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## Balanced ANOVA

Balanced ANOVA  
Import data

Balanced ANOVA balance check

Balanced ANOVA balance check  
All studytime groups should have the same N after balancing

## Means

[BalancedANOVAData] D:\DATA ANALYSIS\E ANOVA Family\Balanced ANOVA\SPSS\_Output  
\sav\Balanced-ANOVA-data.sav

### Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
original_group_n * studytime	140	100.0%	0	0.0%	140	100.0%
balanced_group_n * studytime	140	100.0%	0	0.0%	140	100.0%
within_group_order * studytime	140	100.0%	0	0.0%	140	100.0%

### Report

studytime		original_group_n	balanced_group_n	within_group_order
1	N	35	35	35
	Mean	212.00	35.00	18.00000
	Minimum	212	35	1.000
	Maximum	212	35	35.000
2	N	35	35	35
	Mean	305.00	35.00	18.00000
	Minimum	305	35	1.000
	Maximum	305	35	35.000
3	N	35	35	35
	Mean	97.00	35.00	18.00000
	Minimum	97	35	1.000
	Maximum	97	35	35.000
4	N	35	35	35
	Mean	35.00	35.00	18.00000
	Minimum	35	35	1.000
	Maximum	35	35	35.000
Total	N	140	140	140
	Mean	162.25	35.00	18.00000

Balanced ANOVA balance check  
All studytime groups should have the same N after balancing

### Report

studytime	original_group_n	balanced_group_n	within_group_order
Minimum	35	35	1.000
Maximum	305	35	35.000

## Balanced ANOVA descriptives

Balanced ANOVA descriptives  
 Dependent variable G3 by balanced studytime groups

**Means**

**Case Processing Summary**

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
G3 * studytime	140	100.0%	0	0.0%	140	100.0%

**Report**

G3

studytime	N	Mean	Std. Deviation	Variance	Minimum	Maximum
1	35	12.23	2.315	5.358	7	18
2	35	13.14	1.768	3.126	10	17
3	35	12.89	1.967	3.869	8	16
4	35	13.06	3.038	9.232	6	19
Total	140	12.83	2.326	5.409	6	19

Balanced ANOVA: One-way ANOVA

Balanced ANOVA: One-way ANOVA  
 Classical one-way ANOVA after balancing group sizes

Oneway

Descriptives

G3

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
1	35	12.23	2.315	.391	11.43	13.02	7
2	35	13.14	1.768	.299	12.54	13.75	10
3	35	12.89	1.967	.332	12.21	13.56	8
4	35	13.06	3.038	.514	12.01	14.10	6
Total	140	12.83	2.326	.197	12.44	13.22	6

Descriptives

G3

	Maximum
1	18
2	17
3	16
4	19
Total	19

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
G3	Based on Mean	3.556	3	136	.016
	Based on Median	3.498	3	136	.017
	Based on Median and with adjusted df	3.498	3	119.834	.018
	Based on trimmed mean	3.620	3	136	.015

Balanced ANOVA: One-way ANOVA  
 Classical one-way ANOVA after balancing group sizes

**ANOVA**

G3

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18.000	3	6.000	1.112	.347
Within Groups	733.886	136	5.396		
Total	751.886	139			

**Post Hoc Tests**

**Multiple Comparisons**

Dependent Variable: G3

Tukey HSD

(I) studytime	(J) studytime	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.914	.555	.356	-2.36	.53
	3	-.657	.555	.638	-2.10	.79
	4	-.829	.555	.445	-2.27	.62
2	1	.914	.555	.356	-.53	2.36
	3	.257	.555	.967	-1.19	1.70
	4	.086	.555	.999	-1.36	1.53
3	1	.657	.555	.638	-.79	2.10
	2	-.257	.555	.967	-1.70	1.19
	4	-.171	.555	.990	-1.62	1.27
4	1	.829	.555	.445	-.62	2.27
	2	-.086	.555	.999	-1.53	1.36
	3	.171	.555	.990	-1.27	1.62

**Homogeneous Subsets**

Balanced ANOVA: One-way ANOVA  
Classical one-way ANOVA after balancing group sizes

**G3**

Tukey HSD<sup>a</sup>

studytime	N	Subset for alpha = 0.05 1
1	35	12.23
3	35	12.89
4	35	13.06
2	35	13.14
Sig.		.356

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.000.

Balanced ANOVA: GLM with effect size

Balanced ANOVA: GLM with effect size  
 Partial eta squared is shown through ETASQ output

## General Linear Model

### Between-Subjects Factors

		Value Label	N
studytime	1	Study time group 1	35
	2	Study time group 2	35
	3	Study time group 3	35
	4	Study time group 4	35

### Descriptive Statistics

Dependent Variable: G3

studytime	Mean	Std. Deviation	N
1	12.23	2.315	35
2	13.14	1.768	35
3	12.89	1.967	35
4	13.06	3.038	35
Total	12.83	2.326	140

### Levene's Test of Equality of Error Variances<sup>a,b</sup>

		Levene Statistic	df1	df2	Sig.
G3	Based on Mean	3.556	3	136	.016
	Based on Median	3.498	3	136	.017
	Based on Median and with adjusted df	3.498	3	119.834	.018
	Based on trimmed mean	3.620	3	136	.015

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

a. Dependent variable: G3

b. Design: Intercept + studytime

Balanced ANOVA: GLM with effect size  
 Partial eta squared is shown through ETASQ output

### Tests of Between-Subjects Effects

Dependent Variable: G3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.000 <sup>a</sup>	3	6.000	1.112	.347	.024
Intercept	23040.114	1	23040.114	4269.678	.000	.969
studytime	18.000	3	6.000	1.112	.347	.024
Error	733.886	136	5.396			
Total	23792.000	140				
Corrected Total	751.886	139				

a. R Squared = .024 (Adjusted R Squared = .002)

### Parameter Estimates

Dependent Variable: G3

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	13.057	.393	33.254	.000	12.281	13.834
[studytime=1]	-.829	.555	-1.492	.138	-1.927	.270
[studytime=2]	.086	.555	.154	.878	-1.012	1.184
[studytime=3]	-.171	.555	-.309	.758	-1.270	.927
[studytime=4]	0 <sup>a</sup>	.	.	.	.	.

### Parameter Estimates

Dependent Variable: G3

Parameter	Partial Eta Squared
Intercept	.890
[studytime=1]	.016
[studytime=2]	.000
[studytime=3]	.001
[studytime=4]	.

a. This parameter is set to zero because it is redundant.

Balanced ANOVA: Estimated marginal means

Balanced ANOVA: Estimated marginal means  
Studytime means from balanced sample

## General Linear Model

### Between-Subjects Factors

		Value Label	N
studytime	1	Study time group 1	35
	2	Study time group 2	35
	3	Study time group 3	35
	4	Study time group 4	35

### Descriptive Statistics

Dependent Variable: G3

studytime	Mean	Std. Deviation	N
1	12.23	2.315	35
2	13.14	1.768	35
3	12.89	1.967	35
4	13.06	3.038	35
Total	12.83	2.326	140

### Tests of Between-Subjects Effects

Dependent Variable: G3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.000 <sup>a</sup>	3	6.000	1.112	.347	.024
Intercept	23040.114	1	23040.114	4269.678	.000	.969
studytime	18.000	3	6.000	1.112	.347	.024
Error	733.886	136	5.396			
Total	23792.000	140				
Corrected Total	751.886	139				

a. R Squared = .024 (Adjusted R Squared = .002)

## Estimated Marginal Means

Balanced ANOVA: Estimated marginal means  
Studytime means from balanced sample

**Study time factor**

**Estimates**

Dependent Variable: G3

Study time factor	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	12.229	.393	11.452	13.005
2	13.143	.393	12.366	13.919
3	12.886	.393	12.109	13.662
4	13.057	.393	12.281	13.834

**Pairwise Comparisons**

Dependent Variable: G3

(I) Study time factor	(J) Study time factor	Mean Difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% Confidence ..
					Lower Bound
1	2	-.914	.555	.102	-2.012
	3	-.657	.555	.239	-1.755
	4	-.829	.555	.138	-1.927
2	1	.914	.555	.102	-.184
	3	.257	.555	.644	-.841
	4	.086	.555	.878	-1.012
3	1	.657	.555	.239	-.441
	2	-.257	.555	.644	-1.355
	4	-.171	.555	.758	-1.270
4	1	.829	.555	.138	-.270
	2	-.086	.555	.878	-1.184
	3	.171	.555	.758	-.927

Balanced ANOVA: Estimated marginal means  
Studytime means from balanced sample

**Pairwise Comparisons**

Dependent Variable: G3

(I) Study time factor	(J) Study time factor	95% Confidence Interval for <sup>a</sup> ..
		Upper Bound
1	2	.184
	3	.441
	4	.270
2	1	2.012
	3	1.355
	4	1.184
3	1	1.755
	2	.841
	4	.927
4	1	1.927
	2	1.012
	3	1.270

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

**Univariate Tests**

Dependent Variable: G3

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Contrast	18.000	3	6.000	1.112	.347	.024
Error	733.886	136	5.396			

The F tests the effect of Study time factor. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

## Balanced ANOVA: Residual diagnostics

Balanced ANOVA: Residual diagnostics  
 Save predicted values and residuals for checking assumptions

## General Linear Model

### Between-Subjects Factors

		Value Label	N
studytime	1	Study time group 1	35
	2	Study time group 2	35
	3	Study time group 3	35
	4	Study time group 4	35

### Tests of Between-Subjects Effects

Dependent Variable: G3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	18.000 <sup>a</sup>	3	6.000	1.112	.347
Intercept	23040.114	1	23040.114	4269.678	.000
studytime	18.000	3	6.000	1.112	.347
Error	733.886	136	5.396		
Total	23792.000	140			
Corrected Total	751.886	139			

a. R Squared = .024 (Adjusted R Squared = .002)

## Balanced ANOVA: Residual normality

Balanced ANOVA: Residual normality  
Histogram, boxplot, and normal probability plot of residuals

## Explore

### Case Processing Summary

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
RES_1	140	100.0%	0	0.0%	140	100.0%

### Descriptives

		Statistic	Std. Error
RES_1	Mean	.0000	.19420
	95% Confidence Interval for Mean		
	Lower Bound	-.3840	
	Upper Bound	.3840	
	5% Trimmed Mean	-.0213	
	Median	-.1429	
	Variance	5.280	
	Std. Deviation	2.29777	
	Minimum	-7.06	
	Maximum	5.94	
	Range	13.00	
	Interquartile Range	2.34	
	Skewness	.130	.205
	Kurtosis	.340	.407

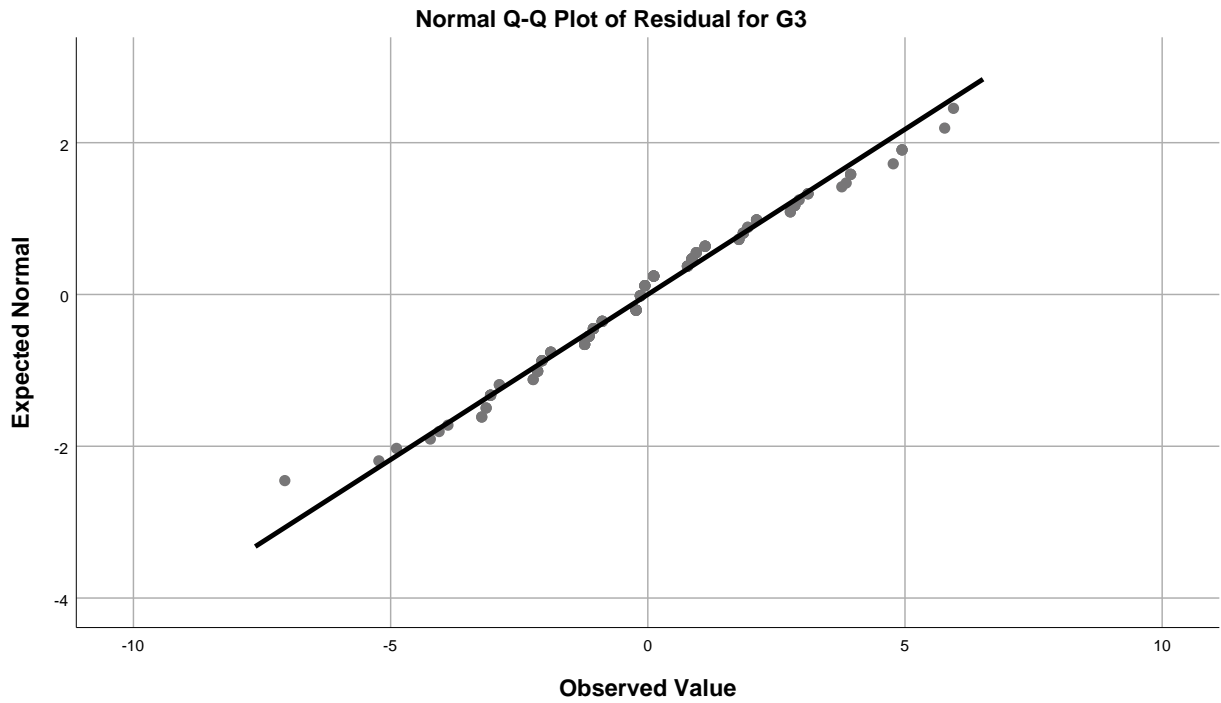
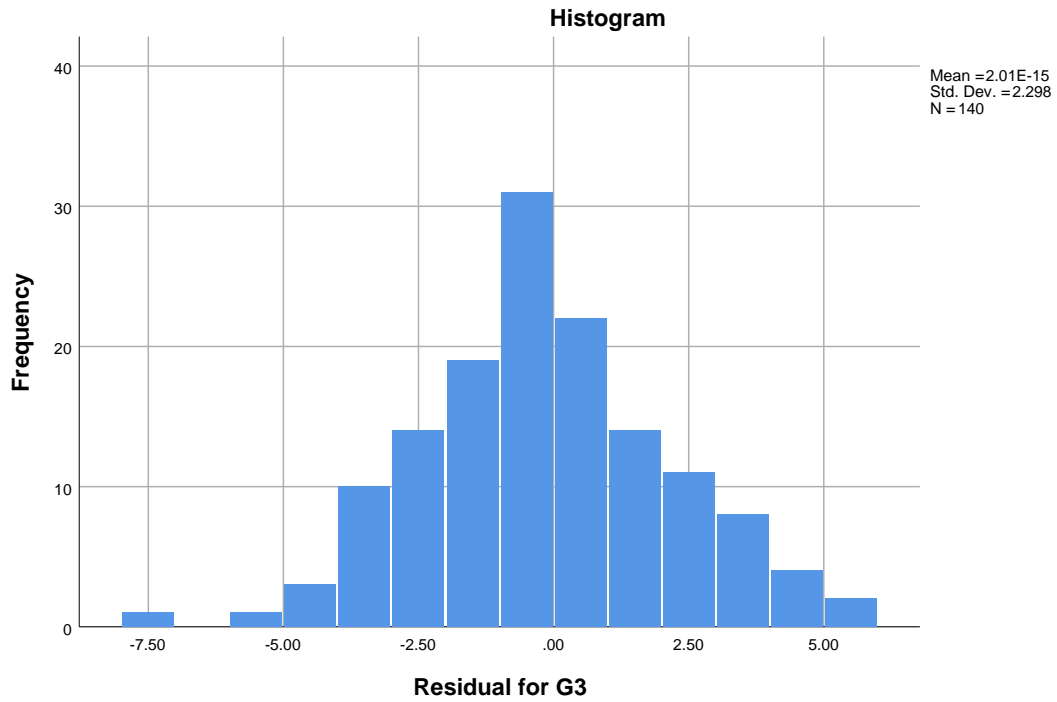
### Tests of Normality

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RES_1	.109	140	.000	.986	140	.154

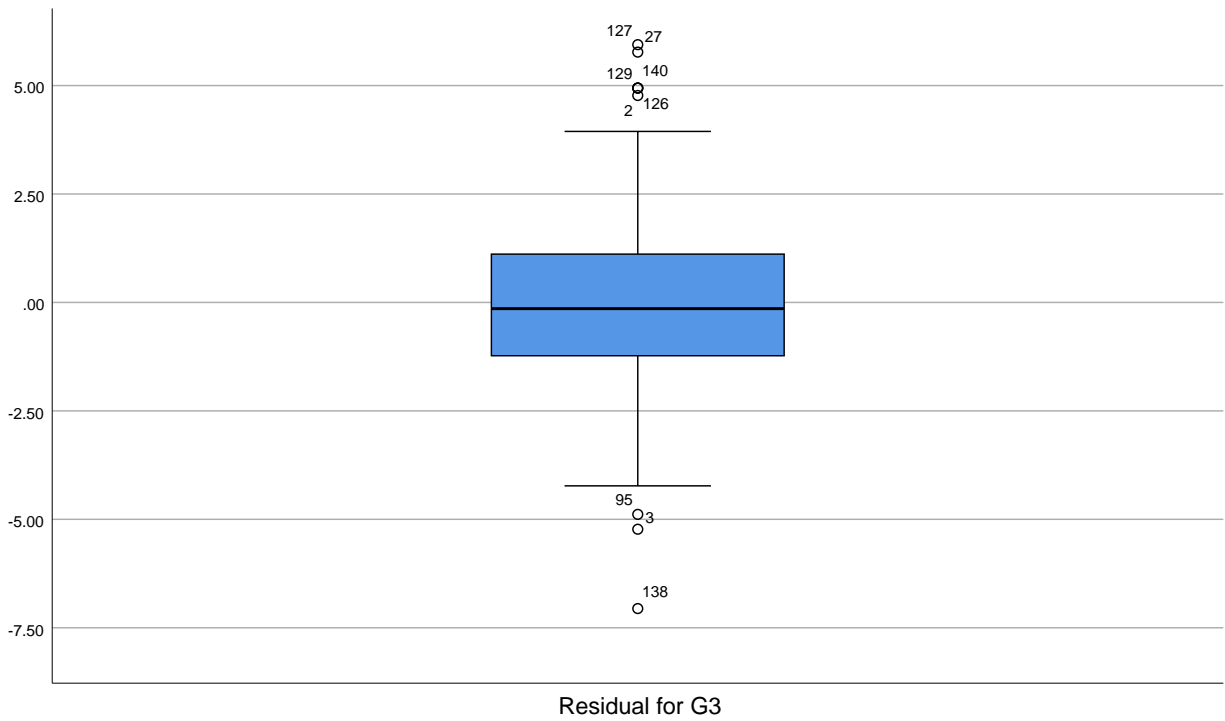
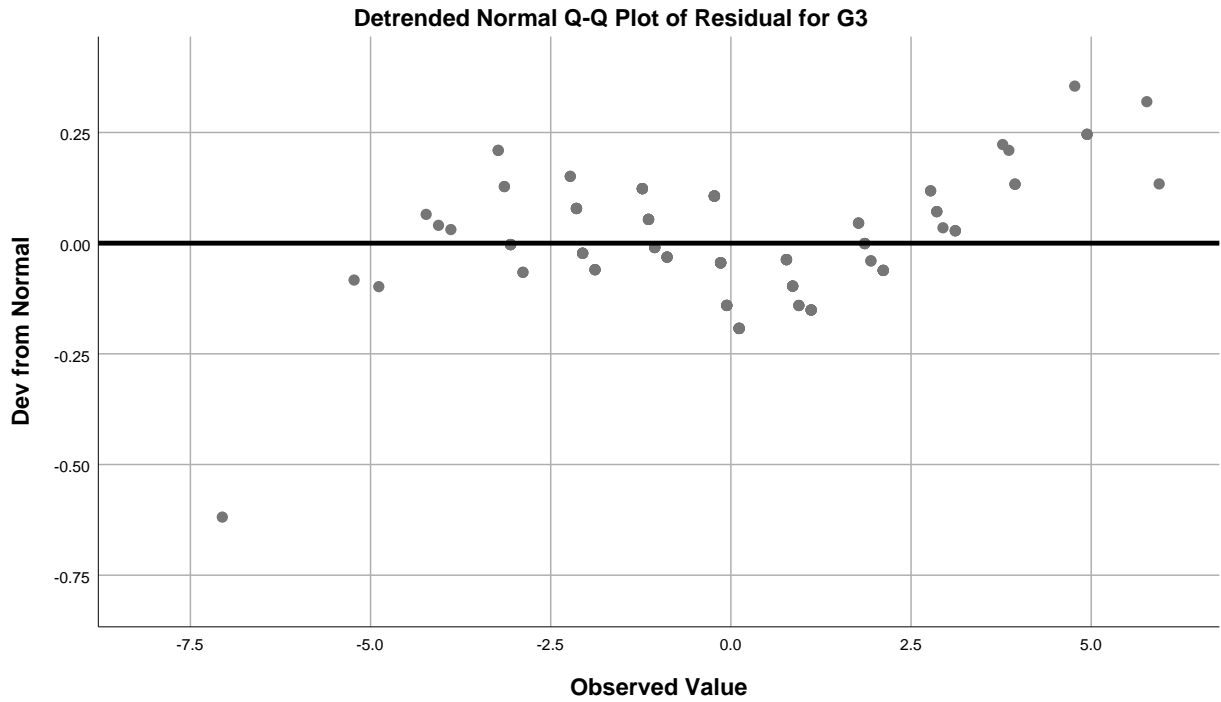
a. Lilliefors Significance Correction

## Residual for G3

Balanced ANOVA: Residual normality  
Histogram, boxplot, and normal probability plot of residuals



Balanced ANOVA: Residual normality  
Histogram, boxplot, and normal probability plot of residuals



## Balanced ANOVA: Group boxplot

Balanced ANOVA: Group boxplot  
 Boxplot of G3 by balanced studytime group

Explore

Study time factor

Case Processing Summary

	studytime	Valid		Cases Missing		Total	
		N	Percent	N	Percent	N	Percent
G3	1	35	100.0%	0	0.0%	35	100.0%
	2	35	100.0%	0	0.0%	35	100.0%
	3	35	100.0%	0	0.0%	35	100.0%
	4	35	100.0%	0	0.0%	35	100.0%

Descriptives

studytime		Statistic	Std. Error		
G3	1	Mean	12.23	.391	
		95% Confidence Interval for Mean	Lower Bound	11.43	
			Upper Bound	13.02	
		5% Trimmed Mean	12.20		
		Median	12.00		
		Variance	5.358		
		Std. Deviation	2.315		
		Minimum	7		
		Maximum	18		
		Range	11		
		Interquartile Range	2		
		Skewness	.248	.398	
		Kurtosis	.780	.778	
		2	2	Mean	13.14
95% Confidence Interval for Mean	Lower Bound			12.54	
	Upper Bound			13.75	
5% Trimmed Mean	13.13				
Median	13.00				
Variance	3.126				
Std. Deviation	1.768				

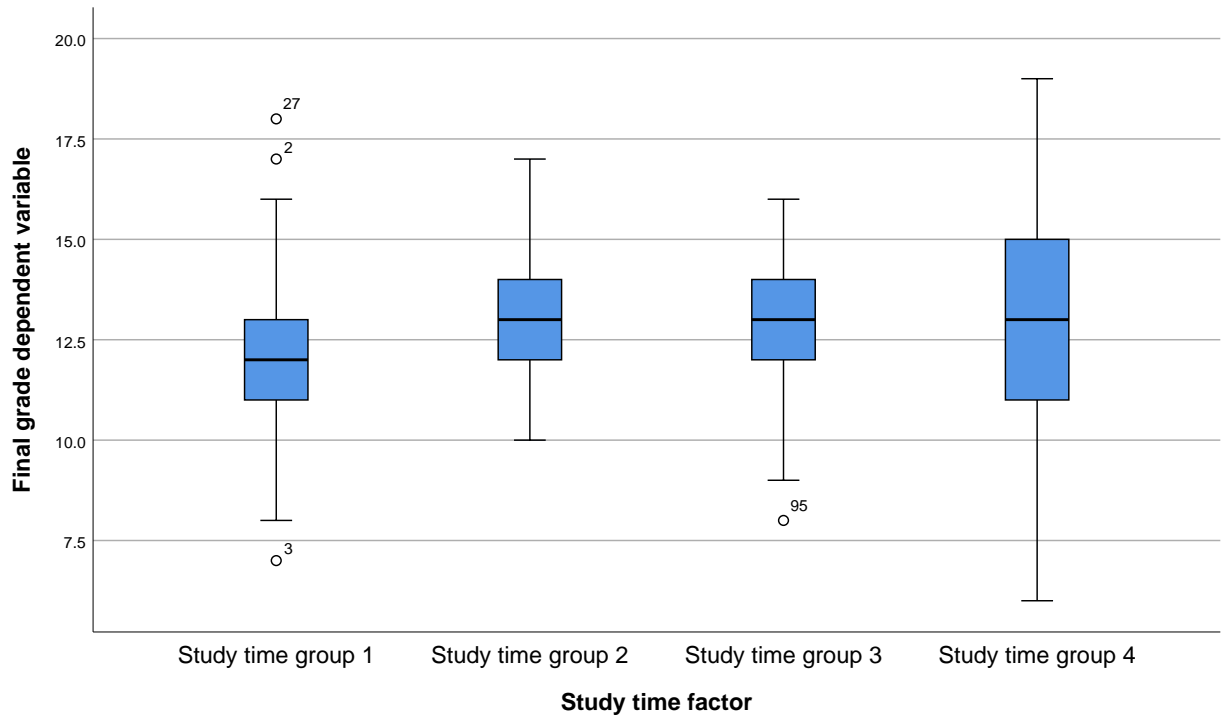
Balanced ANOVA: Group boxplot  
 Boxplot of G3 by balanced studytime group

**Descriptives**

studytime		Statistic	Std. Error	
3	Minimum	10		
	Maximum	17		
	Range	7		
	Interquartile Range	2		
	Skewness	.211	.398	
	Kurtosis	-.481	.778	
	Mean	12.89	.332	
	95% Confidence Interval for Mean	Lower Bound	12.21	
		Upper Bound	13.56	
	5% Trimmed Mean	12.96		
	Median	13.00		
	Variance	3.869		
	Std. Deviation	1.967		
	Minimum	8		
Maximum	16			
Range	8			
Interquartile Range	2			
Skewness	-.446	.398		
Kurtosis	-.049	.778		
4	Mean	13.06	.514	
	95% Confidence Interval for Mean	Lower Bound	12.01	
		Upper Bound	14.10	
	5% Trimmed Mean	13.07		
	Median	13.00		
	Variance	9.232		
	Std. Deviation	3.038		
	Minimum	6		
	Maximum	19		
	Range	13		
	Interquartile Range	4		
	Skewness	.209	.398	
	Kurtosis	-.339	.778	

Balanced ANOVA: Group boxplot  
Boxplot of G3 by balanced studytime group

**Final grade dependent variable**

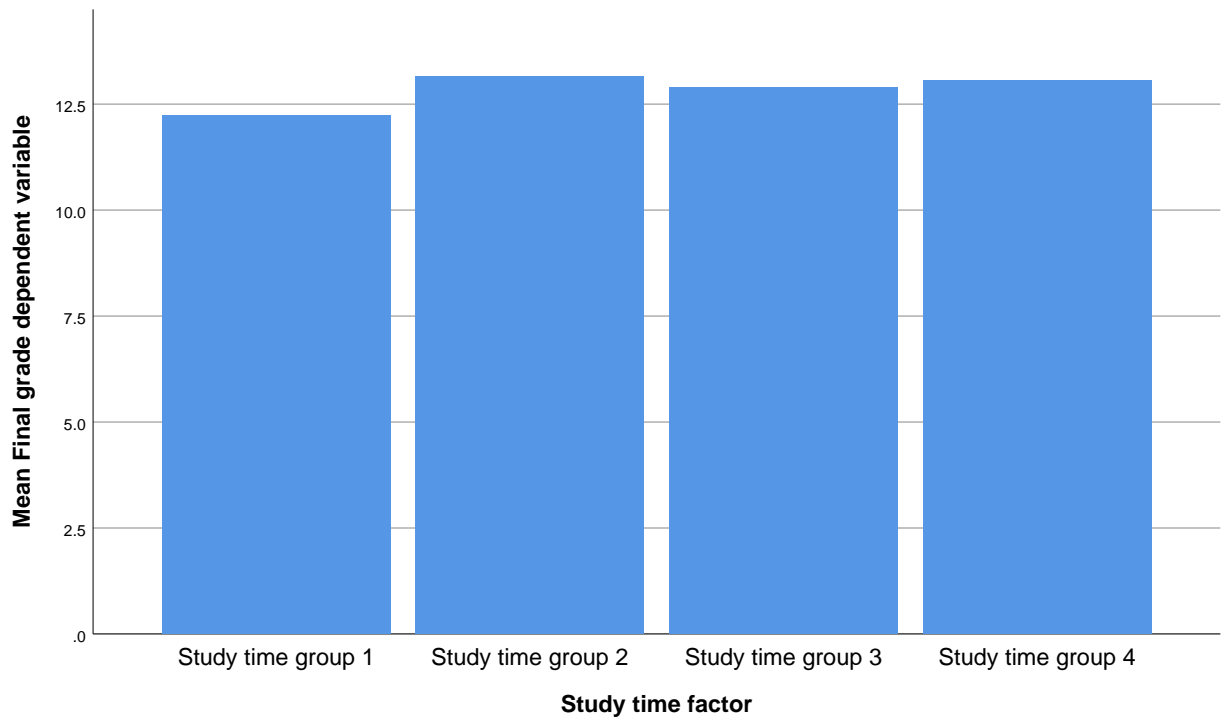


Balanced ANOVA: Means plot

Balanced ANOVA: Means plot  
Mean G3 across balanced studytime groups

## Graph

```
>Warning # 17848  
>The requested bar chart type cannot be drawn with the provided data. Instead  
,  
>Graphics will attempt to draw a simple bar chart.
```



Balanced ANOVA: Residuals versus predicted values

Balanced ANOVA: Residuals versus predicted values  
Model diagnostic scatterplot

Graph

