LESSON 5: TEST 02: *t*-Test (Part II)

In this lesson, I will try to explain the steps you need to follow in order to run (1) an independent *t*-test and (2) a paired-sample *t*-test. But, before we go into the procedure, let's have some practice by analysing the following research questions extracted from the field of TEFL and applied linguistics.

Exercise: Analyse the following RQs and determine what type of *t*-test is required for each one. Provide an explanation for your choice. (Answers are provided below)

RQ1: Does students' vocabulary knowledge improve significantly after completing an intensive vocabulary training course?

RQ2: Is there a difference in student anxiety levels before and after a series of mindfulness and relaxation sessions?

RQ3: Is there a difference in the average post-test scores of students taught using traditional methods versus those taught using e-learning tools?

RQ4: Does exposure to a multicultural environment change individuals' attitudes towards dialects?

RQ5: Is there a significant difference in the usage of regional dialects between urban and rural residents?

RQ6: Does the implementation of a new grammar teaching strategy affect students' performance differently in public schools compared to private schools?

RQ7: Are there differences in the complexity of written discourses produced by native speakers and advanced non-native speakers?

RQ8: Is there a significant change in grammar error rates in writing assignments before and after a targeted grammar intervention?

RQ9: Does gender influence the level of motivation in learning a second language among high school students?

RQ10: How does the complexity of oral narratives change for the same individuals speaking in their first language compared to their second language?

Independent t-test
The independent t-test compares the means of two independent or unrelated groups to determine if there is a significant difference between them. This test is suitable for comparing the means of two groups when the participants in one group are not related in any way to the participants in the other group.
RQ1: Is there a difference in the average post-test scores of students taught using traditional methods versus those taught using e-learning tools?

Explanation: This question compares two independent groups (students taught using traditional methods and students taught using e-learning tools). Since the same students are not in both groups, an independent t-test is suitable to compare the average scores.

RQ2: Does gender influence the level of motivation in learning a second language among high school students?

Explanation: Here, the independent variable is gender (male vs. female), and the dependent variable is the level of motivation. Since males and females are independent groups, an independent t-test can be used to compare the motivation levels between them.

RQ3: Is there a significant difference in the usage of regional dialects between urban and rural residents?

Explanation: This research question involves two independent groups (urban residents and rural residents) and aims to compare their usage of regional dialects. An independent t-test is appropriate for analyzing the difference in dialect usage frequencies between these two groups.

RQ4: Does the implementation of a new grammar teaching strategy affect students' performance differently in public schools compared to private schools?

Explanation: Public school students and private school students form two independent groups. An independent t-test can determine if the new strategy has a significantly different effect on grammar performance between these groups.

RQ5: Are there differences in the complexity of written discourses produced by native speakers and advanced non-native speakers?

Explanation: This question compares the discourse complexity between two independent groups (native speakers and advanced non-native speakers). An independent t-test is suitable for assessing if there's a significant difference in complexity levels.

Paired Sample t-test (dependent):

The dependent t-test (also known as the paired-samples t-test) is used to compare the means of two related groups. This test is suitable when the same participants are measured under two conditions or when pairs of participants are matched in some way (e.g., by age, by gender).

RQ1: Does students' vocabulary knowledge improve significantly after completing an intensive vocabulary training course?

Explanation: The same group of students is tested before and after the training, making their scores on two occasions related. A dependent t-test is used to compare the mean scores before and after the training to see if the course led to significant improvement.

RQ2: Is there a difference in student anxiety levels before and after a series of mindfulness and relaxation sessions?

Explanation: The anxiety levels are measured for the same students before and after the sessions, making the measurements related. A dependent t-test can assess if the sessions significantly reduced anxiety levels.

RQ3: Does exposure to a multicultural environment change individuals' attitudes towards dialects?

Explanation: If individuals' attitudes towards dialects are measured before and after prolonged exposure to a multicultural environment, their responses are related over time. A dependent t-test is appropriate for analyzing attitude changes.

RQ4: Is there a significant change in grammar error rates in writing assignments before and after a targeted grammar intervention?

Explanation: The same students' writing assignments are evaluated before and after the intervention. A dependent t-test can compare the mean error rates to determine if the intervention was effective.

RQ5: How does the complexity of oral narratives change for the same individuals speaking in their first language compared to their second language?

Explanation: The complexity of oral narratives produced by the same individuals in two languages (first and second) are related measures. A dependent t-test can determine if there's a significant difference in complexity between the two conditions.

Test Procedure in SPSS Statistics

In this example, we will use an independent t-test to understand whether there is a difference in English language proficiency scores between students who received traditional classroom instruction and those who received an online instruction.

Let's say you want to compare the speaking fluency scores of students who received traditional classroom instruction (Group 1) and those who received an online instruction (Group 2). You have collected the speaking fluency scores of 50 students in each group.

In SPSS Statistics, you would enter the speaking fluency scores under the variable name "Fluency" (dependent variable) and create a grouping variable called "Instruction" (independent variable) with values "1" for Group 1 and "2" for Group 2.

The eight steps below show you how to analyse your data using an independent t-test in SPSS Statistics when all the assumptions have not been violated. At the end of these eight steps, I will show you how to interpret the results from this test.
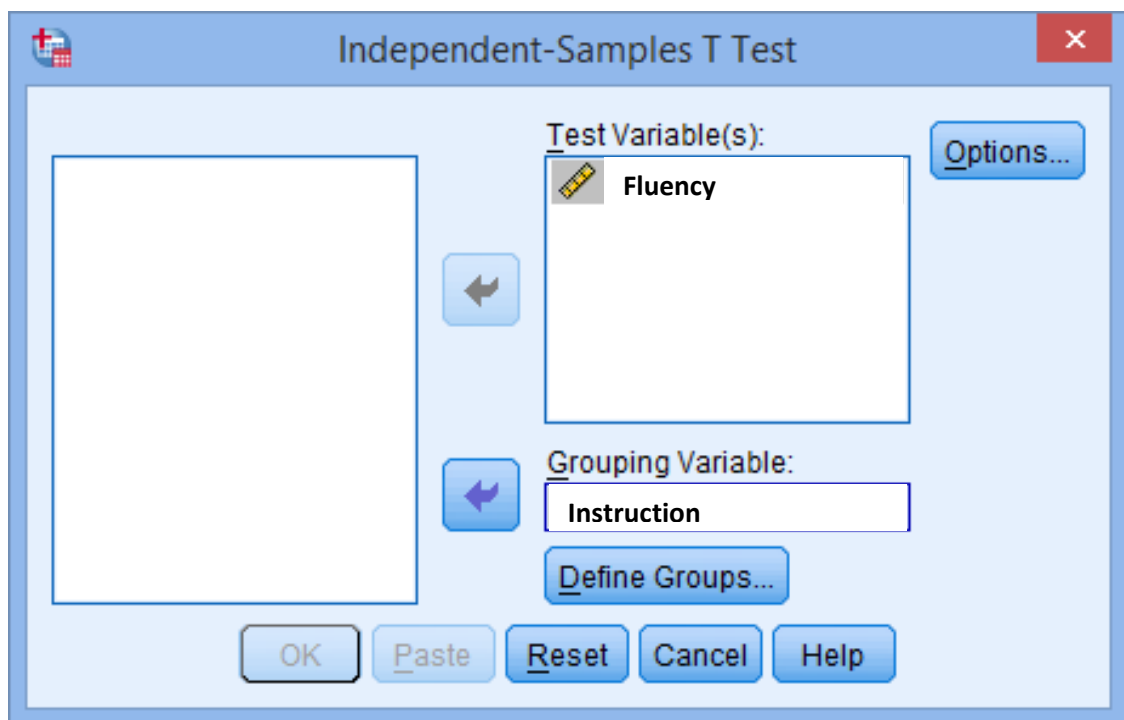
Click Analyze > Compare Means > Independent-Samples T Test... on the top menu, as shown below:
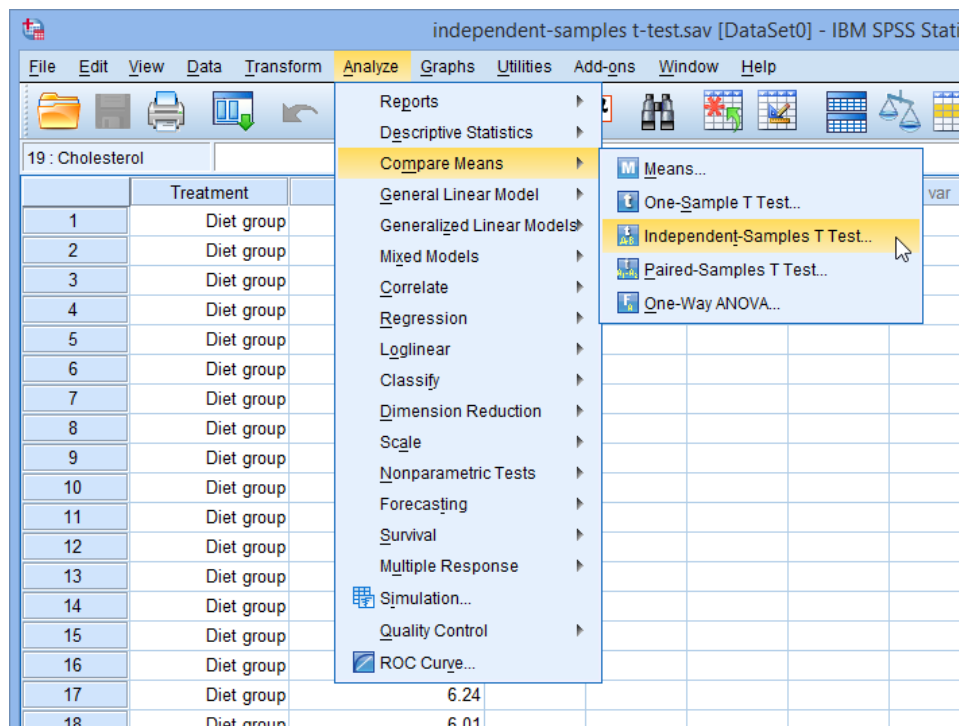

You will be presented with the Independent-Samples T Test dialogue box, as shown below:
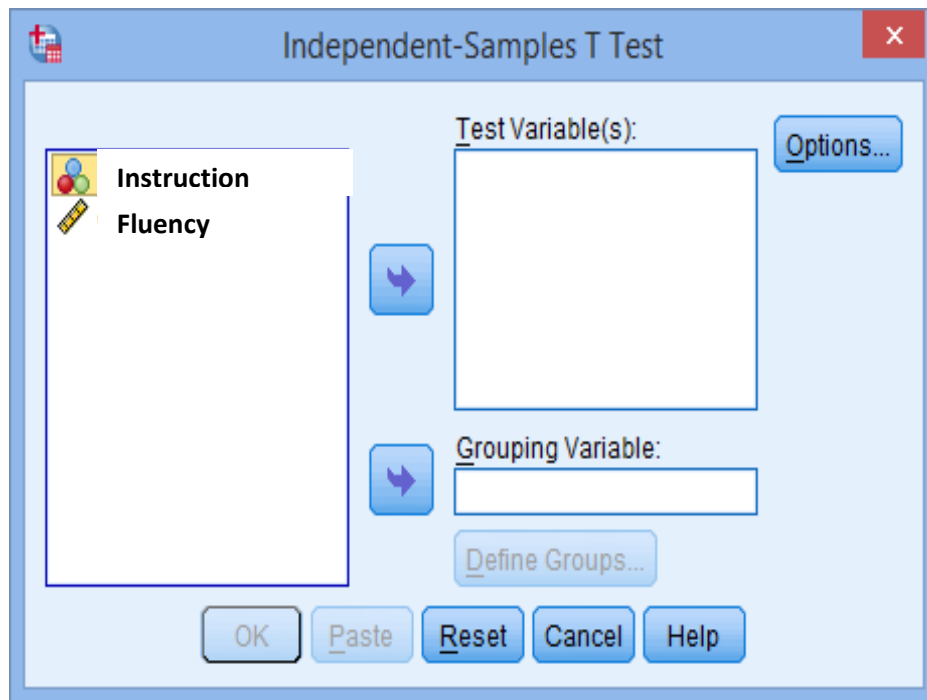
1. Transfer the dependent variable, **Fluency**, into the **Test Variable(s):** box, and transfer the independent variable, **Instruction**, into the **Grouping Variable:** box, by highlighting the relevant variables and pressing the buttons. You will end up with the following screen:


2. You then need to define the groups (Instruction). Click on the button. You will be presented with the **Define Groups** dialogue box, as shown below:
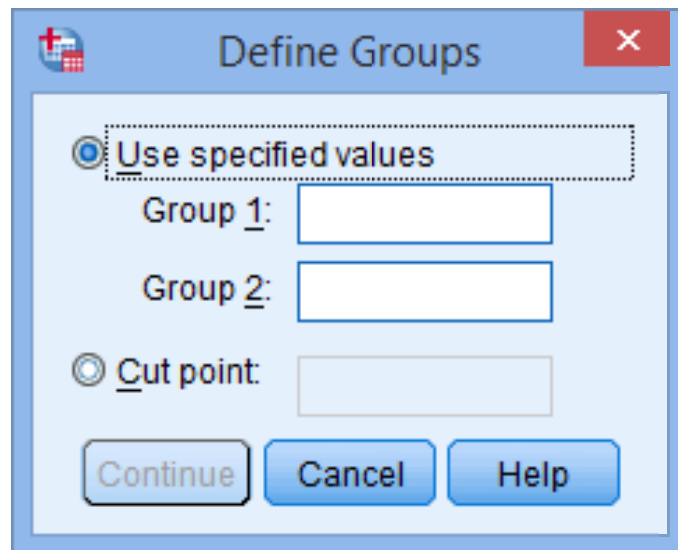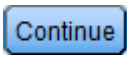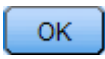
3. Enter "**1**" into the Group <u>1</u>: box for the **Traditional Instruction Group** and enter "**2**" into the Group <u>2</u>: box the **Online Instruction Group.**
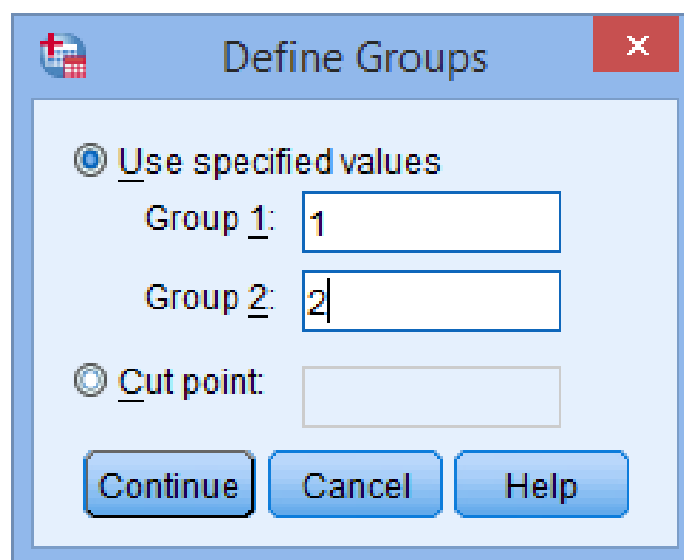
4. Click the Continue button.

5. If you need to change the confidence level limits or change how to exclude cases, click the Options... button. You will be presented with the following:
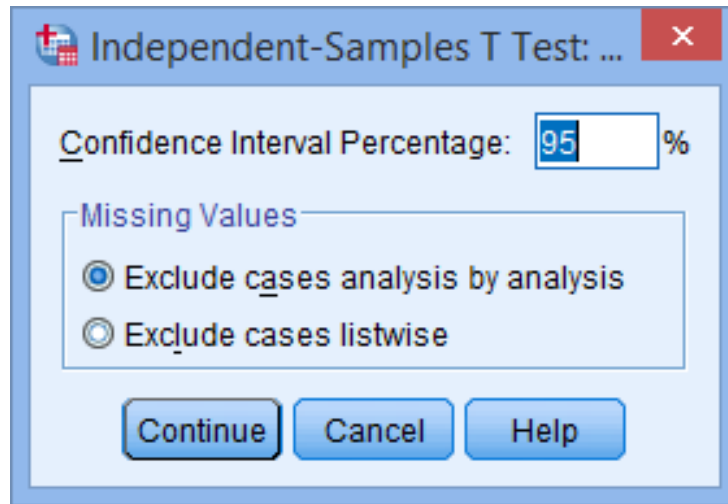
6. Click the **Continue** button. You will be returned to the **Independent-Samples T Test** dialogue box.

7. Click the **OK** button.

Output of the independent t-test in SPSS Statistics

SPSS Statistics generates two main tables of output for the independent t-test. If your data passed the outliers assumption, the normality assumption and the homogeneity of variance assumption, you will only need to interpret these two main tables.

Group Statistics Table

This table provides useful descriptive statistics for the two groups that you compared, including the mean and standard deviation.

Group Statistics

Group		N	Mean	Std. Deviation	Std. Error Mean
Fluency	TI	20	6.1450	.51959	.11618
	Online I	20	5.7950	.38179	.08537

Unless you have other reasons to do so, it would be considered normal to present information on the mean and standard deviation for this data. You might also state the number of participants that you had in each of the two groups. This can be useful when you have missing values and the number of recruited participants is larger than the number of participants that could be analysed.

A diagram can also be used to visually present your results. For example, you could use a bar chart with error bars (e.g., where the error bars could use the standard deviation, standard error or 95% confidence intervals). This can make it easier for others to understand your results.

Independent Samples Test Table

This table provides the actual results from the independent t-test.

Independent Samples Test

		Fluency Level	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	.314	
	Sig.	.579	
t-test for Equality of Means	t	2.428	2.428
	df	38	34.886
	Sig. (2-tailed)	.020	.021
	Mean Difference	.35000	.35000
	Std. Error Difference	.14418	.14418
	95% Confidence Interval of the Difference Lower	.05813	.05727
	Upper	.64187	.64273

You can see that the group means are statistically significantly different because the value in the "**Sig. (2-tailed)**" row is less than 0.05. Looking at the **Group Statistics** table, we can see that those people who took the Online Classes had lower Fluency levels at the end of the programme than those who took the Traditional Classes.