

One way within Anova – Crib Sheet.

Research question

Is there a change in students' math anxiety scores before, during, and after participation in a math anxiety group?:

Experimental hypothesis

There will be a significant change in students' math anxiety scores before, during, and after participation in a math anxiety group

Independent variable: - Time – 3 Levels. Time one (before intervention) Time two (during intervention) Time three (after intervention)

Dependent variable:

Math anxiety score

Since we are examining one group of participants measured on the same scale on three different occasions the one way within (or repeated measures) ANOVA is the most appropriate statistical test

Data Set – Is on Moodle.

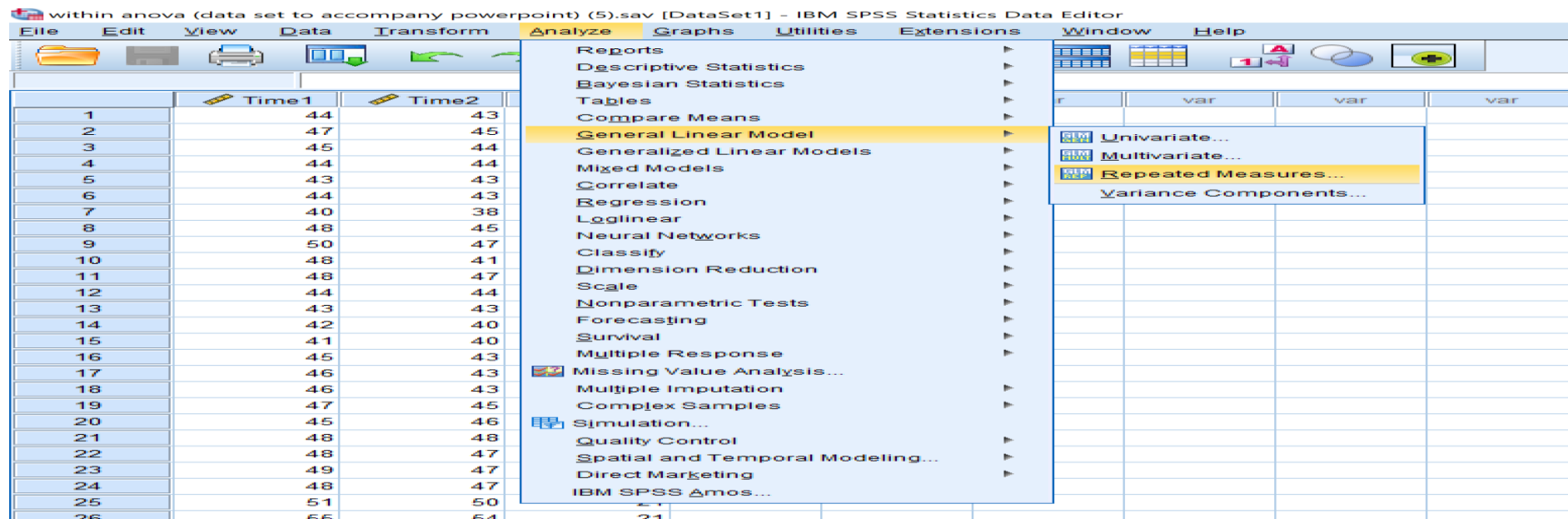
within anova (data set to accompany powerpoint) (5).sav [DataSet1] - IBM SPSS Statistics Data Editor

	Time1	Time2	Time3	var	var	var	var	var	var
1	44	43	23						
2	47	45	24						
3	45	44	25						
4	44	44	23						
5	43	43	24						
6	44	43	23						
7	40	38	25						
8	48	45	23						
9	50	47	24						
10	48	41	26						
11	48	47	27						
12	44	44	23						
13	43	43	25						
14	42	40	27						
15	41	40	28						
16	45	43	29						
17	46	43	30						
18	46	43	26						
19	47	45	24						
20	45	46	25						
21	48	48	23						
22	48	47	23						
23	49	47	23						
24	48	47	24						
25	51	50	21						
26	55	54	21						
27	53	51	21						
28	45	45	23						
29	46	45	24						
30	48	47	25						

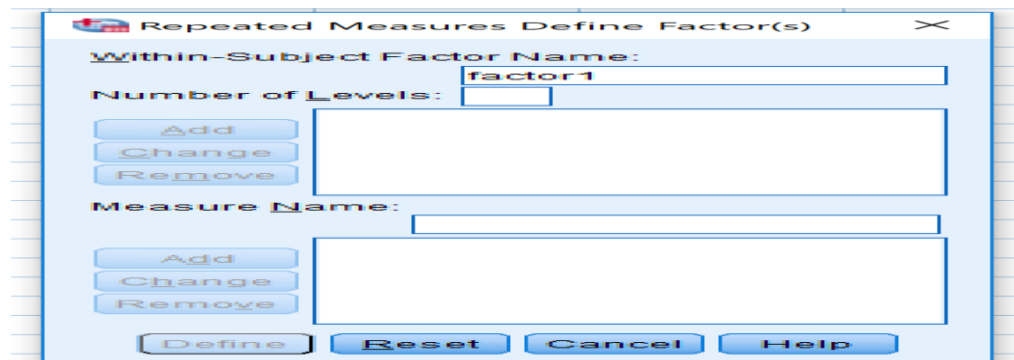
So above you can see some of the data set, the Math Anxiety scores for each participant is in each row. As you can see for Participant 1 – The Math Anxiety at Time 1 was 44, Time 2 was 43 and Time 3 was 23.

So to run the Anova.

Click Analyze > General Linear Model > Repeated Measures... on the top menu, as shown below:



You will be presented with the following screen:



In the Within-Subject Factor Name: box, replace "factor1" with a name that is more meaningful name for your independent variable. In our example, we will call our independent variable name "time" because it represents the different times that we took Math Anxiety Question from our participants (pre, during and post intervention).

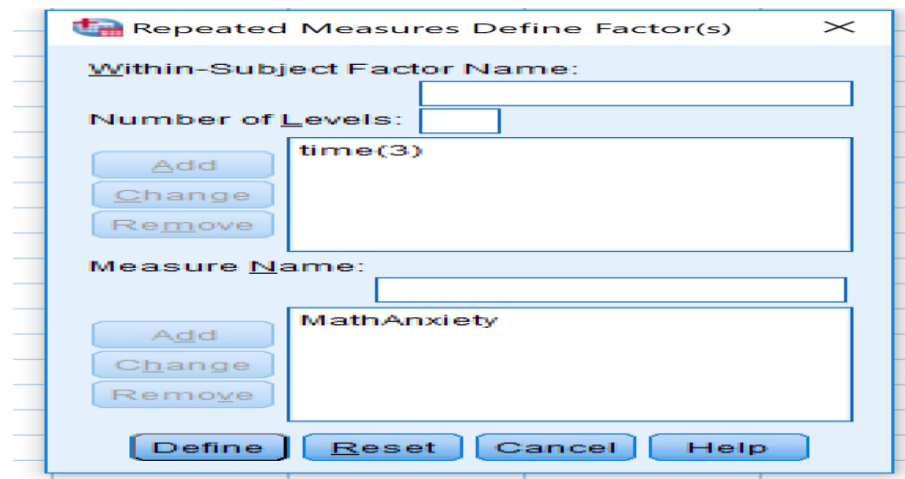
Enter into the Number of Levels: box the number of times the dependent variable has been measured. In this case, enter "3", representing the 3 times we measured math anxiety.

Click the add button.

Put an appropriate name for your dependent variable in the Measure Name: box. In this case, we have labelled our dependent variable MathAnxiety (no spaces can be imputed).

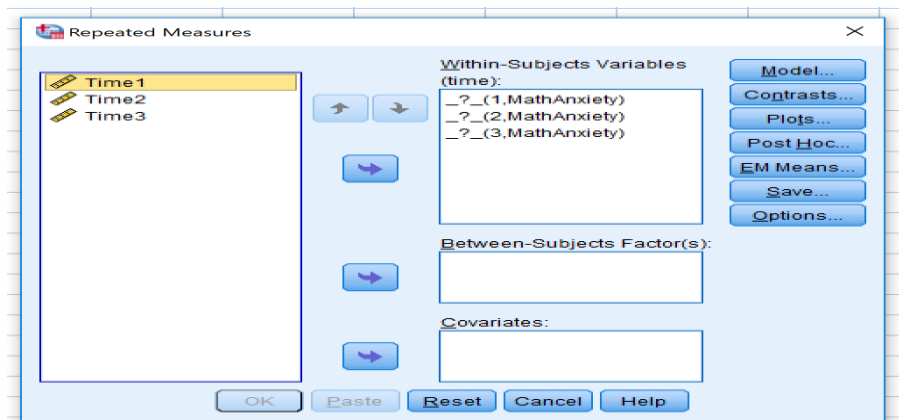
Click the add button.

You will be presented with the screen below:

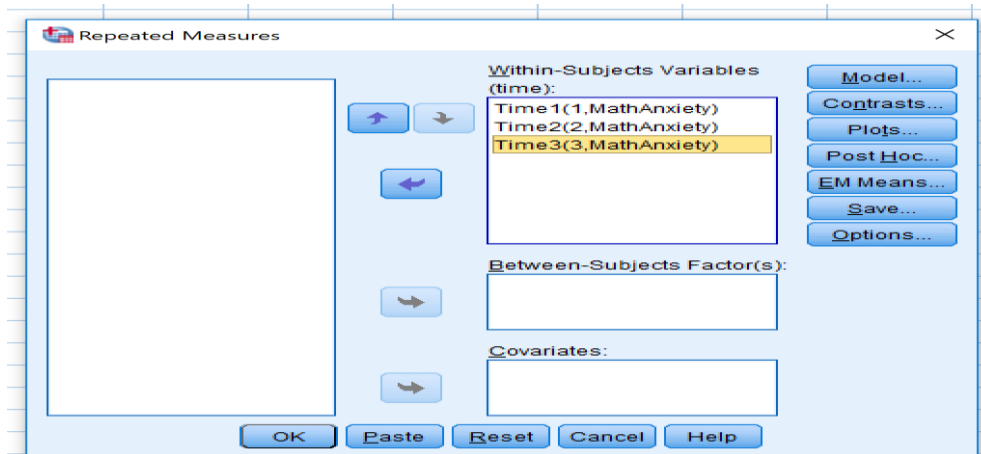


The screenshot shows the 'Repeated Measures Define Factor(s)' dialog box. It has a title bar with a close button. Inside, there are two main sections. The first section is for the 'Within-Subject Factor Name:' with an empty text box. Below it is the 'Number of Levels:' field, which contains the number '3'. To the left of this section are three buttons: 'Add', 'Change', and 'Remove'. The 'Add' button is highlighted. The second section is for the 'Measure Name:' with an empty text box. Below it is the 'Add' button, which is also highlighted. At the bottom of the dialog are four buttons: 'Define', 'Reset', 'Cancel', and 'Help'. The 'Define' button is highlighted.

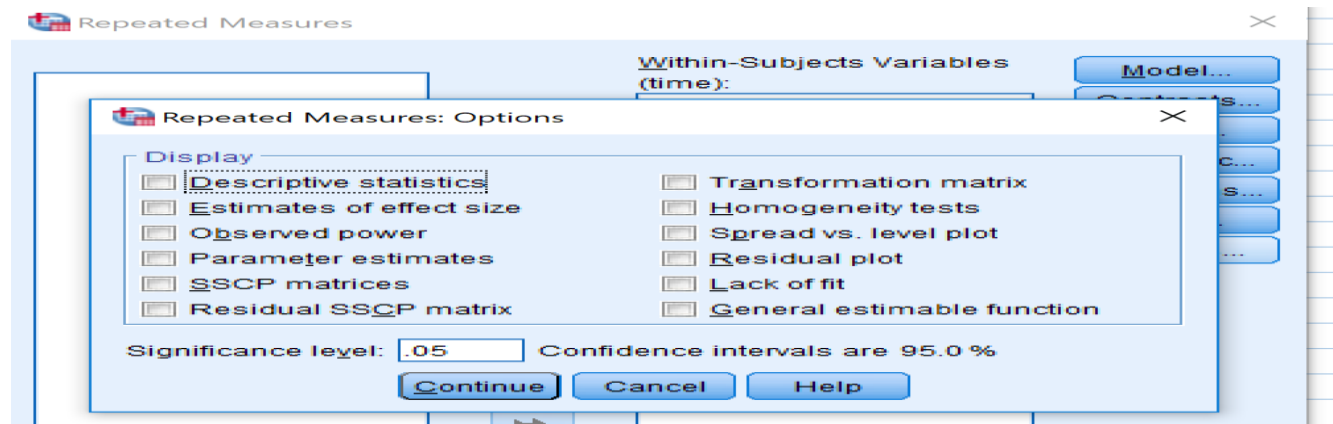
Click the DEFINE button and you will be presented with the following screen:



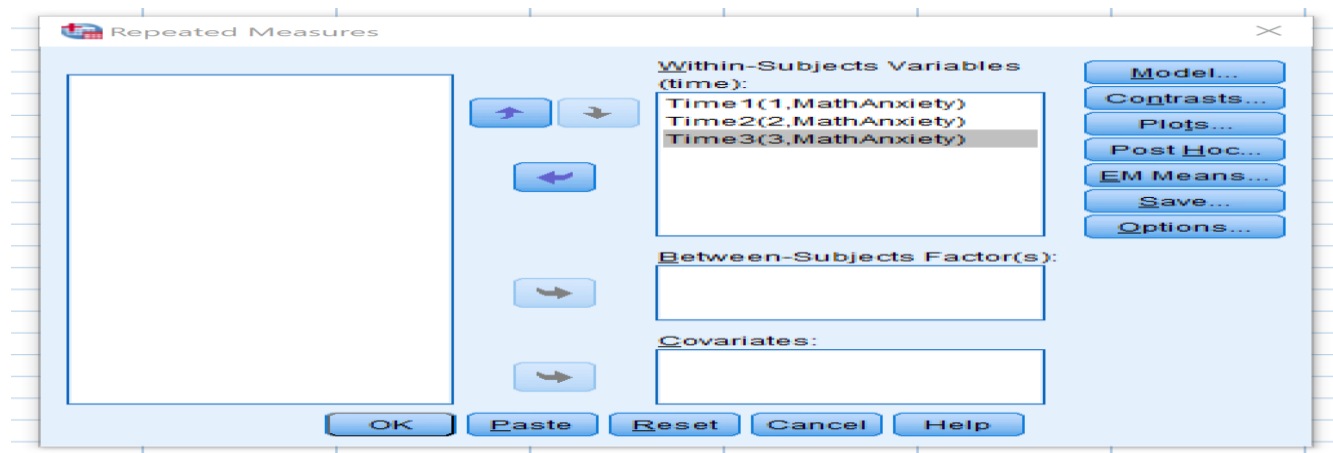
Transfer "Time 1", "Time 2", and "Time 3" into the Within-Subjects Variables (time):



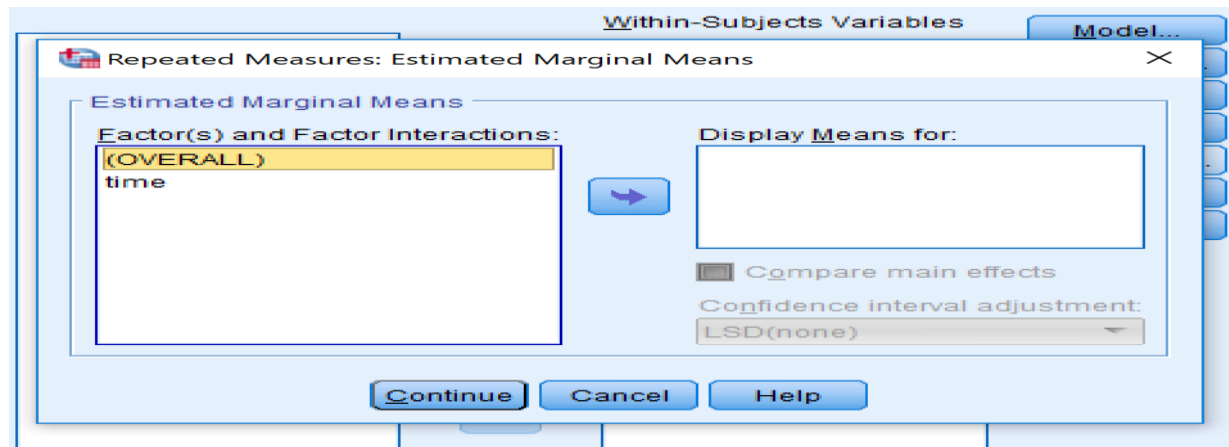
Click the options button. You will be presented with the following Repeated Measures: Options screen:



Tick the Descriptive statistics, Estimates of effect size and Observed power checkboxes in the –Display– area. Then click continue.

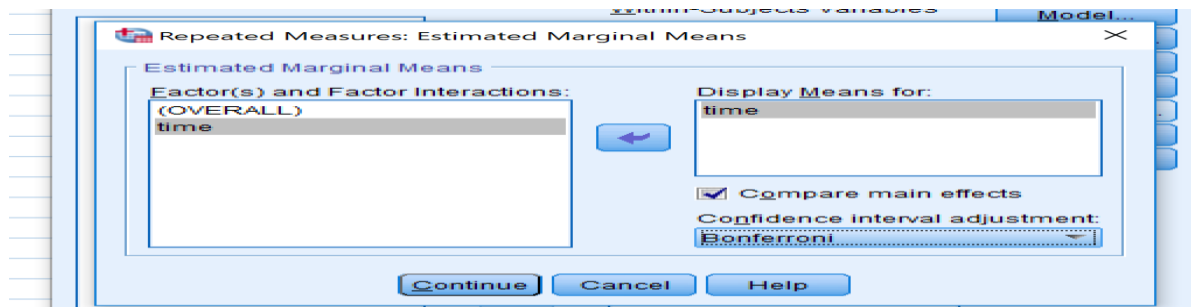


Then click EM Means – The following output box will appear.



Transfer the factor "time" from the Factor(s) and Factor Interactions: box to the Display Means for: box. Tick the Compare main effects checkbox and select "Bonferroni" from the drop-down menu under Confidence interval adjustment:.

It should look as below.



Click continue and then click OK.

Interpreting the SPSS Output.

I will now go through the boxes that feature on the SPSS output, much of the interpretation is the same as a One Way Between Groups output.

Within subject factors table

This just tells us the variables we have imputed and the number of levels.

Within-Subjects Factors

Measure: MathAnxiety

Dependent

time	Variable
1	Time1
2	Time2
3	Time3

Descriptive Statistics Table.

This tells us the means and standard deviations for the 3 levels of the IV – Time 1, Time 2 and Time 3.

Descriptive Statistics			
	Mean	Std. Deviation	N
Time1	47.80	3.965	60
Time2	46.18	3.890	60
Time3	24.27	1.858	60

Multivariate Tests Table.

This can be largely ignored in the case of a one way within anova.

Mauchly's Test of Sphericity Table.

This table is important as Sphericity is one of the key assumptions in a one way within Anova – if the significance value is $<.05$ then we can assume sphericity and when it comes to the Anova table we follow the sphericity assumed line.

Mauchly's Test of Sphericity^a

Measure: MathAnxiety

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Epsilon ^b	
						Huynh-Feldt	Lower-bound
time	.249	80.579	2	.000	.571	.575	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: time

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Test of within subjects effects table.

This is your Anova table and it is much the same as the between subjects Anova. If Sphericity is assumed you follow the Sphericity Assumed line. Make a note of the df (and df error) the F statistic, the significance value and the partial eta squared which is the effect size.

Tests of Within-Subjects Effects

Measure: MathAnxiety

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^a
time	Sphericity Assumed	20735.433	2	10367.717	1338.648	.000	.958	2677.296	1.000
	Greenhouse-Geisser	20735.433	1.142	18151.258	1338.648	.000	.958	1529.230	1.000
	Huynh-Feldt	20735.433	1.150	18029.224	1338.648	.000	.958	1539.581	1.000
	Lower-bound	20735.433	1.000	20735.433	1338.648	.000	.958	1338.648	1.000
Error(time)	Sphericity Assumed	913.900	118	7.745					
	Greenhouse-Geisser	913.900	67.400	13.559					
	Huynh-Feldt	913.900	67.856	13.468					
	Lower-bound	913.900	59.000	15.490					

a. Computed using alpha = .05

The next three boxes can be largely ignored.

Remember the test of within subjects effects box is telling us about the Anova has a whole and not if there is significance between Time 1 and Time 2, Time 1 and Time 3 and Time 2 and Time 3. To do this post hoc analysis you need to look at the pairwise comparison box.

Pairwise Comparisons

Measure: MathAnxiety

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
1	2	1.617*	.186	.000	1.159	2.074
	3	23.533*	.605	.000	22.042	25.025
2	1	-1.617*	.186	.000	-2.074	-1.159
	3	21.917*	.611	.000	20.410	23.423
3	1	-23.533*	.605	.000	-25.025	-22.042
	2	-21.917*	.611	.000	-23.423	-20.410

Based on estimated marginal means

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

b. Adjustment for multiple comparisons: Bonferroni.

This tells you specifically is there is a significant difference between Time 1 and Time 2, Time 1 and Time 3 and Time 2 and Time 3. As you can see there was significant difference between Time and Time 2, Time 1 and Time 3 and Time 2 and Time 3. You would then need to look back at your descriptive statistics to find out the direction of the difference (e.g. which time had the lowest math anxiety score).

The remaining tables can be largely ignored.

Please see the embedded video and slides for more details on reporting this one way within Anova.