	22.161 ^a	4.000	238.000	.000
	Hotelling's Trace	.867	25.591	4.000	236.000	.000
	Roy's Largest Root	.848	50.908 ^b	2.000	120.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (*p*) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Dependent Variable	Group	Group			
		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Prop_86	Control	4.023	.261	3.506	4.540
	Print	3.579	.281	3.022	4.135
	Video	4.268	.271	3.733	4.804
Prop_99	Control	2.841	.223	2.399	3.283
	Print	3.447	.240	2.972	3.923
	Video	5.561	.231	5.103	6.019

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Prop_86	Control	Print	.44	.384	.749	-.49	1.38
		Video	-.25	.376	1.000	-1.16	.67
	Print	Control	-.44	.384	.749	-1.38	.49
		Video	-.69	.390	.239	-1.64	.26
	Video	Control	.25	.376	1.000	-.67	1.16
		Print	.69	.390	.239	-.26	1.64
Prop_99	Control	Print	-.61	.328	.201	-1.40	.19
		Video	-2.72 [*]	.322	.000	-3.50	-1.94
	Print	Control	.61	.328	.201	-.19	1.40
		Video	-2.11 [*]	.334	.000	-2.92	-1.30
	Video	Control	2.72 [*]	.322	.000	1.94	3.50
		Print	2.11 [*]	.334	.000	1.30	2.92

Based on observed means.

The error term is Mean Square(Error) = 2.195.

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

Drawing the means from the *Group* table and the *p* values from the *Sig.* column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

Group Comparisons		<i>p</i>
Prop 86	M(Control) = 4.02 : M(Print) = 3.58	.749
Prop 86	M(Control) = 4.02 : M(Video) = 4.27	1.000
Prop 86	M(Print) = 3.58 : M(Video) = 4.27	.239
Prop 99	M(Control) = 2.84 : M(Print) = 3.45	.201
Prop 99	M(Control) = 2.84 : M(Video) = 5.56	.000*
Prop 99	M(Print) = 3.45 : M(Video) = 5.56	.000*

*Statistically significant ($p < .05$).

Statistically significant differences were detected among the groups for Prop 99. Based on these results, I would reject H_0 & H_1 , and accept H_2 .

(d)

In order to determine the most persuasive form of advertisement to encourage people to vote *yes* on Propositions 86 and 99, we convened focus groups consisting of registered voters. We recruited 123 participants and randomly assigned them to one of three media groups control (no media), print advertisement, and video advertisement. Prior to dismissing the participants, each was asked to indicate the likelihood that they would vote *yes* on Proposition 86 using a 1 to 7 scale (1 = Will definitely vote *no* . . . 7 = Will definitely vote *yes*). We then asked the participants to use the same scale to rate their voting intentions for Proposition 99.

No statistically significant differences ($\alpha = .05$) emerged among the groups for Proposition 86; the scores from each group were relatively similar: M(Video) = 4.27, M(Control) = 4.02, M(Print) = 3.58. The pairwise comparisons were as follows: Control : Print ($p = .749$), Control : Video ($p = 1.000$), and Print : Video ($p = .239$). Based on these findings, we reject H_1 . Unexpectedly, the control group rendered a higher score than the print advertisement; as such, we will review and revise the print advertisement prior to our next focus group.

For Proposition 99, the video group ($M = 5.56$) had the highest score, significantly outperforming the control group ($M = 2.84$, $p = .001$) and the print group ($M = 3.45$) ($p = .001$, $\alpha = .05$). Although the print score is higher than the control group, the difference is statistically insignificant ($p = .201$, $\alpha = .05$). Based on these findings, we reject H_0 and accept H_2 . Apparently, the best advertising media for Proposition 99 is video.

EXERCISE 7.9A

Data set: Ch 07 – Exercise 09A.sav

(a)

H_0 : Lighting source has no effect on reading rate or lighting satisfaction.

H_1 : Lighting source has an effect on reading rate.

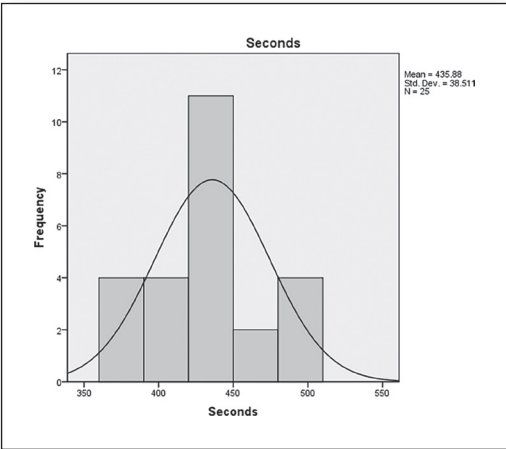
H_2 : Lighting source has an effect on lighting satisfaction.

(b)

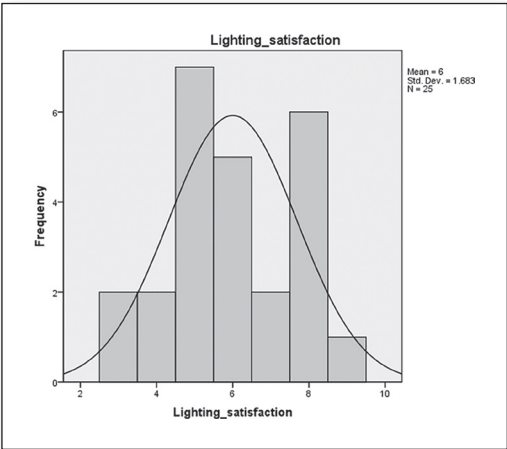
		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Room lighting	25	23.4	23.4	23.4
	Acme lamp	28	26.2	26.2	49.5
	Generic lamp	30	28.0	28.0	77.6
	Flashlight	24	22.4	22.4	100.0
	Total	107	100.0	100.0	

Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are slightly fewer than 30 in three of the groups. Since the histograms present normal distributions, the sample size criterion is considered satisfied.

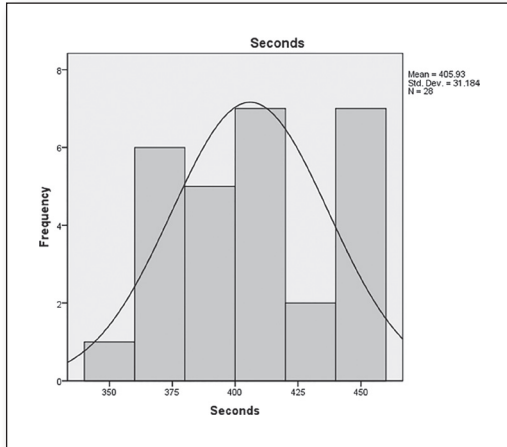
Histogram of *Seconds* for *Room lighting* (Group 1)



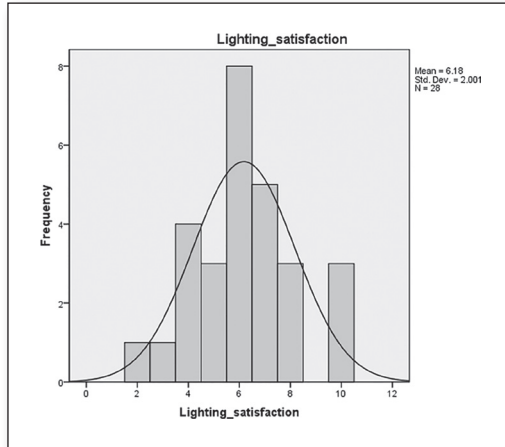
Histogram of *Lighting_satisfaction* for *Room lighting* (Group 1)



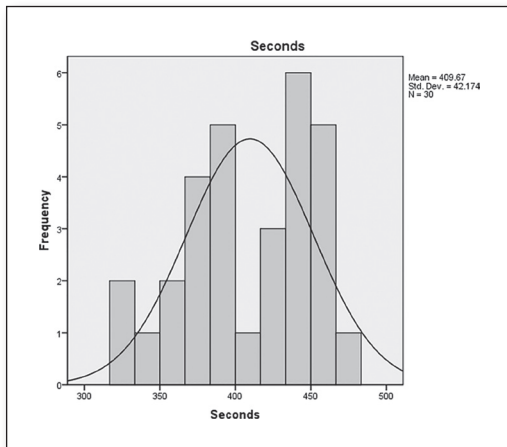
Histogram of *Seconds* for *Acme lamp* (Group 2)



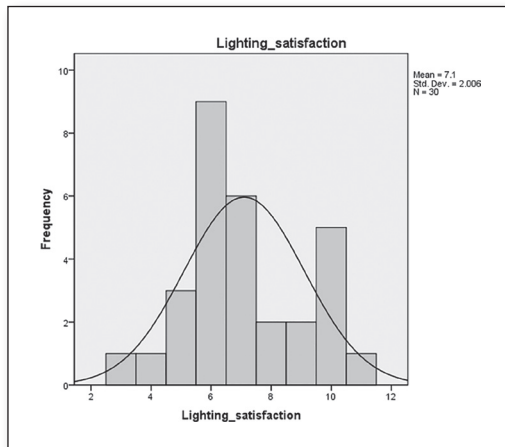
Histogram of *Lighting_satisfaction* for *Acme lamp* (Group 2)

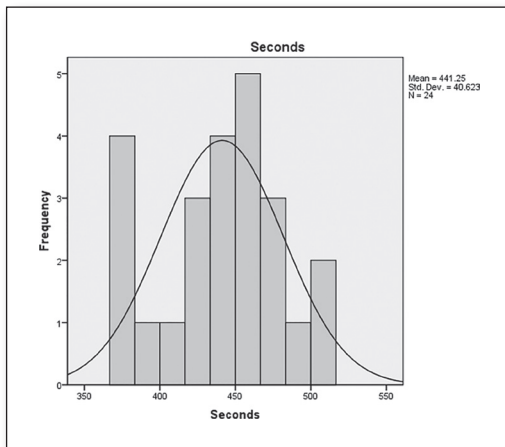
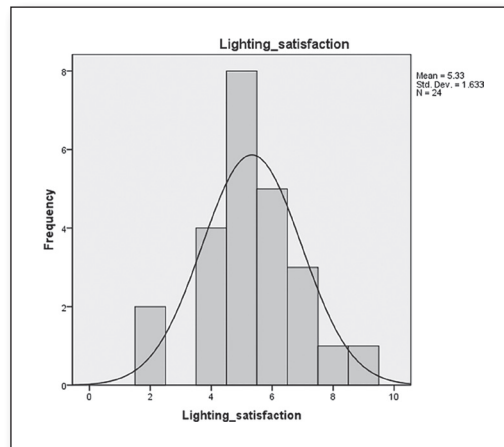


Histogram of *Seconds* for *Generic lamp* (Group 3)



Histogram of *Lighting_satisfaction* for *Generic lamp* (Group 3)



Histogram of *Seconds* for
Flashlight (Group 4)Histogram of *Lighting_satisfaction* for
Flashlight (Group 4)

Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations

		Seconds	Lighting_satisfaction
Seconds	Pearson Correlation	1	-.641**
	Sig. (2-tailed)		.000
	N	107	107
Lighting_satisfaction	Pearson Correlation	-.641**	1
	Sig. (2-tailed)	.000	
	N	107	107

**. Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is -.641; hence, the criterion of moderate correlation is satisfied.

Box's Test of Equality of Covariance Matrices^a

Box's M	8.026
F	.860
df1	9
df2	107443.502
Sig.	.560

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of .560; since this is greater than .001, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Seconds	1.499	3	103	.219
Lighting satisfaction	.565	3	103	.640

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test):

Levene's Test produced Sig. (p) values of .219 and .640; since both are greater than .05, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.997	15448.114 ^a	2.000	102.000	.000
	Wilks' Lambda	.003	15448.114 ^a	2.000	102.000	.000
	Hotelling's Trace	302.904	15448.114 ^a	2.000	102.000	.000
	Roy's Largest Root	302.904	15448.114 ^a	2.000	102.000	.000
Group	Pillai's Trace	.224	4.331	6.000	206.000	.000
	Wilks' Lambda	.787	4.314 ^a	6.000	204.000	.000
	Hotelling's Trace	.255	4.297	6.000	202.000	.000
	Roy's Largest Root	.169	5.790 ^b	3.000	103.000	.001

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (p) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Group					
Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Seconds	Room lighting	435.880	7.667	420.673	451.087
	Acme lamp	405.929	7.245	391.560	420.298
	Generic lamp	409.667	6.999	395.785	423.548
	Flashlight	441.250	7.826	425.730	456.770
Lighting_satisfaction	Room lighting	6.000	.371	5.265	6.735
	Acme lamp	6.179	.350	5.484	6.874
	Generic lamp	7.100	.339	6.429	7.771
	Flashlight	5.333	.378	4.583	6.084

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Seconds	Room lighting	Acme lamp	29.95	10.549	.033	1.57	58.33
		Generic lamp	26.21	10.382	.079	-1.72	54.14
		Flashlight	-5.37	10.956	1.000	-34.84	24.10
	Acme lamp	Room lighting	-29.95	10.549	.033	-58.33	-1.57
		Generic lamp	-3.74	10.074	1.000	-30.84	23.36
		Flashlight	-35.32	10.665	.008	-64.01	-6.63
	Generic lamp	Room lighting	-26.21	10.382	.079	-54.14	1.72
		Acme lamp	3.74	10.074	1.000	-23.36	30.84
		Flashlight	-31.58	10.499	.020	-59.83	-3.34
	Flashlight	Room lighting	5.37	10.956	1.000	-24.10	34.84
		Acme lamp	35.32	10.665	.008	6.63	64.01
		Generic lamp	31.58	10.499	.020	3.34	59.83
Lighting_satisfaction	Room lighting	Acme lamp	-.18	.510	1.000	-1.55	1.19
		Generic lamp	-1.10	.502	.184	-2.45	.25
		Flashlight	.67	.530	1.000	-.76	2.09
	Acme lamp	Room lighting	.18	.510	1.000	-1.19	1.55
		Generic lamp	-.92	.487	.369	-2.23	.39
		Flashlight	.85	.516	.626	-.54	2.23
	Generic lamp	Room lighting	1.10	.502	.184	-.25	2.45
		Acme lamp	.92	.487	.369	-.39	2.23
		Flashlight	1.77	.508	.004	.40	3.13
	Flashlight	Room lighting	-.67	.530	1.000	-2.09	.76
		Acme lamp	-.85	.516	.626	-2.23	.54
		Generic lamp	-1.77	.508	.004	-3.13	-.40

Based on observed means.

The error term is Mean Square(Error) = 3.438.

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

Drawing the means from the *Group* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

	Group Comparisons	<i>p</i>
Seconds	Room lighting (M = 436) : Acme lamp (M = 406)	.033*
Seconds	Room lighting (M = 436) : Generic lamp (M = 410)	.079
Seconds	Room lighting (M = 436) : Flashlight (M = 441)	1.000
Seconds	Acme lamp (M = 406) : Generic lamp (M = 410)	1.000
Seconds	Acme lamp (M = 406) : Flashlight (M = 441)	.008*
Seconds	Generic lamp (M = 410) : Flashlight (M = 441)	.020*
Lighting satisfaction	Room lighting (M = 6.0) : Acme lamp (M = 6.2)	1.000
Lighting satisfaction	Room lighting (M = 6.0) : Generic lamp (M = 7.1)	.184
Lighting satisfaction	Room lighting (M = 6.0) : Flashlight (M = 5.3)	1.000
Lighting satisfaction	Acme lamp (M = 6.2) : Generic lamp (M = 7.1)	.369
Lighting satisfaction	Acme lamp (M = 6.2) : Flashlight (M = 5.3)	.626
Lighting satisfaction	Generic lamp (M = 7.1) : Flashlight (M = 5.3)	.004*

*Statistically significant ($p < .05$).

Based on these results, I would reject H_0 and accept H_1 and H_2 .

(d)

We divided 107 participants into four groups to discover if the lighting source had an effect how long it took them to read a 1,000-word essay and their satisfaction with the lighting source.

The mean reading times were as follows (from shortest to longest read times): Acme lamp (M = 406 seconds), Generic lamp (M = 410 seconds), room lighting (M = 436 seconds), and Flashlight (M = 441 seconds). Participants who read by the Acme lamp completed the reading significantly sooner than those who read by room lighting ($p = .033$, $\alpha = .05$) and those who read by flashlight ($p = .008$, $\alpha = .05$). Additionally, those who read by the generic lamp significantly outperformed those who read by flashlight ($p = .020$, $\alpha = .05$). Per these findings, we reject H_0 and accept H_1 .

We also measured lighting satisfaction using a 10 point scale: Generic lamp (M = 7.1), Acme lamp (M = 6.2), Room lighting (M = 6.0), and Flashlight (M = 5.3). Pairwise comparisons revealed that participants scored the generic reading lamp as significantly better than the flashlight ($p = .004$, $\alpha = .05$). All other group comparisons rendered statistically insignificant *p* values ranging from .184 to 1.000 ($\alpha = .05$). Based on these findings, we accept H_2 .

EXERCISE 7.9B

Data set: Ch 07 – Exercise 09B.sav

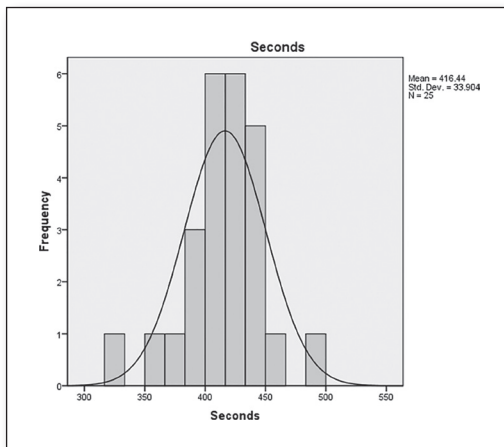
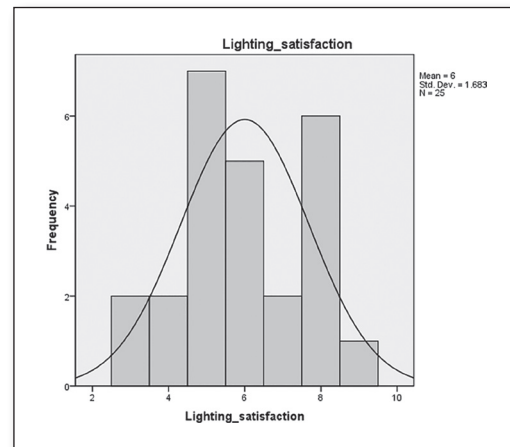
(a)

 H_0 : Lighting source has no effect on reading rate or lighting satisfaction. H_1 : Lighting source has an effect on reading rate. H_2 : Lighting source has an effect on lighting satisfaction.

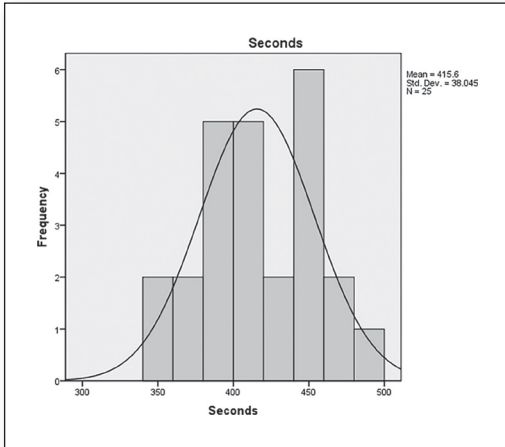
(b)

		Group			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Room lighting	25	25.0	25.0	25.0
	Acme lamp	25	25.0	25.0	50.0
	Generic lamp	25	25.0	25.0	75.0
	Flashlight	25	25.0	25.0	100.0
	Total	100	100.0	100.0	

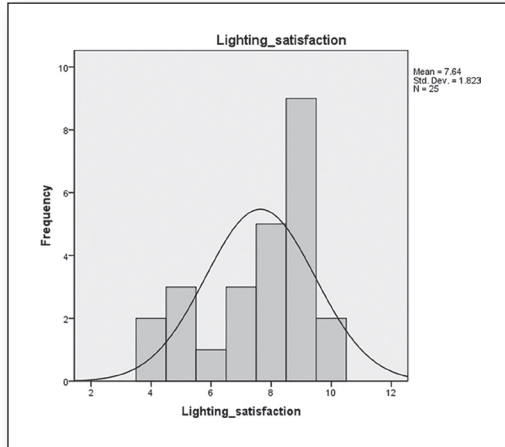
Pretest Checklist Criterion 1 – Sample size: The *Frequency* (n) column of this table shows that there are less than 30 per group; since the histograms show a predominate normal distribution, the sample size is considered satisfactory.

Histogram of *Seconds* for *Room lighting* (Group 1)Histogram of *Lighting_satisfaction* for *Room lighting* (Group 1)

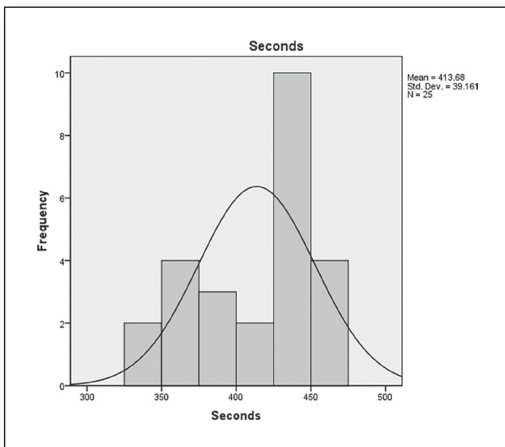
Histogram of *Seconds* for *Acme lamp* (Group 2)



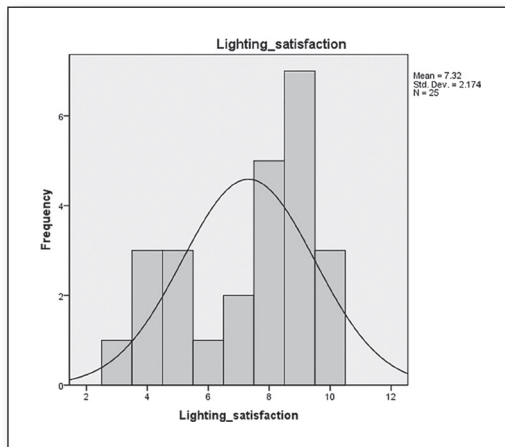
Histogram of *Lighting_satisfaction* for *Acme lamp* (Group 2)



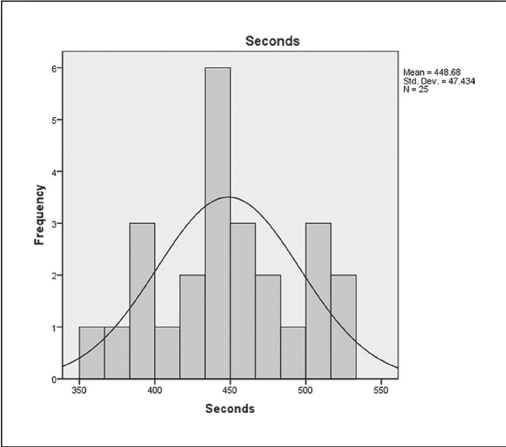
Histogram of *Seconds* for *Generic lamp* (Group 3)



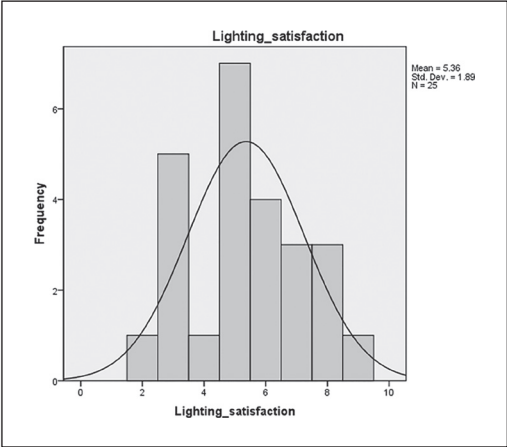
Histogram of *Lighting_satisfaction* for *Generic lamp* (Group 3)



Histogram of *Seconds* for
Flashlight (Group 4)



Histogram of *Lighting_satisfaction* for
Flashlight (Group 4)



Pretest Checklist Criterion 2 – Normality: All of the histograms with normal curves for the variables involved show normal distribution; hence, the criterion of normality is satisfied.

Correlations			
		Seconds	Lighting_satisfaction
Seconds	Pearson Correlation	1	-.501**
	Sig. (2-tailed)		.000
	N	100	100
Lighting_satisfaction	Pearson Correlation	-.501**	1
	Sig. (2-tailed)	.000	
	N	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

Pretest Checklist Criterion 3 – Moderate correlation: The Pearson correlation between the outcome variables is $-.501$; it would be preferable if this figure were between $-.3$ and $-.9$ but this result is close to $-.3$.

Box's Test of Equality of Covariance Matrices^a

Box's M	11.015
F	1.178
df1	9
df2	105613.582
Sig.	.304

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 4 – Homogeneity of variance-covariance (Box's M Test): Box's M Test produced a Sig. (p) of $.304$; since this is greater than $.001$, this indicates that there is no statistically significant difference among the variance-covariance of the variables; hence, this criterion is satisfied.

Levene's Test of Equality of Error Variances^a

	F	df1	df2	Sig.
Seconds	1.163	3	96	.328
Lighting satisfaction	.731	3	96	.536

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group

Pretest Checklist Criterion 5 – Homogeneity of variance (Levene's test):

Levene's Test produced Sig. (p) values of $.328$ and $.536$; since both are greater than $.05$, this indicates that no statistically significant differences have been detected in the variances among the variables; hence, this criterion is satisfied.

(c)

Multivariate Tests ^c						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.995	10282.297 ^a	2.000	95.000	.000
	Wilks' Lambda	.005	10282.297 ^a	2.000	95.000	.000
	Hotelling's Trace	216.469	10282.297 ^a	2.000	95.000	.000
	Roy's Largest Root	216.469	10282.297 ^a	2.000	95.000	.000
Group	Pillai's Trace	.372	7.323	6.000	192.000	.000
	Wilks' Lambda	.657	7.407 ^a	6.000	190.000	.000
	Hotelling's Trace	.478	7.489	6.000	188.000	.000
	Roy's Largest Root	.351	11.238 ^b	3.000	96.000	.000

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai's Trace produced a Sig. (p) of .000 for *Group*; since this is less than .05, this indicates that a statistically significant difference has been detected among the groups; for specifics as to which group(s) performed different from which, we look to the Multiple Comparisons table.

Dependent Variable		Group		95% Confidence Interval	
		Mean	Std. Error	Lower Bound	Upper Bound
Seconds	Room lighting	416.440	7.988	400.584	432.296
	Acme lamp	415.600	7.988	399.744	431.456
	Generic lamp	413.680	7.988	397.824	429.536
	Flashlight	448.680	7.988	432.824	464.536
Lighting_satisfaction	Room lighting	5.000	.413	4.181	5.819
	Acme lamp	7.640	.413	6.821	8.459
	Generic lamp	7.320	.413	6.501	8.139
	Flashlight	5.360	.413	4.541	6.179

Multiple Comparisons							
Bonferroni							
Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Seconds	Room lighting	Acme lamp	.84	11.296	1.000	-29.59	31.27
		Generic lamp	2.76	11.296	1.000	-27.67	33.19
		Flashlight	-32.24 [*]	11.296	.032	-62.67	-1.81
	Acme lamp	Room lighting	-.84	11.296	1.000	-31.27	29.59
		Generic lamp	1.92	11.296	1.000	-28.51	32.35
		Flashlight	-33.08 [*]	11.296	.026	-63.51	-2.65
	Generic lamp	Room lighting	-2.76	11.296	1.000	-33.19	27.67
		Acme lamp	-1.92	11.296	1.000	-32.35	28.51
		Flashlight	-35.00 [*]	11.296	.015	-65.43	-4.57
	Flashlight	Room lighting	32.24	11.296	.032	1.81	62.67
		Acme lamp	33.08 [*]	11.296	.026	2.65	63.51
		Generic lamp	35.00 [*]	11.296	.015	4.57	65.43
Lighting_satisfaction	Room lighting	Acme lamp	-2.64	.584	.000	-4.21	-1.07
		Generic lamp	-2.32	.584	.001	-3.89	-.75
		Flashlight	-.36	.584	1.000	-1.93	1.21
	Acme lamp	Room lighting	2.64	.584	.000	1.07	4.21
		Generic lamp	.32	.584	1.000	-1.25	1.89
		Flashlight	2.28 [*]	.584	.001	.71	3.85
	Generic lamp	Room lighting	2.32	.584	.001	.75	3.89
		Acme lamp	-.32	.584	1.000	-1.89	1.25
		Flashlight	1.96 [*]	.584	.007	.39	3.53
	Flashlight	Room lighting	.36	.584	1.000	-1.21	1.93
		Acme lamp	-2.28 [*]	.584	.001	-3.85	-.71
		Generic lamp	-1.96 [*]	.584	.007	-3.53	-.39

Based on observed means.

The error term is Mean Square(Error) = 4.260.

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

Drawing the means from the *Group* table and the *p* values from the Sig. column on the *Multiple Comparisons* table, the following table summarizes the results of this MANOVA:

	Group Comparisons	<i>p</i>
Seconds	Room lighting (M = 416) : Acme lamp (M = 416)	1.000
Seconds	Room lighting (M = 416) : Generic lamp (M = 414)	1.000
Seconds	Room lighting (M = 416) : Flashlight (M = 449)	.032*
Seconds	Acme lamp (M = 416) : Generic lamp (M = 414)	1.000
Seconds	Acme lamp (M = 416) : Flashlight (M = 449)	.026*
Seconds	Generic lamp (M = 414) : Flashlight (M = 449)	.015*
Lighting satisfaction	Room lighting (M = 5.0) : Acme lamp (M = 7.6)	.000*
Lighting satisfaction	Room lighting (M = 5.0) : Generic lamp (M = 7.3)	.001*
Lighting satisfaction	Room lighting (M = 5.0) : Flashlight (M = 5.4)	1.000
Lighting satisfaction	Acme lamp (M = 7.6) : Generic lamp (M = 7.3)	1.000
Lighting satisfaction	Acme lamp (M = 7.6) : Flashlight (M = 5.4)	.001*
Lighting satisfaction	Generic lamp (M = 7.3) : Flashlight (M = 5.4)	.007*

*Statistically significant ($p < .05$).

Based on these results, I would reject H_0 and accept H_1 and H_2 .

(d)

We divided 100 participants into four groups to discover if the lighting source had an effect how long it took them to read a 1,000-word essay and their satisfaction with the lighting source.

The mean reading times were as follows (from shortest to longest read times): Generic lamp (M = 414 seconds), Acme lamp (M = 416 seconds), Room lighting (M = 416 seconds), and Flashlight (M = 449 seconds). Participants who read using the flashlight took significantly longer to read the essay compared to the other 3 groups; pairwise *p* values range from .015 to .032 ($\alpha = .05$). No other statistically significant differences in reading times were detected among the other groups ($p = 1.000$, $\alpha = .05$). Per these findings, we reject H_0 and accept H_1 .

We also measured lighting satisfaction using a 10 point scale: Acme lamp (M = 7.6), Generic lamp (M = 7.3), Flashlight (M = 5.4), and Room lighting (M = 5.0). Pairwise comparisons revealed that participants scored Acme lamp and the generic lamp significantly higher than room lighting ($p < .001$ and $p = .001$ respectively, $\alpha = .05$). Additionally, participants significantly favored the Acme lamp and generic lamp over the flashlight ($p = .001$ and $p = .007$ respectively, $\alpha = .05$). All other group comparisons rendered statistically insignificant differences ($p = 1.000$, $\alpha = .05$). Based on these findings, we accept H_2 .