SAS Tutorial for STAT 350 Lab 8

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Example 1: (Data Set: eduproduct.txt)

Evaluation of a New Educational Product Your company markets educational materials aimed at parents of young children. You are planning a new product that is designed to improve children's reading comprehension. Your product is based on new ideas from educational research, and you would like to claim that children will acquire better reading comprehension skills utilizing these new ideas than with the traditional approach. Your marketing material will include the results of a study conducted to compare two versions of the new approach with the traditional method. The standard method is called Basal, and the two variations of the new method are called DRTA and Strat.

Education researchers randomly divided 66 children into three groups of 22. Each group was taught by one of the three methods. The response variable is a measure of reading comprehension called COMP that was obtained by a test taken after the instruction was completed.

a) Make side-by-side boxplots and an effects plot of the data. Also, make a table giving the sample size, mean, and standard deviation for each treatment group. From this information, do you think that all of the means are the same? Be sure to comment on each of the plots.

b) Examine the assumptions necessary for ANOVA. Is it appropriate to continue the analysis? Be sure to state each of the assumptions and comment on each of them using the appropriate plots/data. Remember, you need to generate the normal probability plots and histograms for each population.

c) Report the results of the ANOVA significance test (4 steps) using a significance level of 0.05. Are your results in this step consistent with part a?

d) Use an appropriate multiple-comparison method to determine if the different types of educational methods affects reading comprehension. Explain why you chose this method. Present a graphical representation of the results if appropriate for your method. Write a short statement for your conclusion.

e) Write a short report explaining the effect of this study. Be sure to answer the question posed in this question and how far this study can be generalized. This paragraph should be written in complete English sentences and should be understandable to someone who has not taken a course in Statistics.

Solution:

```
data ed;
  infile 'W:\PC-Text\eduproduct.txt' firstobs = 2 delimiter = '09'x;
  input Subject Group$ Comp;
run;

proc print data = ed; run;

*effects plot and table of means and standard deviations;

proc sort data = ed; *again the data needs to be sorted
  the result is that the groups are alphabetized;
  by Group;
run;
```

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```
proc means data=ed; *first calculate the averages;
  var Comp; *response variable;
  by Group;  *categorical variable;
  output out=means mean=average;
  *create a file named means which has the means;
run;

symbol1 v=dot i=join; *to make the effects plot 'pretty';
proc gplot data=means;
  plot average*Group; *y = means, x = factor;
run;

*side-by-side boxplots are included automatically in the output, this
 time, we need to create the histograms and QQplots manually;

proc sgplot data=ed;
  By Group; *to print out the histograms for each of the groups;
  histogram Comp;
  density Comp; *this adds the normal density curve;
  density Comp/type=kernel; *this adds the smoothed density curve;
run;

proc univariate data=ed noprint; *noprint: only thing printed are the
  requested graphs;
  By Group; *to print out the QQplots for each of the groups;
  QQplot Comp/normal (mu=est sigma=est);
run;

proc glm data=ed alpha=0.05;
  *glm stands for generalized linear model;
  class Group; *categorical variable;
  model Comp = Group; *response variable = categorical variable;
*In your lab report, choose only one of the two options;
  means Group /Tukey lines; *multicomparisons;
  means Group /Tukey cldiff; *provides the CI of the pairs;
run;
```

a) Make side-by-side boxplots and an effects plot of the data. Also, make a table giving the sample size, mean, and standard deviation for each treatment group. From this information, do you think that all of the means are the same? Be sure to comment on each of the plots.

Solution:

Note: The side-by-side boxplots are from proc glm. The rest of the information needs to be generated manually.

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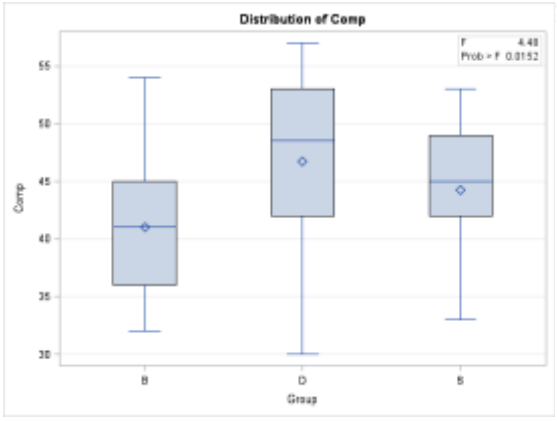
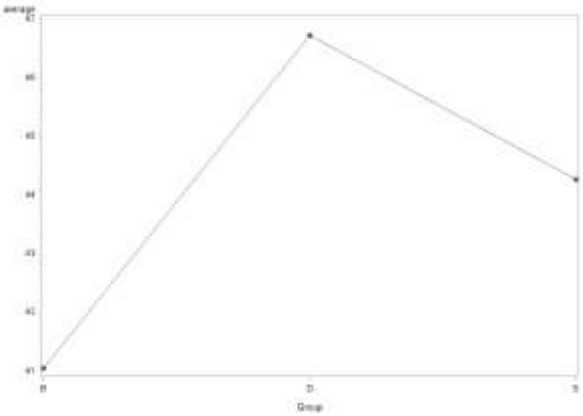


From this plot, I would state that all of the means are close to being the same.



From the effects plot, it looks like B might be different from D and S, but it is hard to tell because of the scale.

The MEANS Procedure

Group=B

Analysis Variable : Comp				
N	Mean	Std Dev	Minimum	Maximum
22	41.0454545	5.6355781	32.0000000	54.0000000

Group=D

Analysis Variable : Comp				
N	Mean	Std Dev	Minimum	Maximum
22	46.7272727	7.3884196	30.0000000	57.0000000

Group=S

Analysis Variable : Comp				
N	Mean	Std Dev	Minimum	Maximum
22	44.2727273	5.7667505	33.0000000	53.0000000

Group	n	sample mean	sample standard deviation
B	22	41.0454545	5.6355781
D	22	46.7272727	7.3884196
S	22	44.27272727	5.7667505

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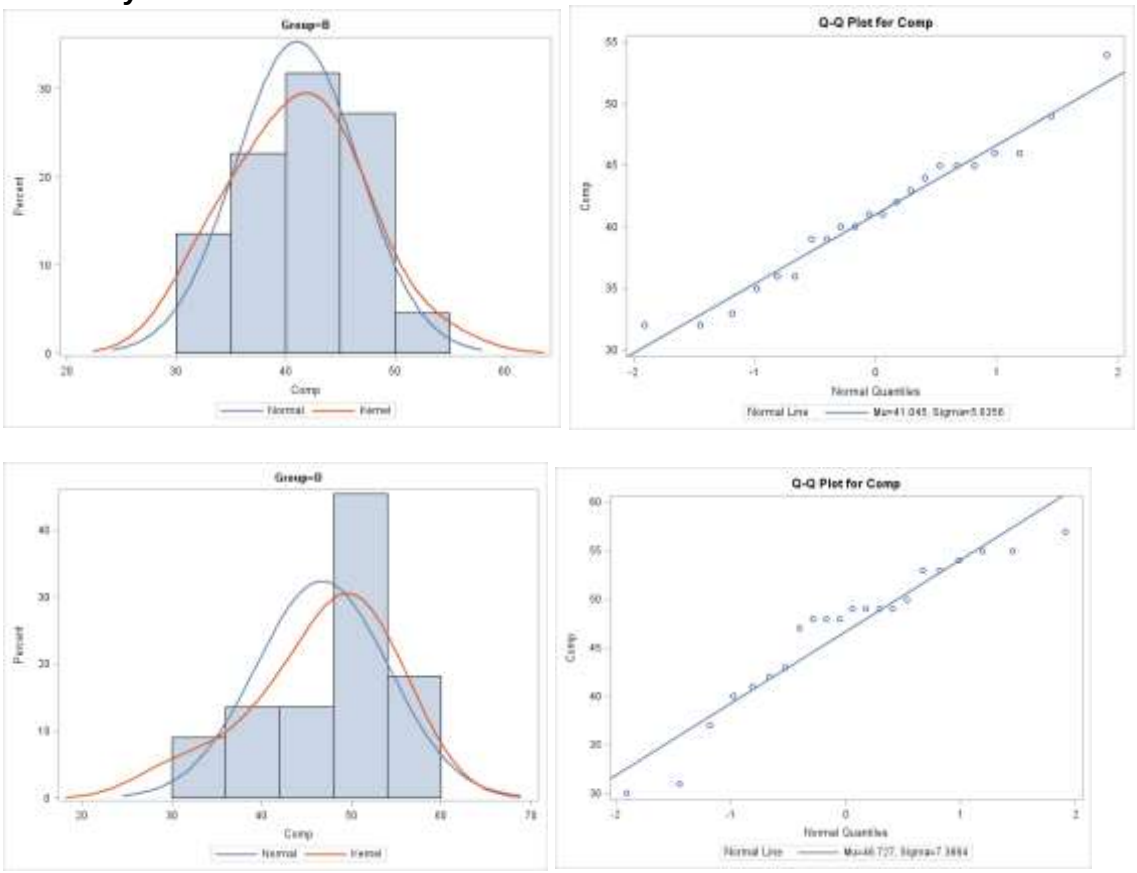
It appears group D is higher than the other two. Inference needs to be determine, both (c) and (d) to determine if the impressions are correct or not.

b) Examine the assumptions necessary for ANOVA. Is it appropriate to continue the analysis? Be sure to state each of the assumptions and comment on each of them using the appropriate plots/data. Remember, you need to generate the normal probability plots and histograms for each population.

Solution:

Normality:



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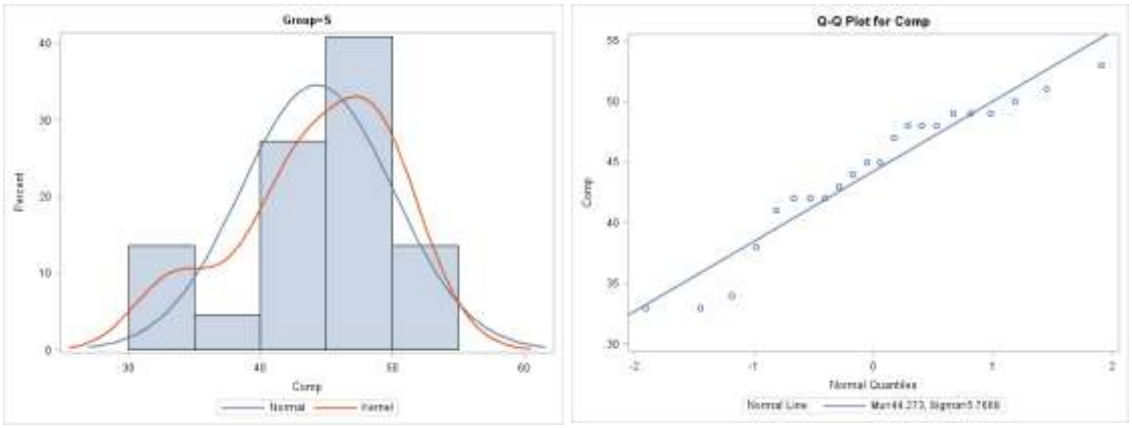

With a sample size of 22 *3 = 66, these distributions are close enough to being normal.

Constant standard deviation

Group	n	sample mean	sample standard deviation
B	22	41.0454545	5.6355781
D	22	46.7272727	7.3884196
S	22	44.27272727	5.7667505

$$\frac{s_{max}}{s_{min}} = \frac{7.3884196}{5.6355781} = 1.31 < 2$$

Therefore the constant standard deviation assumption is valid.

c) Report the results of the ANOVA significance test (4* steps) using a significance level of 0.05. Are your results in this step consistent with part a?

Solution:

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	357.303030	178.651515	4.48	0.0152
Error	63	2511.681818	39.867965		
Corrected Total	65	2868.984848			

R-Square	Coeff Var	Root MSE	Comp Mean
0.124540	14.34531	6.314108	44.01515

Step 1: Definition of the terms

μ_B is the population mean COMP score for the Basal method.
μ_D is the population mean COMP score for the DRTA method.
μ_S is the population mean COMP score for the Strat method.

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Step 2: State the hypotheses
H_0: $\mu_B = \mu_D = \mu_S$
H_a: at least two μ_i's are different.

Step 3: Find the *Test Statistic*, *p-value, report DF:*

$F_{ts} = 4.48$
DF1 = 2, DF2 = 63
P-value = 0.0152

Step 4: Conclusion:
$\alpha = 0.05$
Since 0.0152 < 0.05, we should reject H_0

The data provides sufficiently strong evidence (P-value = 0.0152) to the claim that the population mean values of at least one of the education methods is different from the rest.

d) Use an appropriate multiple-comparison method to determine if the different types of educational methods affects reading comprehension. Explain why you chose this method. Present a graphical representation of the results if appropriate for your method. Write a short statement on your conclusion.

Solution:

The Tukey method was chosen because we want to compare all of the means in a pairwise fashion.

From the first 'means' statement

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Tukey's Studentized Range (HSD) Test for Comp

Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	63
Error Mean Square	39.86797
Critical Value of Studentized Range	3.39448
Minimum Significant Difference	4.5696

Means with the same letter are not significantly different.

Tukey Grouping		Mean	N	Group
	A	46.727	22	D
	A			
B	A	44.273	22	S
B				
B		41.045	22	B

From means statement with 'cldiff' line

Comparisons significant at the 0.05 level are indicated by ***.

Group Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
D - S	2.455	-2.115	7.024	
D - B	5.682	1.112	10.251	***
S - D	-2.455	-7.024	2.115	
S - B	3.227	-1.342	7.797	
B - D	-5.682	-10.251	-1.112	***
B - S	-3.227	-7.797	1.342	

What is included in the **red box** is the only output that needs to be presented. So not include both statements in your lab report.

I consider the above table with A/B to be the graphical representation.
What both of these tables tell us that methods D and S are the same and methods S and B are the same. Therefore the best method would be D and/or S.

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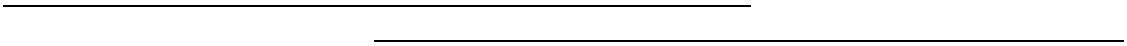
How to do the graphical representation by hand:

This is easily seen using the following procedure:
1) Order the means in descending (or ascending order)
2) Draw a line when the groups are the same:

D (46.727) S (44.273) B (41.045)



e) Write a short report explaining the effect of this study. Be sure to answer the question posed in this question and how far this study can be generalized. This paragraph should be written in complete English sentences and should be understandable to someone who has not taken a course in Statistics.

From the original question, we want to determine if the new methods D and S are better than the traditional method, B. We determined that our assumptions are correct therefore, we can look at the results of the study. These results show that method S is the same as method B (traditional method). However, it can be seen that method D is better than the original method.

When answering this question, you do need to know whether a better score or a worse score is better.