

Two-Way ANOVA

In this study, we are trying to assess the effects of teaching methods (independent variable), or teacher types (independent variable) or a teaching method by teacher type interaction on mathematics achievement (dependent variable). In general, the interaction effects of independent variables need to be ruled out before the assessment of the respective main effects of those two independent variables becomes meaningful.

In order to control extraneous variables and isolate the causal effect of teaching methods, an experimental design should be adopted to collect the data. **Research questions: (a) Is there an interaction between the teaching method and the teacher type?, (b) Is there a significant difference in math achievement across the three different teaching methods?, and (c) Is there a significant difference in math achievement across the two different teacher types?**

1. Click on Variable View on the bottom left.

Starting at the top of the far left column (under Name), type in the variable names (Math, Method, Teacher).

Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
Math	Numeric	8	2		None	None	8	Right	Scale
Method	Numeric	8	2		None	None	8	Right	Scale
Teacher	Numeric	8	2		None	None	8	Right	Scale

2. Label the categorical variables (Method, Teacher).

3. Click on the Values box for the categorical variable Method.

Type 1 for Value and Traditional for the Value label. Click add.

Type 2 for Value and Traditional/Progressive for the Value label. Click add.

Type 3 for Value and Progressive for the Value label. Click add.

Click OK.

4. Click on the Values box for the categorical variable Teacher.

Type 1 for Value and Friendly for the Value label. Click add.

Type 2 for Value and Standoffish for the Value label. Click add.

Click OK.

5. Click on Data View on the bottom left.

6. Enter data into SPSS.

Math	Method	Teacher
3.00	1.00	1.00
5.00	1.00	1.00
2.00	1.00	1.00
4.00	1.00	1.00
8.00	1.00	2.00
4.00	1.00	2.00
3.00	1.00	2.00
9.00	1.00	2.00
4.00	2.00	1.00
4.00	2.00	1.00
3.00	2.00	1.00
8.00	2.00	1.00
7.00	2.00	2.00
4.00	2.00	2.00
2.00	2.00	2.00
5.00	2.00	2.00
6.00	3.00	1.00
7.00	3.00	1.00
8.00	3.00	1.00
6.00	3.00	1.00
7.00	3.00	2.00
9.00	3.00	2.00
10.00	3.00	2.00
9.00	3.00	2.00

7. Click on Analyze.

General Linear Models.

Univariate.

8. Click on Math in the box on the left.

Click on the arrow next to Dependent Variable.

9. Click on Method in the box on the left.

Click on the arrow next to Fixed Factor(s).

10. Click on Teacher in the box on the left.

Click on the arrow next to Fixed Factor(s).

11. Click Options.**Check Descriptive statistics, Homogeneity tests.****Click Continue.****12. Click Plots.****Click on Method in the box on the left.****Click on the arrow next to Horizontal Axis.****Click on Teacher in the box on the left.****Click on the arrow next to Separate Lines.****Click Add.****Click Continue.****12. Click OK.****SPSS Output:****Univariate Analysis of Variance****Between-Subjects Factors**

	Value Label	N
Method	1.00 Traditional	8
	2.00 Traditional/Progressive	8
	3.00 Progressive	8
Teacher	1.00 Friendly	12
	2.00 Standoffish	12

Descriptive Statistics

Dependent Variable: Math

Method	Teacher	Mean	Std. Deviation	N
Traditional	Friendly	3.5000	1.29099	4
	Standoffish	6.0000	2.94392	4
	Total	4.7500	2.49285	8
Traditional/Progressive	Friendly	4.7500	2.21736	4
	Standoffish	4.5000	2.08167	4
	Total	4.6250	1.99553	8

Progressive	Friendly	6.7500	.95743	4
	Standoffish	8.7500	1.25831	4
	Total	7.7500	1.48805	8
Total	Friendly	5.0000	2.00000	12
	Standoffish	6.4167	2.71221	12
	Total	5.7083	2.44023	24

$$\bar{X}_G$$

Levene's Test of Equality of Error Variances(a)

Dependent Variable: Math

F	df1	df2	Sig.
2.473	5	18	.071

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

a. Design: Intercept+Method+Teacher+Method * Teacher

Conclusion of results for Interaction Effects of Teaching Method and Teaching Type:

Tests of Between-Subjects Effects

Dependent Variable: Math

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	70.708(a)	5	14.142	3.842	.015
Intercept	782.042	1	782.042	212.479	.000
Method	50.083	2	25.042	6.804	.006
Teacher	12.042	1	12.042	3.272	.087
Method * Teacher	8.583	2	4.292	1.166	.334
Error	66.250	18	3.681		
Total	919.000	24			
Corrected Total	136.958	23			

a. R Squared = .516 (Adjusted R Squared = .382)

F - observed

p - value

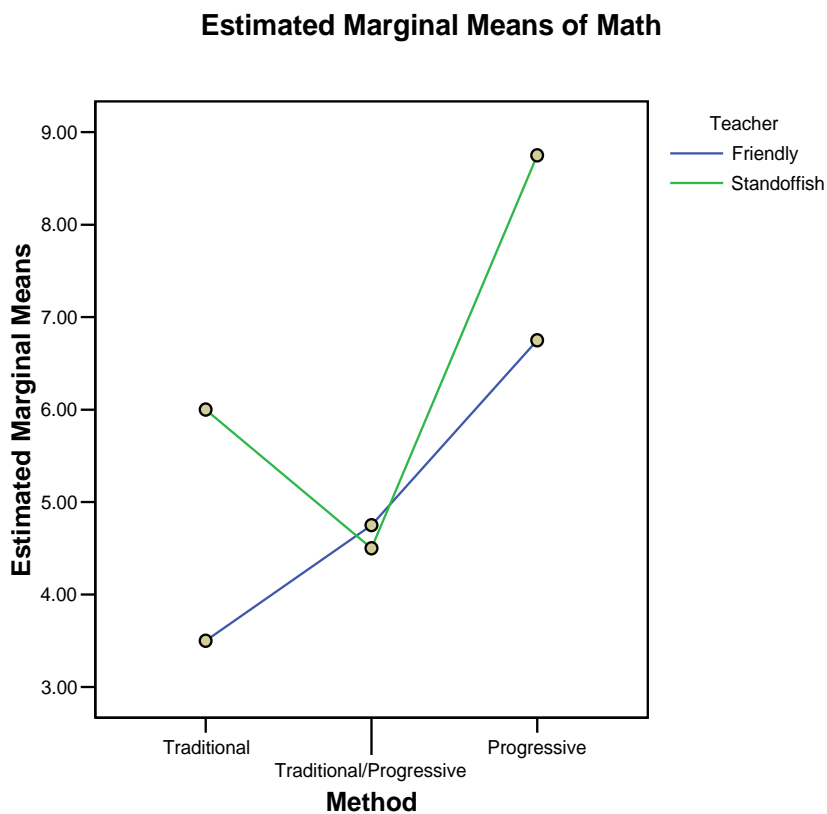
For the current tutorial, the α level is set at the .05 level. The result of the F-test fails to support the interaction effect of Teaching Method and Teaching Type on math achievement in the target population. $F_{\text{method*teacher}}(2, 18) = 1.166, p > 0.05$. As a result, we can proceed to assess the main effects of those two independent variables respectively.

Note: In general, it appears that TM3 ($\bar{X}_{TM3} = 7.75$) is larger than TM1 and TM2 for both types of teacher types (TT1, TT2).

Means Table	TM 1	TM 2	TM 3	
TT 1	3.50	4.75	6.75	5.0
TT 2	6.00	4.50	8.75	6.4
	4.75	4.625	7.75	5.708

← \bar{X}_G

Profile Plots



Note: Although statistically significant results were not found for the interaction effect, the profile plot displays greater means for the standoffish teacher type for both the traditional and progressive teaching methods and similar means for both the friendly and standoffish teacher type for the traditional/progressive teaching method.

Conclusion of Results for Teaching Method:

Tests of Between-Subjects Effects

Dependent Variable: Math

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	70.708(a)	5	14.142	3.842	.015
Intercept	782.042	1	782.042	212.479	.000
Method	50.083	2	25.042	6.804	.006
Teacher	12.042	1	12.042	3.272	.087
Method * Teacher	8.583	2	4.292	1.166	.334
Error	66.250	18	3.681		
Total	919.000	24			
Corrected Total	136.958	23			

a. R Squared = .516 (Adjusted R Squared = .382)

← p - value

↑ F - observed

For the current tutorial, the α level is set at the .05 level. The result of the F-test lends support to the effect of Teaching Method on math achievement in the target population. $F_{\text{method}}(2,18) = 6.804, p < 0.05$.

Note: Difference exist amongst the means of the different teaching methods ($\bar{X}_{\text{TM}_1} = 4.75, \bar{X}_{\text{TM}_2} = 4.65, \text{ and } \bar{X}_{\text{TM}_3} = 7.75$) and Post-Hoc comparisons (see One-way ANOVA tutorial) would need to be conducted to identify pairs of groups with statistically significant differences.

Conclusion of Results for Teacher Type:

Tests of Between-Subjects Effects

Dependent Variable: Math

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	70.708(a)	5	14.142	3.842	.015
Intercept	782.042	1	782.042	212.479	.000
Method	50.083	2	25.042	6.804	.006
Teacher	12.042	1	12.042	3.272	.087
Method * Teacher	8.583	2	4.292	1.166	.334
Error	66.250	18	3.681		
Total	919.000	24			
Corrected Total	136.958	23			

a. R Squared = .516 (Adjusted R Squared = .382)

← p - value

↑ F - observed

For the current tutorial, the α level is set at the .05 level. The result of the F-test failed to lend support to the effect of Teacher Type on math achievement in the target population. $F_{\text{teacher}}(1,18) = 3.272, p > 0.05$.

Note: The difference that exists amongst the means of the different teacher types ($\bar{X}_{\text{TT1}} = 5.0$ and $\bar{X}_{\text{TT2}} = 6.4$) is not enough to be considered statistically significant.