Example 1: The data file Score.xlsx has final scores for STATS 101 class at a university. Test if the true mean μ for STATS 101 class equals 90.

This problem is formulated as testing H_0: μ = 90 vs. H_1: μ ≠ 90.

Run SPSS, open data file Score.xlsx. Once data file opens in SPSS, follow the sequence

Analyze/Compare means/One-sample T Test (see Figure 1)
Select variable Score (see Figure 2), click on OK.
The output is shown in Figure 3.

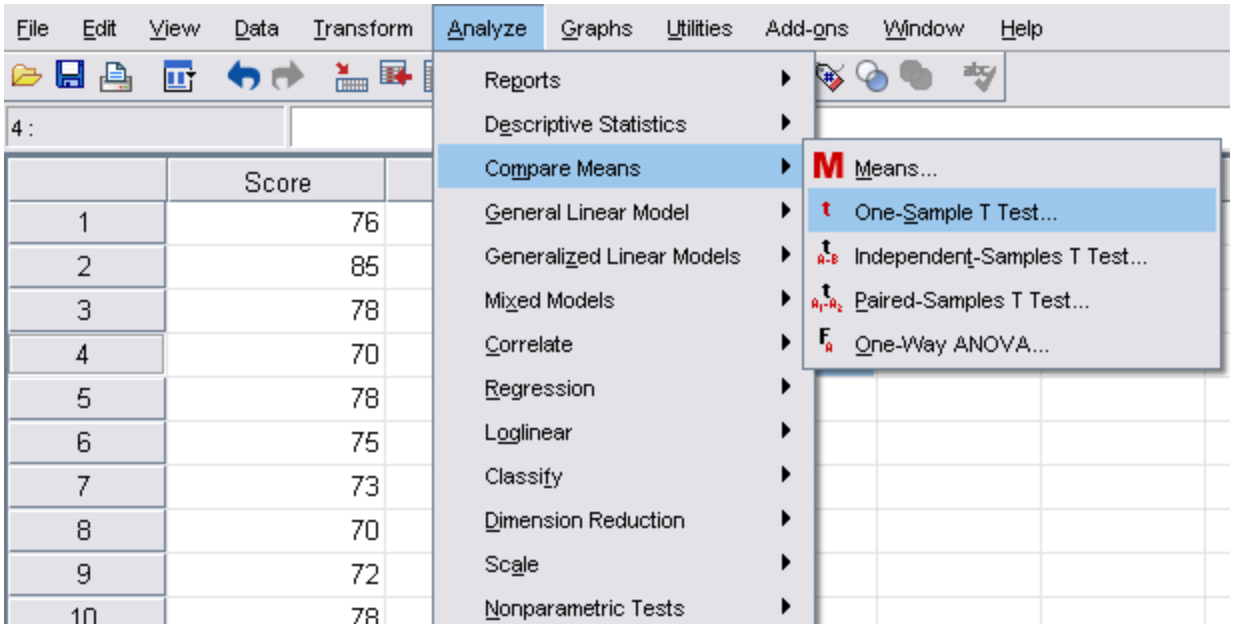


Figure 1: Analyze/Compare Means/One-Sample T Test

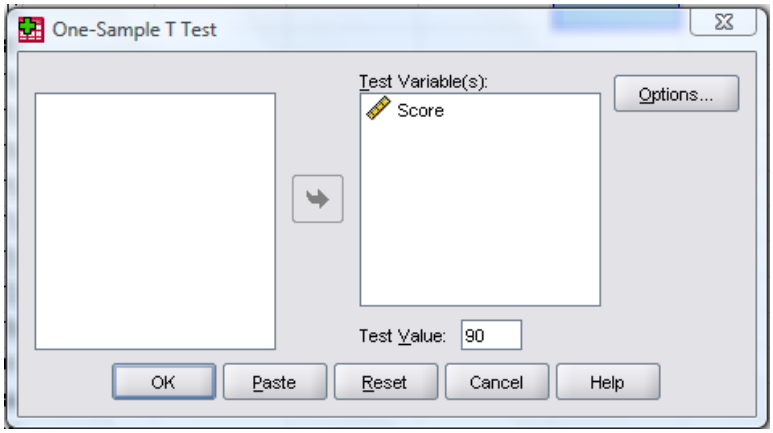


Figure 2: Select Score as variable, click OK.

SPSS will open an OUTPUT WINDOW and show the following output.

Test H0: mu = 90
vs. H1: mu NOT EQUAL TO 90

T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Score	60	74.88	10.617	1.371

One-Sample Test

	Test Value = 90					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Score	-11.029	59	.000	-15.117	-17.86	-12.37

P-value for H0 vs 2-sided H1 = 0.000 < .05
Reject H0, conclude μ≠90.

95% Confidence Interval for μ does not contain 90, so
reject H0, conclude μ≠90.

Figure 3: Output of 1-sample T-Test for data of Example 1.

One of the assumptions of 1-sample t-test is that sample be normally distributed (or sample size n be sufficiently large, typically $n \geq 30$ is considered a large sample). We show how to assess the normality of a sample in SPSS on the next page.

Click on the sequence Analyze/Descriptive Statistics/Q-Q Plots (Figure 4)

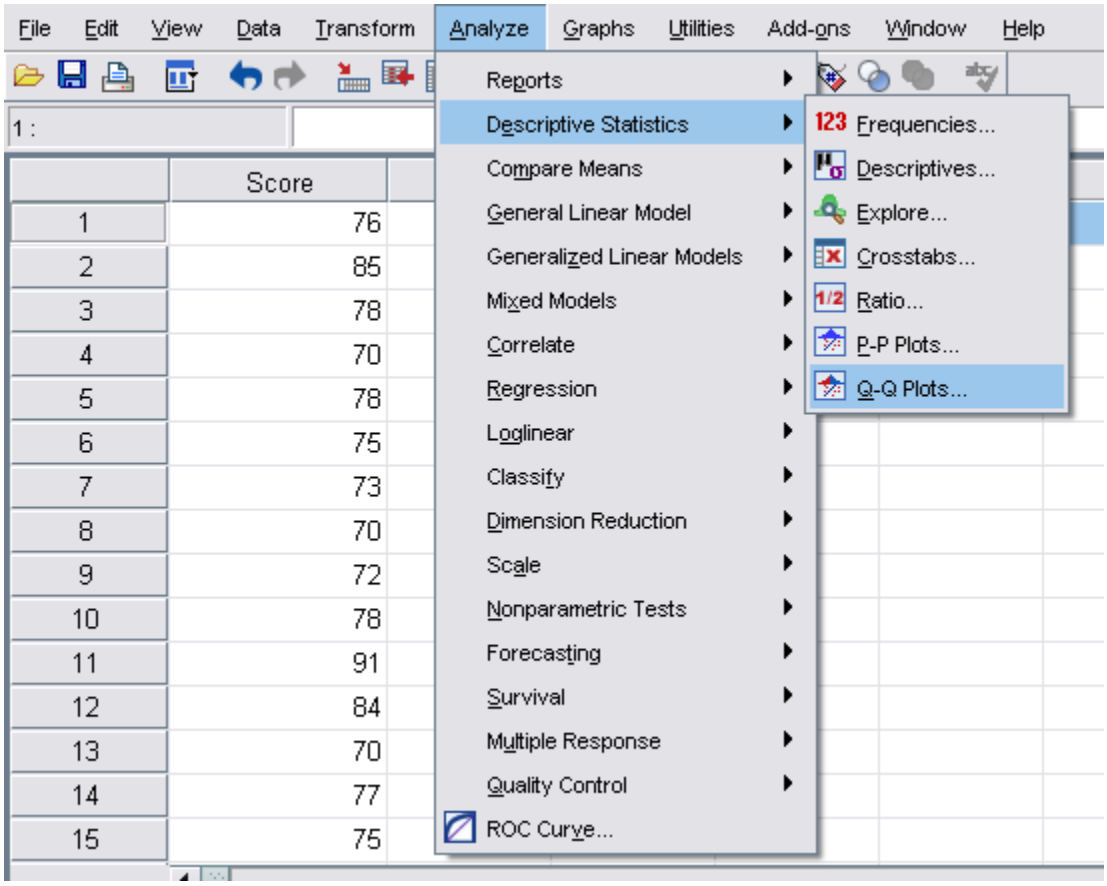
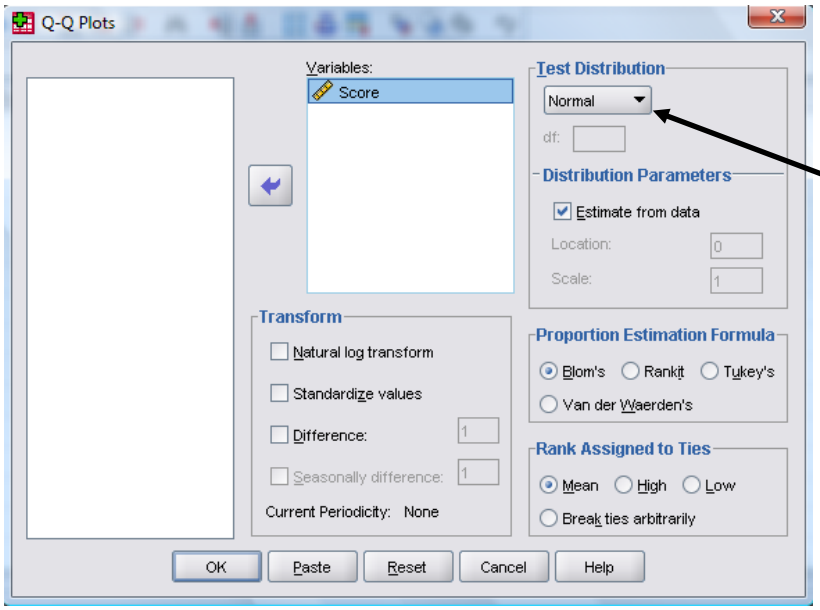


Figure 4: Analyze/Descriptive Statistics/Q-Q Plots



Select Score as the variable (Figure 5) Make sure that Test Distribution box is showing Normal distribution.
Click OK.

Figure 5: Select Score in Variables Box, check that Normal distribution is selected.

SPSS will produce the following Quantile-Quantile Plot of the variable Score (Figure 6). Since the pairs of points (Observed sample quantiles, Expected sample quantiles assuming the normal distribution) plot along the line Y = X, the sample (Score) appears to come from a normally distributed population.

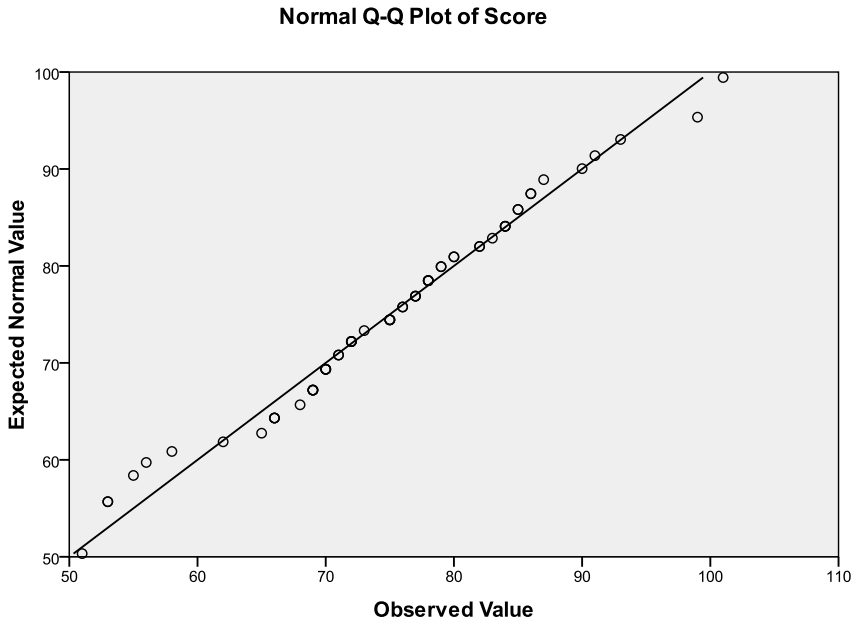


Figure 6: Q-Q Plot of the variable Score

Example 2: Example 4: Measured weights 0f 20 '3 lbs hamburger meat' packets from Grocery store A and 15 from Grocery Store B are given in the data file Weights.xlsx. Test to see if the true means of '3 lbs hamburger meat' packets from Grocery store A and Grocery Store B are equal.

The null hypothesis H_0: $\mu_1 = \mu_2$ is to be tested vs. the alternative H_1: $\mu_1 \neq \mu_2$.

- Open the data file Weights.xlsx in excel (has weights for stores A and B in 2 columns).

- Convert data into GROUPED DATA format (required by SPSS) - see file Weights2.xlsx and open Weights2.xlsx in SPSS.

- Then click the sequence Analyze/Compare Means/Independent-Samples T Test (Figure 7)

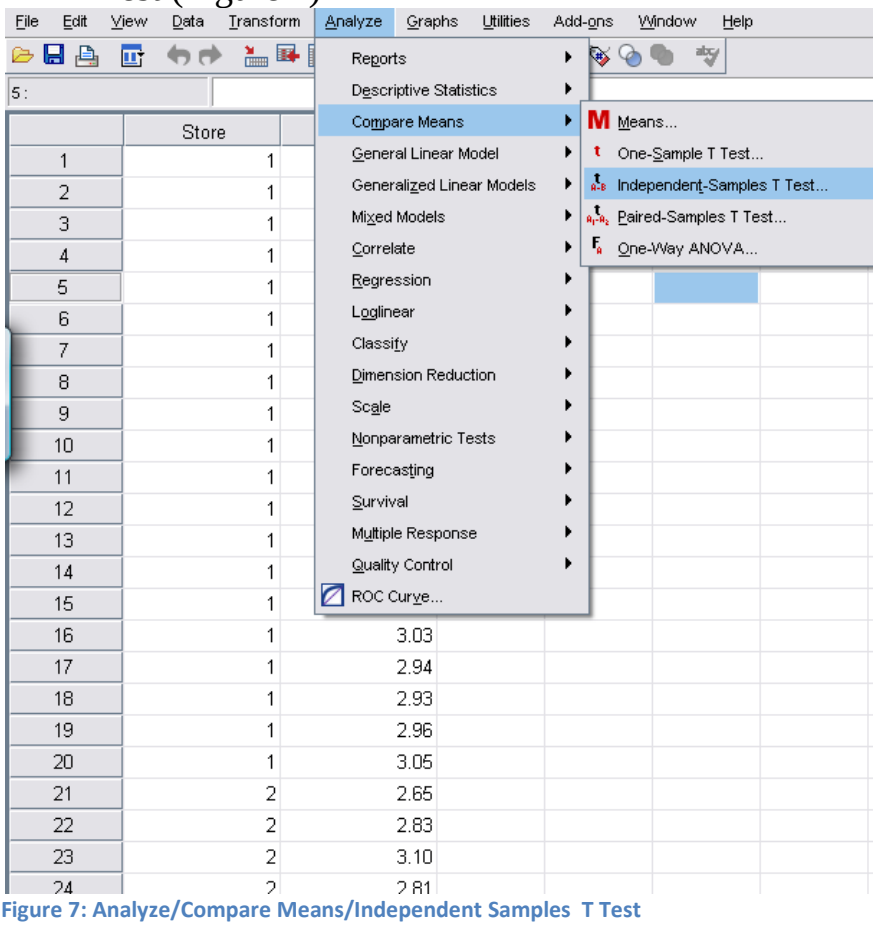


Figure 7: Analyze/Compare Means/Independent Samples T Test

Select Weight as 'Test Variable', Store as 'Grouping Variable' (Figure 8(a)), click on 'Define Groups' box which will open 'Define Groups' window (Figure 8(b)), Enter 1 for Group 1, 2 for Group 2, click on Continue, and then click on OK.

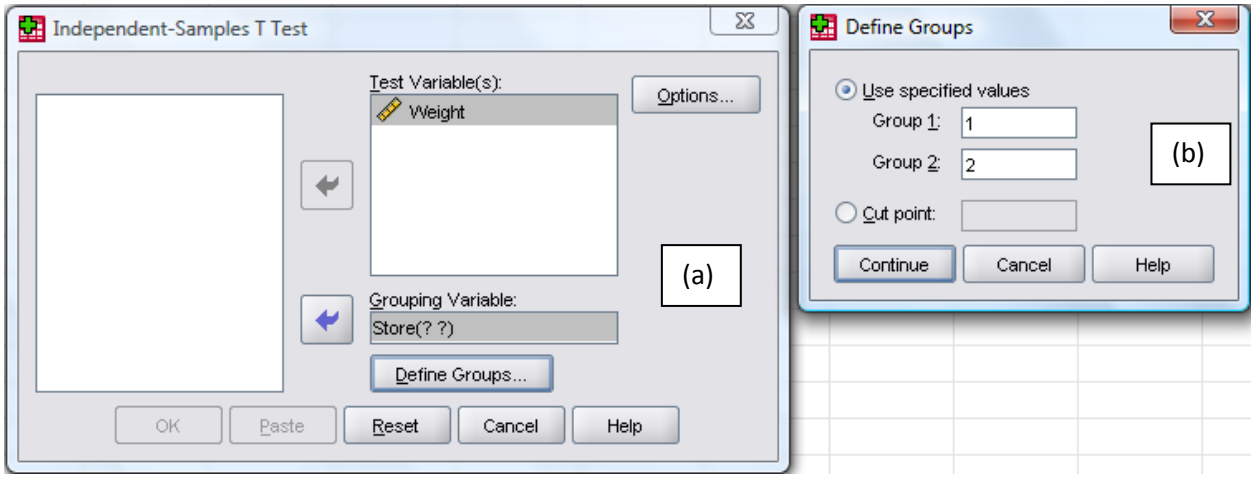


Figure 8: Select variables and define groups.

The output from SPSS is shown below (Figure 9). The test is run ASSUMING EQUAL VARIANCES and EQUAL VARIANCES NOT ASSUMED. The Levene's Test for Equal variances has a P-value of 0.000, implying that the two population variances are not equal so we should be using the T Test when EQUAL VARIANCES NOT ASSUMED, which has a P-value (for the null hypothesis of Equal Means) of 0.117, indicating that the true population mean weights for the two scores are equal at 5% test size. Note that the normality of both samples must be verified using the graphical method of Q-Q Plot shown in Example 1.

➔ **T-Test**

```
[DataSet4]
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Group Statistics

	Store	N	Mean	Std. Deviation	Std. Error Mean
Weight	1	20	2.9845	.04605	.01030
	2	15	3.1180	.30746	.07939

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Weight	Equal variances assumed	34.995	.000	-1.923	33	.063	-.13350	.06944	-.27477	.00777
	Equal variances not assumed			-1.668	14.472	.117	-.13350	.08005	-.30467	.03767

Figure 9: T-Test Output for Example 2

Sig.-0.000 is the P-value for testing equal varian-

Sig. = .117 is the P-value for testing equal means

Example 3: The data file Burger_Sales.xlsx shows daily sales of two adjacent fast food places for 14 randomly selected days. Test to see if the average sales of the two fast food restaurants are equal.

The data in this example is PAIRED since the *sales for the two restaurants are for same day, and we will need to run the paired T Test for this example.*

Open the data file Burger_Sales.xlsx in SPSS.
Click on the sequence Analyze/Compare Means/Paired-Samples T Test (Figure 10)
Select variables for 1st Paired Variable (Figure 11) and click on OK to obtain the output shown after the figures.

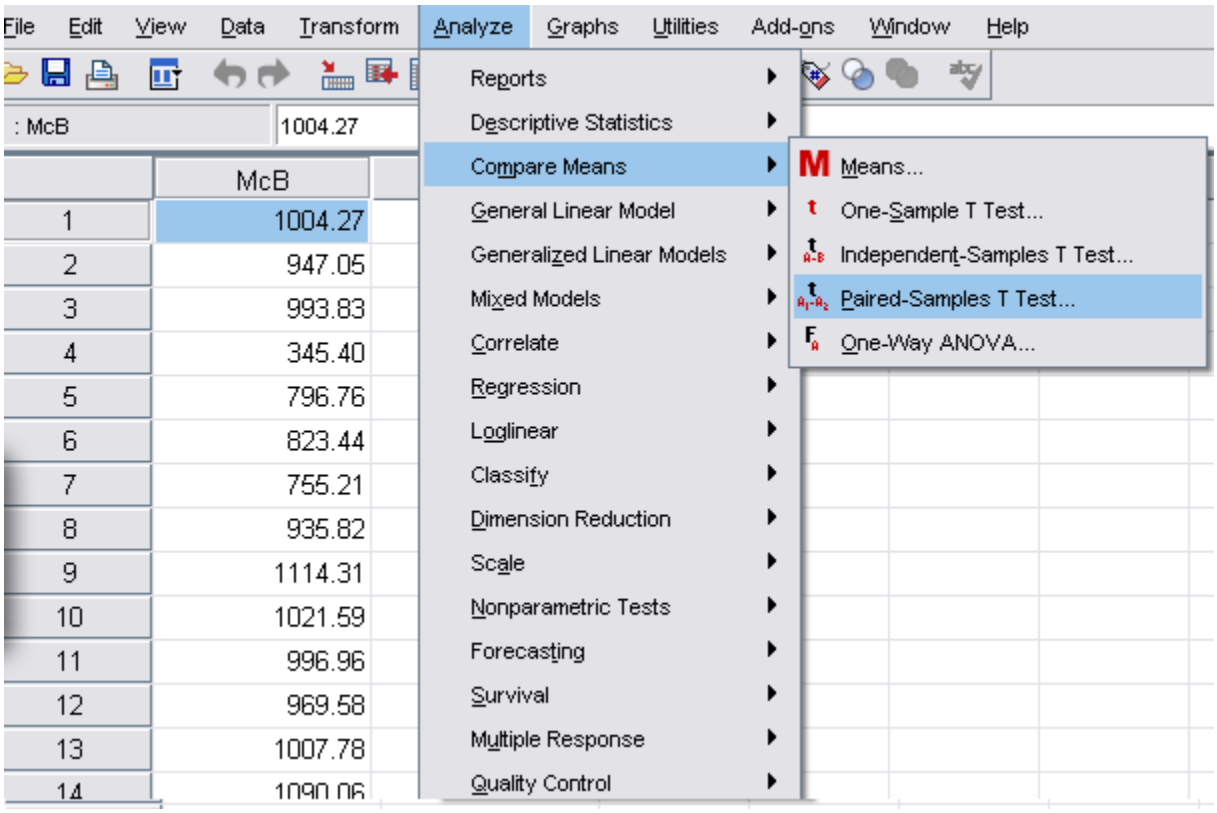


Figure 10: Analyze/Compare Means/Paired-Samples T Test

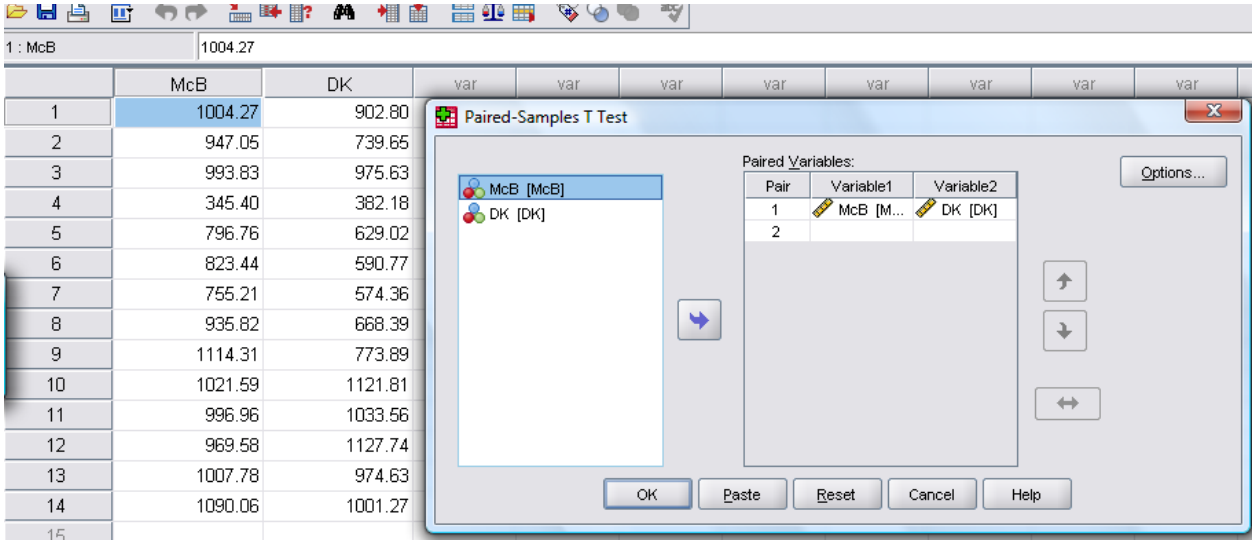


Figure 11: Select variables for the paired data

T-Test

[DataSet1]

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	McB	914.4329	14	193.75180	51.78235
	DK	821.1214	14	230.69164	61.65493

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	McB & DK	14	.774	.001

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	McB - DK	93.31143	146.98528	39.28347	8.44466	178.17820	2.375	13	.034

Since the Confidence Interval for $\mu_1 - \mu_2$ = (8.44, 178.18) falls to the right of 0, we can conclude that $\mu_1 > \mu_2$

P-value = 0.034 < .05 so reject the null hypothesis of equal means.

For the paired t-test, we need to verify the normality of the difference DIFF = McB – DK.
In SPSS, click on Transform/Compute Variable, the type DIFF in the Target variable box, and McB – DK in the Numeric Expression Box, and click OK (Figure 12). This will result in a new column DIFF in the open data file.

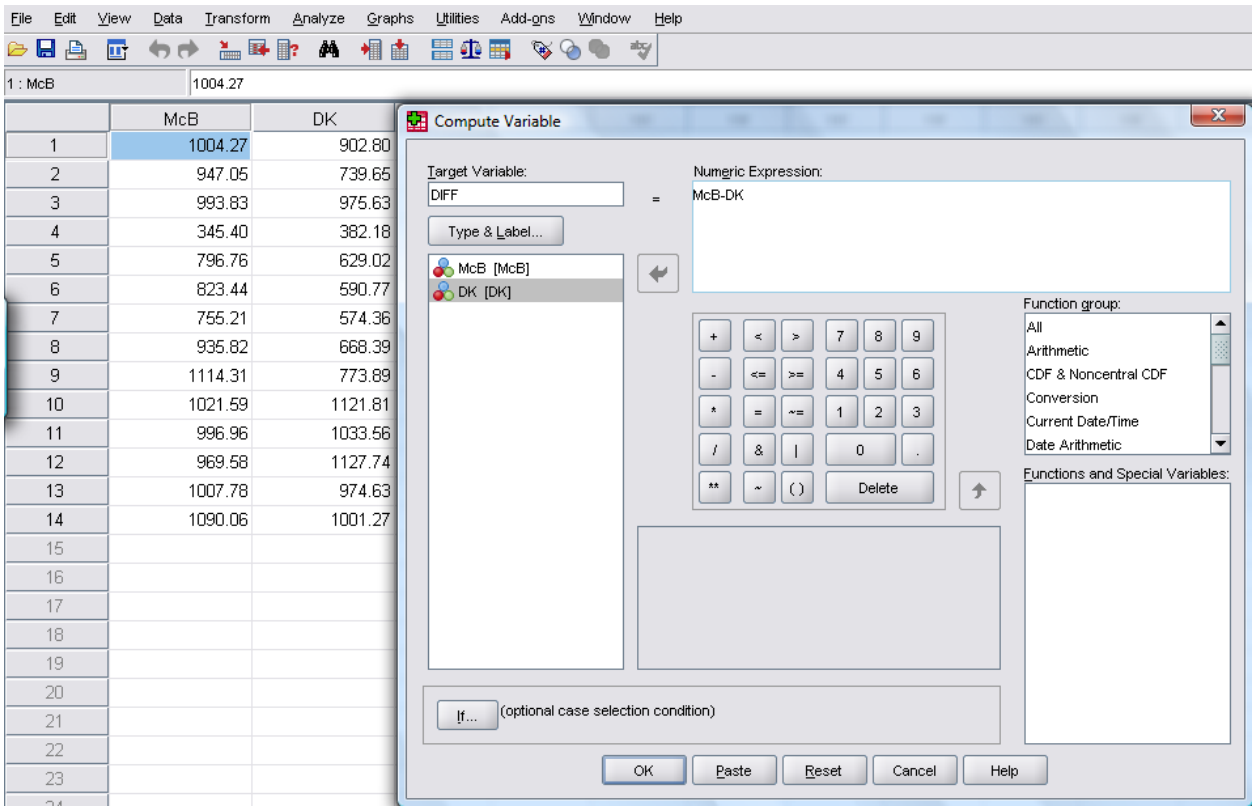
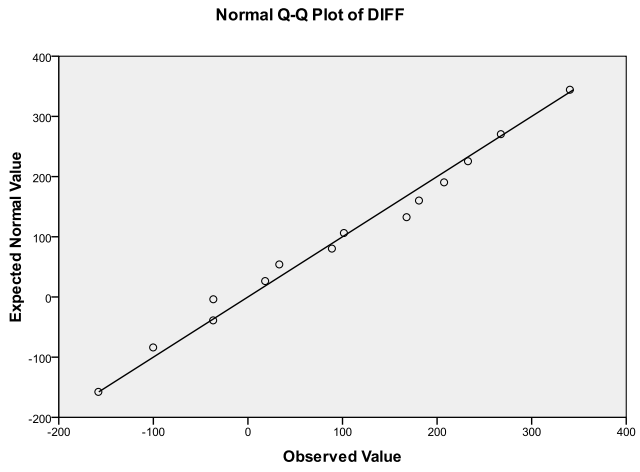


Figure 3: Running the Paired T Test in SPSS

Next click on the sequence Analyze/Descriptive Statistics/Q-Q Plot, and select DIFF as the variable, then click OK to obtain the Q-Q Plot of DIFF.



Since the points in the Q-Q Plot for DIFF fall along Y=X line, the differences are normally distributed and the result of paired T Test is valid.