

# Learn How to Perform a One-Way ANOVA Test in SPSS

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The [One-Way Analysis of Variance](#) (ANOVA) is a fundamental statistical technique employed to ascertain whether a [statistically significant difference](#) exists among the means of three or more independent, or unrelated, groups. This method is particularly useful in experimental and observational research where the effect of a categorical factor on a continuous outcome variable needs assessment.

This specific test is termed a **one-way** ANOVA because the analysis focuses on how a single [predictor variable](#) (or factor) influences a continuous response variable. The predictor variable must possess at least three distinct, mutually exclusive levels or groups. If, hypothetically, a researcher were interested in examining the impact of **two** separate predictor variables on the response variable simultaneously, the appropriate statistical procedure would be a [two-way ANOVA](#). Understanding this distinction is crucial for selecting the correct model.

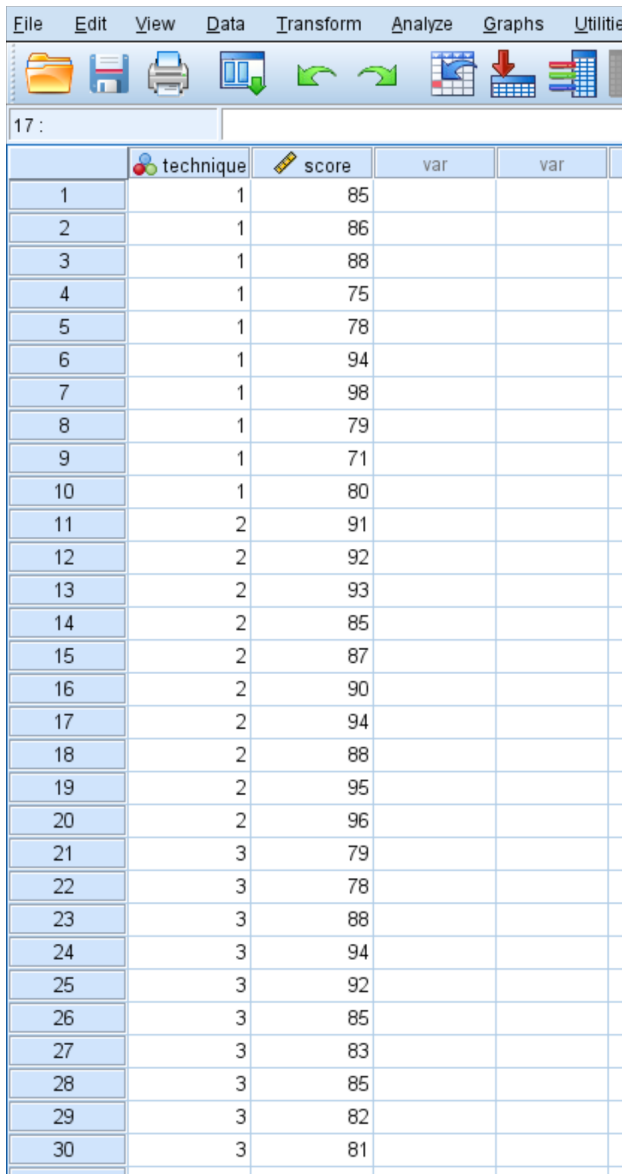
This comprehensive guide details the precise methodology for performing and interpreting a one-way ANOVA using the **SPSS** (Statistical Package for the Social Sciences) software, ensuring the results are robust and accurately reported according to standard statistical conventions.

## Illustrative Example and Data Setup

To demonstrate the procedure, consider a classic research scenario. Suppose a research institution aims to compare the effectiveness of different studying strategies. A total of **30 students** are recruited for the study and are randomly assigned to one of three experimental conditions, representing three distinct studying techniques. Students are instructed to utilize their assigned technique exclusively for a period of one month while preparing for a standardized examination.

At the conclusion of the month-long preparation phase, all 30 participants take the identical exam. The primary outcome variable is the final test score achieved by each student. The fundamental research question is whether the average test scores differ significantly across the three independent groups (Technique 1, Technique 2, and Technique 3). This setup perfectly mandates the use of a one-way ANOVA.

The raw data collected from this experiment, detailing the test scores achieved under each technique, is structured as follows in the SPSS data view:



The screenshot shows the SPSS data editor interface. The menu bar includes File, Edit, View, Data, Transform, Analyze, Graphs, and Utilities. The toolbar contains icons for file operations, data manipulation, and analysis. The data grid shows 30 rows of data with the following columns: technique, score, var, and var. The data is as follows:

	technique	score	var	var
1	1	85		
2	1	86		
3	1	88		
4	1	75		
5	1	78		
6	1	94		
7	1	98		
8	1	79		
9	1	71		
10	1	80		
11	2	91		
12	2	92		
13	2	93		
14	2	85		
15	2	87		
16	2	90		
17	2	94		
18	2	88		
19	2	95		
20	2	96		
21	3	79		
22	3	78		
23	3	88		
24	3	94		
25	3	92		
26	3	85		
27	3	83		
28	3	85		
29	3	82		
30	3	81		

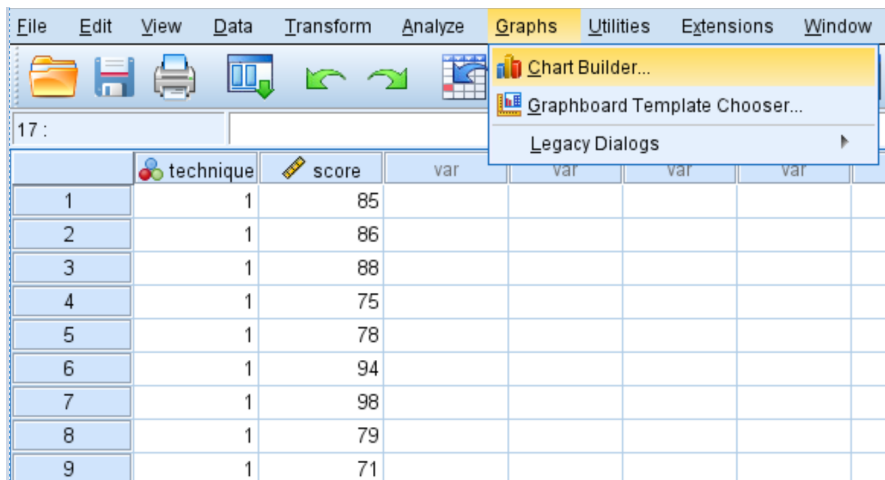
We will now proceed through the necessary steps within SPSS to execute the one-way [ANOVA](#) test and determine if the observed differences in average scores among the three techniques are statistically meaningful.

## Step 1: Visualizing Group Distributions with Boxplots

Before conducting any formal inferential statistical test, it is best practice to visually inspect the data distributions across the groups. This initial visualization helps detect potential outliers, assess the spread of scores, and provide a preliminary indication of differences in means. For comparing continuous data across multiple categorical groups, [boxplots](#) are the ideal visualization tool.

To generate [boxplots](#) in SPSS, navigate to the **Graphs** tab and select **Chart Builder**. In the dialogue box that appears, select **Boxplot** from the "Choose from:" list in the lower left corner.

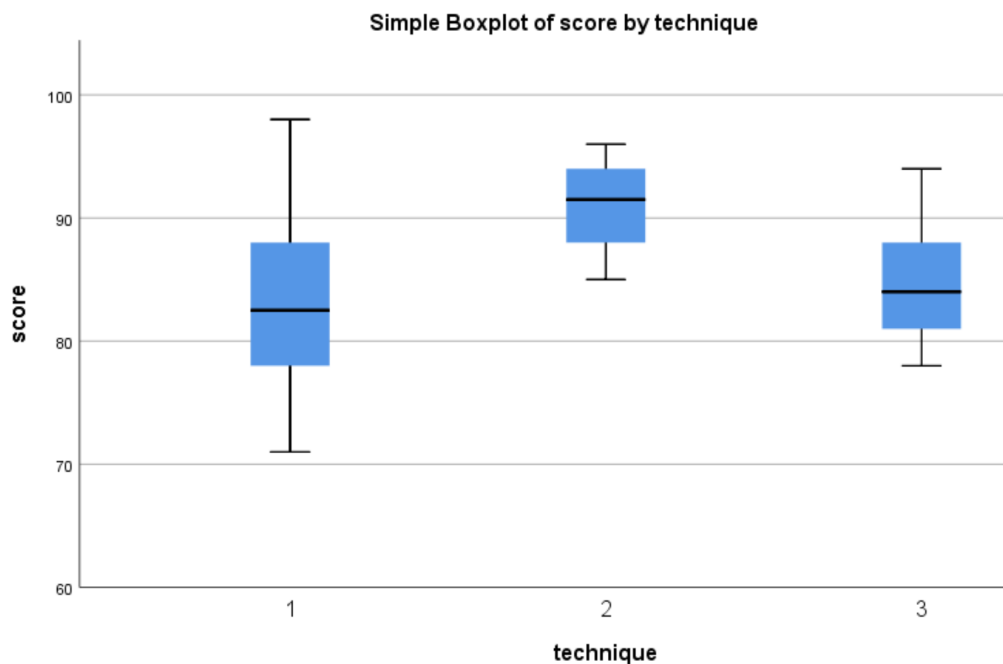
Drag the first chart type, titled **Simple boxplot**, into the main chart editing canvas.



Once the template is on the canvas, map your variables correctly: drag the categorical grouping variable, **technique**, onto the X-Axis drop zone, and the continuous outcome variable, **score**, onto the Y-Axis drop zone. For enhanced visual clarity and focus, you may adjust the scale. Click **Element Properties**, select **Y-axis1**, and then change the **minimum** value of the score axis to 60. Click **OK** to generate the chart.

The screenshot shows the SPSS Chart Builder interface. On the left, the 'Variables' list contains 'technique' and 'score'. The 'Simple Boxplot of score by technique' chart is displayed in the center. The Y-axis is labeled 'score' and the X-axis is labeled 'technique'. The chart shows three boxplots for 'Category 1', 'Category 2', and '[More...]'. The right panel shows the 'Edit Properties of:' section for 'Box1', with 'Y-Axis1 (Box1)' selected. The 'Scale Range' section shows 'Variable: score' and 'Minimum' set to 60. The 'Scale Type' section shows 'Type: Linear'.

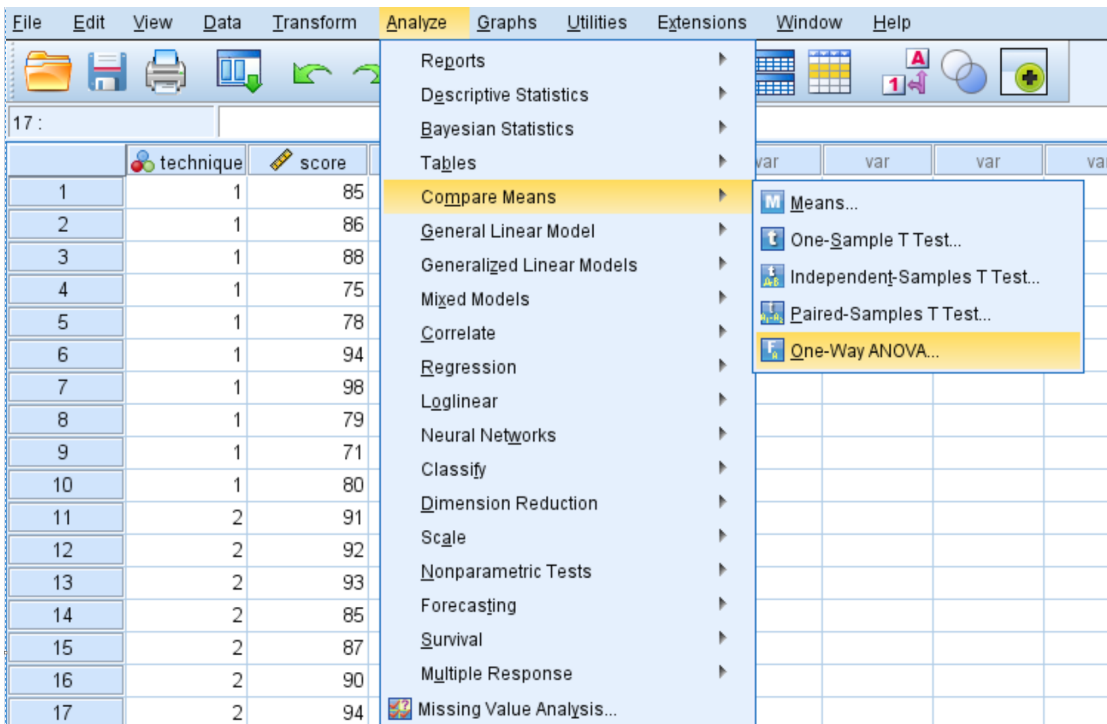
The resulting visualization clearly displays the median, quartiles, and range of test scores for each studying technique. Observing the difference in the central lines (medians) and the overall box positions provides strong graphical evidence regarding the equality of group means.



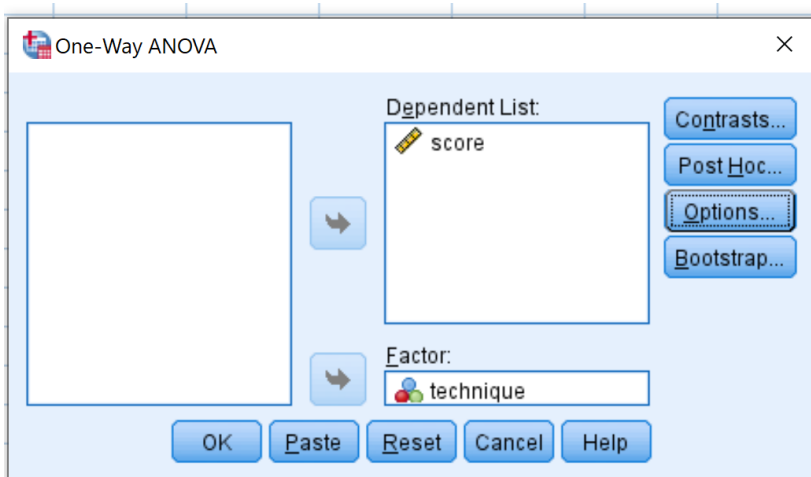
## Step 2: Executing the ANOVA Test in SPSS

With the initial data exploration complete, the next critical step is to execute the formal one-way [ANOVA](#) test. This procedure calculates the F-statistic and associated [p-value](#) required to test the null hypothesis of equal population means.

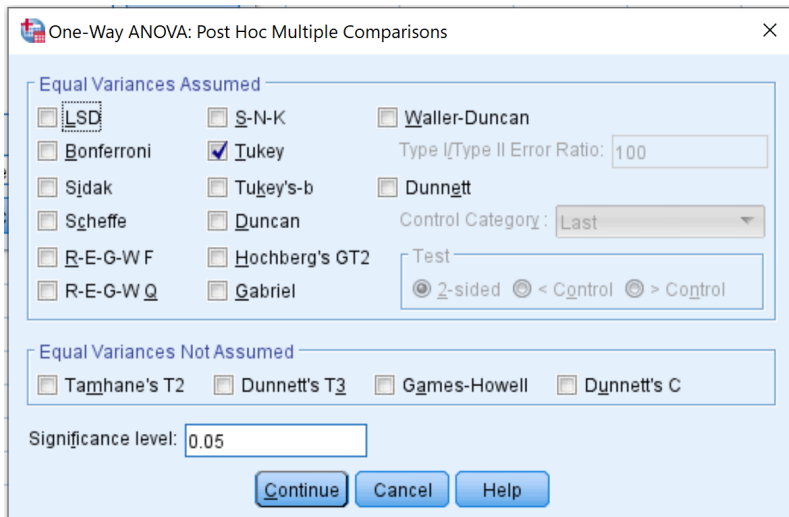
Initiate the procedure by navigating the menu: click the **Analyze** tab, hover over **Compare Means**, and then select **One-Way ANOVA**. This action opens the main dialogue window for the test configuration.



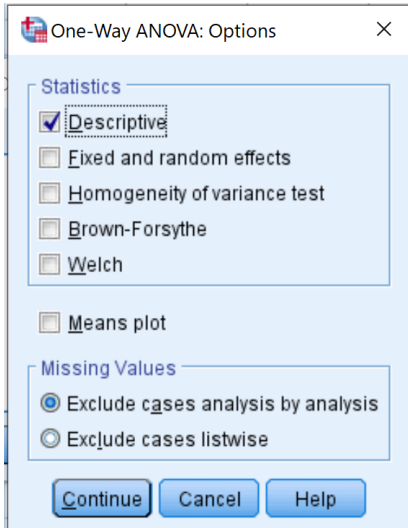
In the resulting dialogue box, correctly assign the variables: the continuous outcome variable, **score**, must be moved into the box labeled **Dependent List**. The categorical grouping variable, **technique**, which defines the independent groups, must be placed into the box labeled **Factor**.



Since ANOVA only tells us if **at least one** group mean is different, but not **which specific pairs** differ, we must request a post-hoc test. Click the **Post Hoc** button. For studies involving equal sample sizes and an assumption of homogeneity of variances (which we typically verify), the **Tukey's Honestly Significant Difference (HSD)** test is a highly recommended and robust option. Check the box next to **Tukey**, and then click **Continue**.



Finally, click the **Options** button. It is essential to generate descriptive statistics alongside the main ANOVA table for complete reporting. Check the box next to **Descriptive**. Researchers often also check for homogeneity of variance here, but for this demonstration, we focus on the core output. Click **Continue** and then click **OK** in the main One-Way ANOVA dialogue box to execute the analysis and display the results in the SPSS Output Viewer.



### Step 3: Interpreting the Statistical Output

The SPSS output provides several critical tables necessary for a thorough interpretation of the results. We must systematically examine the descriptive statistics, the main ANOVA table, and the [Tukey post-hoc multiple comparisons](#) table.

## Descriptives Table Analysis

The first table provides detailed descriptive statistics for the test scores within each of the three studying technique groups. This table is indispensable for quantifying the differences observed visually in the boxplots.

**Descriptives**

score

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	10	83.40	8.435	2.667	77.37	89.43	71	98
2	10	91.10	3.604	1.140	88.52	93.68	85	96
3	10	84.70	5.293	1.674	80.91	88.49	78	94
Total	30	86.40	6.821	1.245	83.85	88.95	71	98

Key metrics to focus on in this table include:

**N:** This confirms the sample size for each group (in this case, N=10 for all groups, totaling 30 participants).

**Mean:** This is the average test score achieved by students utilizing that specific technique. For instance, Technique 1 has a mean score of 81.30, while Technique 2 has a mean of 90.00.

**Std. Deviation:** This measures the spread or variability of the scores around the mean for each group. Lower standard deviation indicates less variability and more consistency within the group's performance.

## ANOVA Table Interpretation

The central output for the one-way [ANOVA](#) test is presented in the ANOVA table. This table determines whether there is an overall significant difference among the group means.

**ANOVA**

score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	339.800	2	169.900	4.545	.020
Within Groups	1009.400	27	37.385		
Total	1349.200	29			

The ANOVA test operates under the following set of hypotheses:

**H<sub>0</sub> (null hypothesis):**  $\mu_1 = \mu_2 = \mu_3$  (All population means are equal; the studying technique has no effect).

**H<sub>A</sub> (alternative hypothesis):** At least one population mean is different from the rest (the studying technique does have a statistically significant effect).

The crucial values derived from the ANOVA table are:

**F:** This is the calculated overall F-statistic (4.545), which represents the ratio of variance between groups to variance within groups.

**Sig. (Significance):** This column contains the [p-value](#) corresponding to the calculated F-statistic, considering the degrees of freedom (df numerator = 2, df denominator = 27). In this specific example, the [p-value](#) is **.020**.

To make a decision, we compare the [p-value](#) (0.020) to the standard significance level (alpha = 0.05). Since 0.020 is less than 0.05, we possess sufficient evidence to **reject the null hypothesis**. This statistically confirms that there is a significant difference in average test scores between at least two of the studying technique groups.

### Multiple Comparisons (Post-Hoc) Table

Although the ANOVA test confirms an overall difference, it does not identify which specific pairs of groups are significantly different. For this detailed pairwise comparison, we turn to the [Tukey post-hoc multiple comparisons](#) table, which adjusts the significance level to control the family-wise error rate.

#### Multiple Comparisons

Dependent Variable: score

Tukey HSD

(I) technique	(J) technique	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-7.700*	2.734	.024	-14.48	-.92
	3	-1.300	2.734	.883	-8.08	5.48
2	1	7.700*	2.734	.024	.92	14.48
	3	6.400	2.734	.067	-.38	13.18
3	1	1.300	2.734	.883	-5.48	8.08
	2	-6.400	2.734	.067	-13.18	.38

\*. The mean difference is significant at the 0.05 level.

We analyze the **Sig.** column within this table, which displays the adjusted [p-values](#) for the difference in means between every possible pair of groups:

**Technique 1 vs. Technique 2:** The [p-value](#) is **0.024**. Since  $0.024 < 0.05$ , this comparison is **statistically significant**.

**Technique 1 vs. Technique 3:** The p-value is **0.883**. Since  $0.883 > 0.05$ , there is **no significant difference**.

**Technique 2 vs. Technique 3:** The p-value is **0.067**. Since  $0.067 > 0.05$ , there is **no significant difference** (though this result is borderline).

The post-hoc analysis clearly indicates that the only group comparison yielding a statistically significant difference in average test scores is between Technique 1 and Technique 2. Technique 2 proved significantly more effective than Technique 1, but neither Technique 1 nor Technique 2 differed significantly from Technique 3.

#### Step 4: Reporting the Final Results

The final stage of the analysis involves reporting the findings in a clear, standardized format, typically adhering to APA style guidelines. This ensures that readers can quickly understand the statistical procedure, the key results, and the corresponding conclusions. The report must include the descriptive statistics, the main ANOVA results (F-statistic, degrees of freedom, and p-value), and the outcome of the post-hoc tests.

When synthesizing the results, emphasize the relationship between the overall test outcome and the specific pairwise comparisons. For example, the rejection of the [null hypothesis](#) by the ANOVA is confirmed and detailed by the Tukey's test, which isolates the significant difference to a single pair of groups.

Here is an exemplary structure for reporting the findings of this one-way ANOVA:

A one-way [ANOVA](#) was conducted to investigate whether three distinct studying techniques resulted in differing average test scores.

A total of 30 students, with 10 students randomly assigned to each of the three techniques, participated in the study over one month. Descriptive statistics showed mean scores of 81.30 (Technique 1), 90.00 (Technique 2), and 85.80 (Technique 3).

The one-way [ANOVA](#) revealed a statistically significant difference in test scores between at least two of the groups ( $F(2, 27) = 4.545, p = 0.020$ ).

Subsequent [Tukey's test for multiple comparisons](#) was performed to explore these differences. The analysis indicated that mean test scores were significantly higher for students using Technique 2 compared to those using Technique 1 ( $p = .024, 95\% \text{ C.I.} =$ ).

However, no statistically [significant difference](#) was found between Technique 1 and Technique 3 ( $p$

= .883) or between Technique 2 and Technique 3 ( $p = .067$ ). This suggests that while Technique 2 is superior to Technique 1, Technique 3's performance is not reliably distinct from either of the other two methods at the 0.05 significance level.