PERFORMING THE MANN–WHITNEY *U*-TEST AND THE KOLMOGOROV–SMIRNOV TWO-SAMPLE TEST USING SPSS

OBJECTIVE

In this lecture, you will learn the following items:

- How to perform the Mann−Whitney *U*-test and the Kolmogorov−Smirnov two-sample test using SPSS.

PERFORMING THE MANN–WHITNEY *U*-TEST AND THE KOLMOGOROV–SMIRNOV TWO-SAMPLE TEST USING SPSS

We will analyze the data from the example in Lecture 7 using SPSS.

Define Your Variables

First, click the “Variable View” tab at the bottom of your screen.

Then, type the names of your variables in the “Name” column. Unlike the related samples described in Lecture 2, you cannot simply enter each unrelated samples into a separate column to execute the Mann–Whitney *U*-test or Kolmogorov–Smirnov two-sample test.

You must use a grouping variable to distinguish each sample. As shown in Figure 2, the first variable is the grouping variable that we called “Method.” The second variable that we called “Score” will have our actual values.

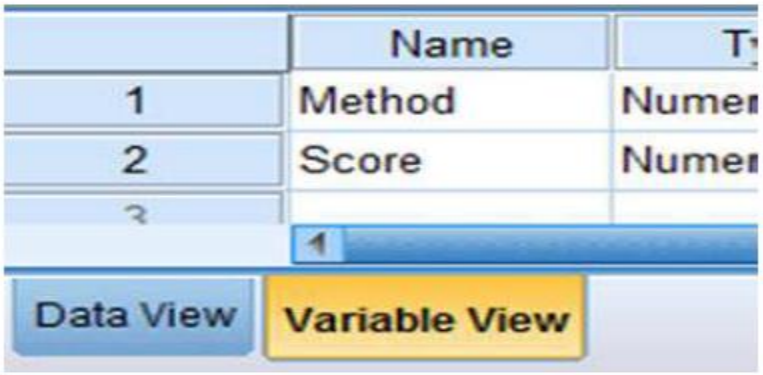


FIGURE 2

When establishing a grouping variable, it is often asiest to assign each group a whole number value. In our example, our groups are “Method 1” and “Method 2.”

Therefore, we must set our grouping variables for the variable “Method.” First, we selected the “Values” column and clicked the gray square, as shown in Figure 3. Then, we set a value of 1 to equal “Method 1.” Now, as soon as we click the “Add” button, we will have set “Method 2” equal to 2 based on the values we inserted above.

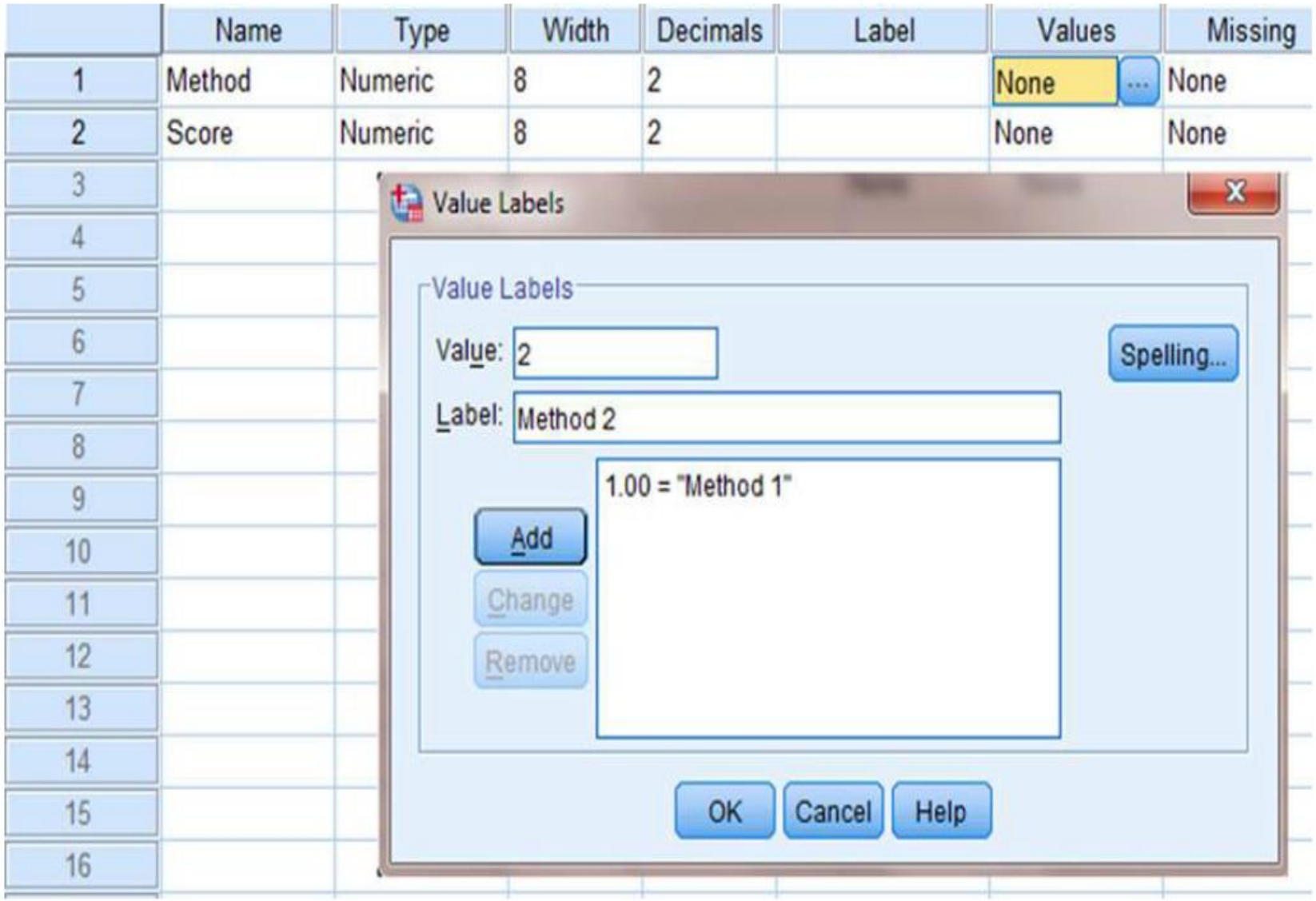
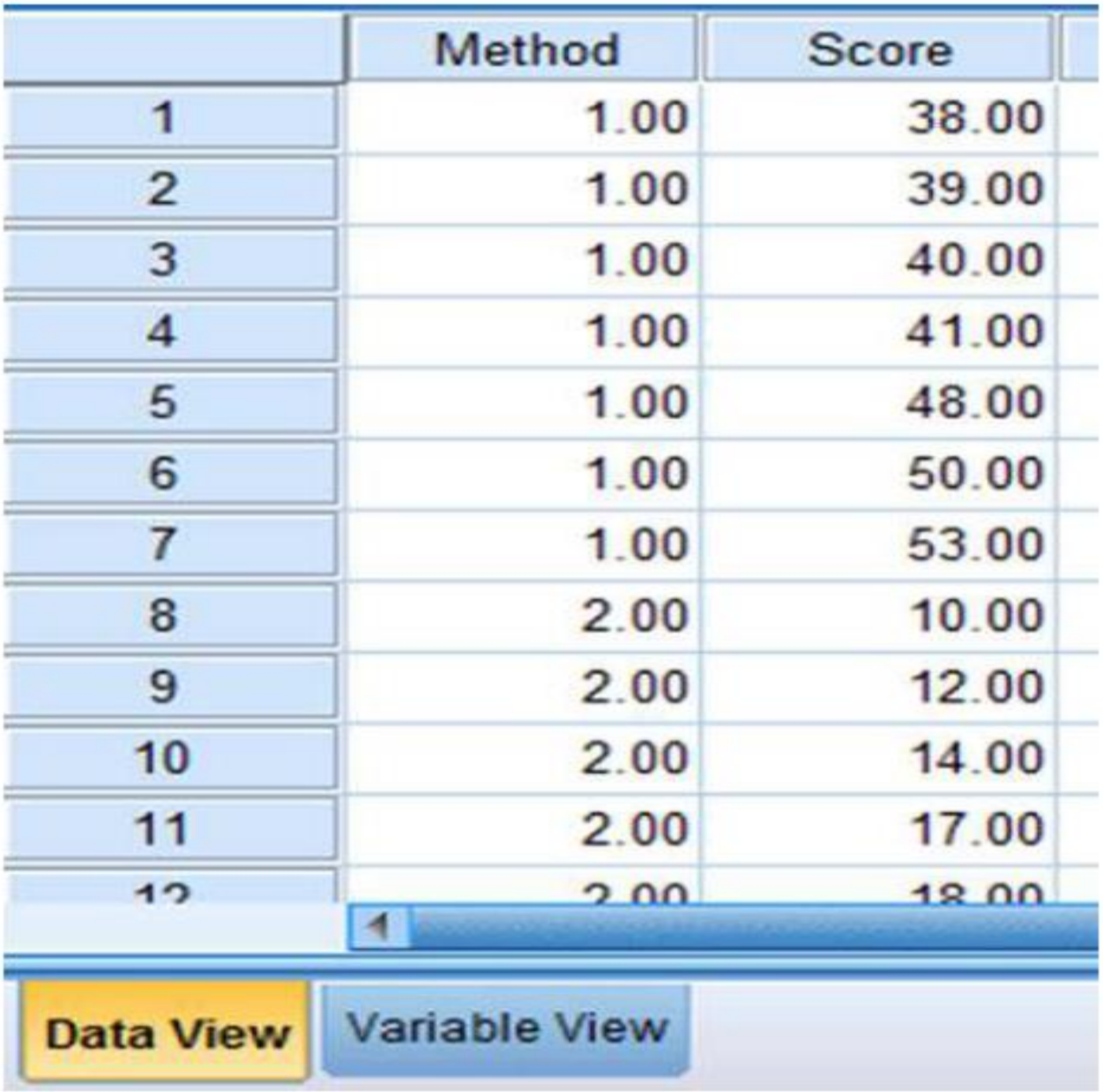

Name
Type
Width
Decimals
Label
Values
Missing
1
Method
Numeric
8
2
None
None
2
Score
Numeric
8
2
None
None
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Value Labels
Value Labels
Value: 2
Label: Method 2
Spelling...
1.00 = "Method 1"
Add
Change
Remove
OK
Cancel
Help

FIGURE 3

Type in Your Values

Click the “Data View” tab at the bottom of your screen as shown in Figure 4. Type in the values for both sets of data in the “Score” column. As you do so, type in the corresponding grouping variable in the “Method” column. For example, all of the values for “Method 2” are signified by a value of 2 in the grouping variable column that we called “Method.”



	Method	Score
1	1.00	38.00
2	1.00	39.00
3	1.00	40.00
4	1.00	41.00
5	1.00	48.00
6	1.00	50.00
7	1.00	53.00
8	2.00	10.00
9	2.00	12.00
10	2.00	14.00
11	2.00	17.00
12	2.00	18.00

FIGURE 4

Analyze Your Data

As shown in Figure 5, use the pull-down menus to choose "Analyze," "Nonparametric Tests," "Legacy Dialogs," and "2 Independent Samples. . . ."

Use the top arrow button to place your variable with your data values, or dependent variable (DV), in the box labeled "Test Variable List:." Then, use the lower arrow button to place your grouping variable, or independent variable (IV), in the box labeled "Grouping Variable."

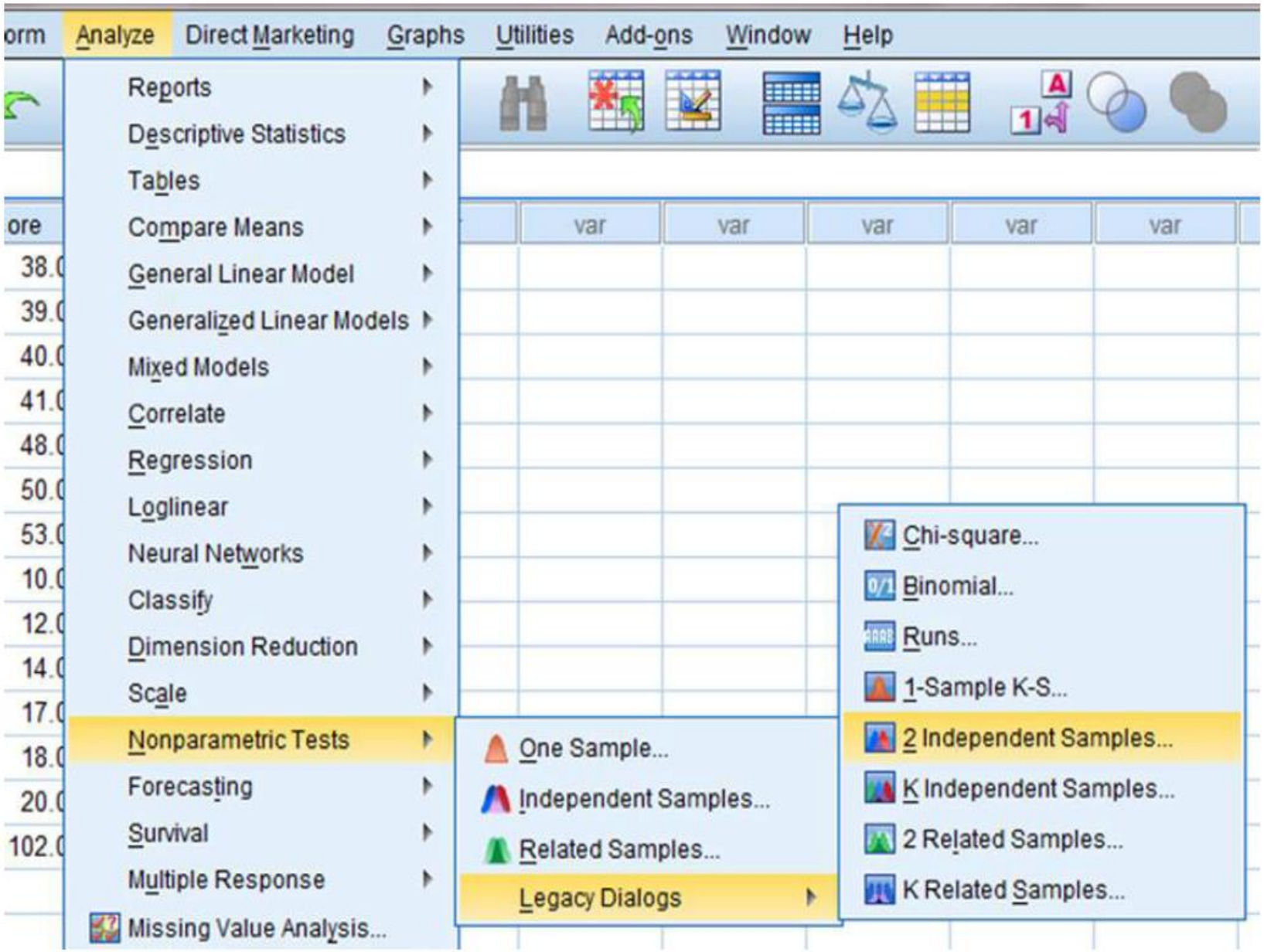

orm
Analyze
Direct Marketing
Graphs
Utilities
Add-ons
Window
Help
Reports
Descriptive Statistics
Tables
Compare Means
General Linear Model
Generalized Linear Models
Mixed Models
Correlate
Regression
Loglinear
Neural Networks
Classify
Dimension Reduction
Scale
Nonparametric Tests
Forecasting
Survival
Multiple Response
Missing Value Analysis...
One Sample...
Independent Samples...
Related Samples...
Legacy Dialogs
Chi-square...
Binomial...
Runs...
1-Sample K-S...
2 Independent Samples...
K Independent Samples...
2 Related Samples...
K Related Samples...
ore
var
38.0
39.0
40.0
41.0
48.0
50.0
53.0
10.0
12.0
14.0
17.0
18.0
20.0
102.0

FIGURE 5

As shown in Figure 6, we have placed the “Score” variable in the “Test Variable List” and the “Method” variable in the “Grouping Variable” box. Click on the “Define Groups . . .” button to assign a reference value to your IV (i.e., “Grouping Variable”).

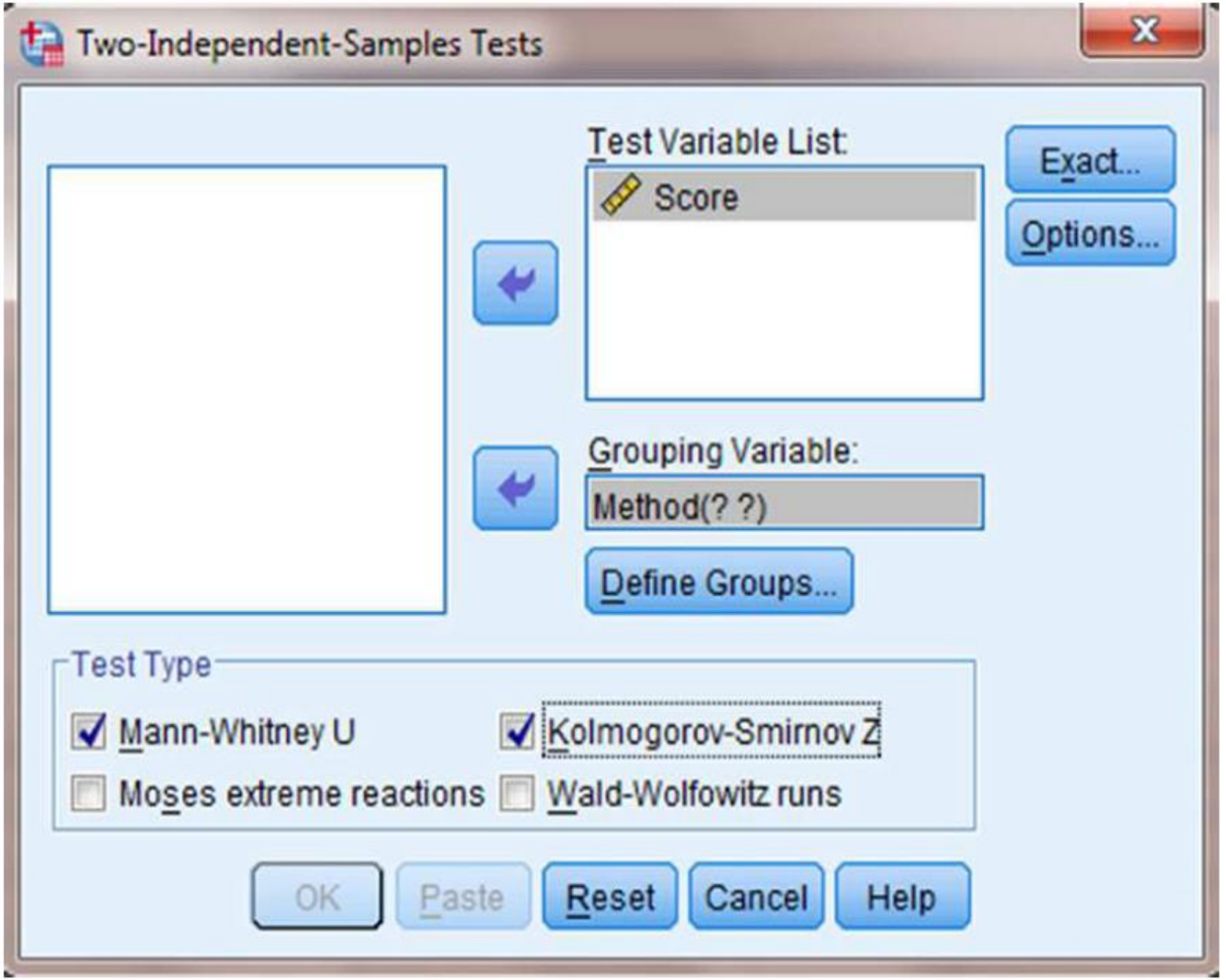

Two-Independent-Samples Tests
Test Variable List:
Score
Exact...
Options...
Grouping Variable:
Method(? ?)
Define Groups...
Test Type
Mann-Whitney U
Kolmogorov-Smirnov Z
Moses extreme reactions
Wald-Wolfowitz runs
OK
Paste
Reset
Cancel
Help

FIGURE 6

As shown in Figure 7, type 1 into the box next to “Group 1:” and 2 in the box next to “Group 2:.” Then, click “Continue.” This step references the value labels you created when you defined your grouping variable in step 1. Now that the groups have been assigned, click “OK” to perform the analysis.

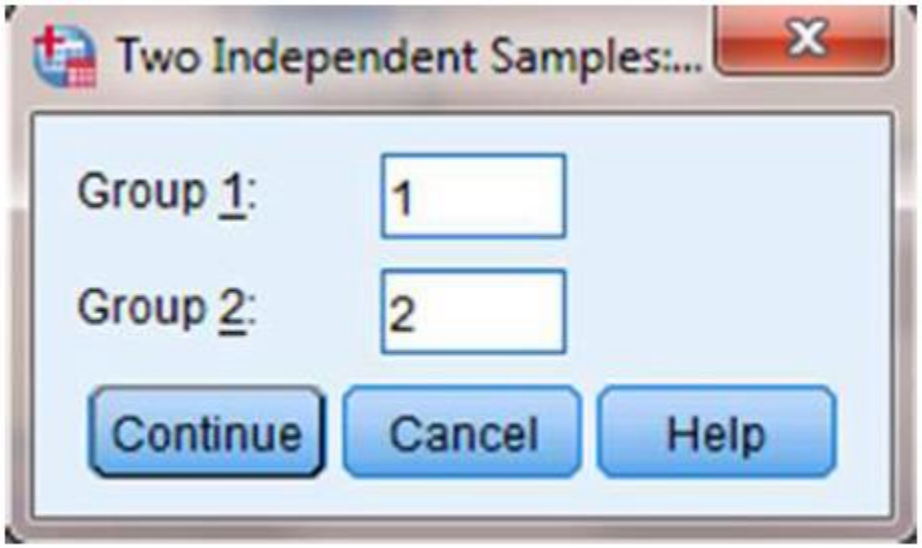


FIGURE 7

Interpret the Results from the SPSS Output Window

We first compare the samples with the Mann–Whitney U-test. SPSS Output 1 provides the sum of ranks and sample sizes for comparing the two groups. The second output table provides the Mann–Whitney U-test statistic (U = 7.0).

As described in Figure 2, it also returns a similar nonparametric statistic called the Wilcoxon W-test statistic (W = 35.0). Notice that the Wilcoxon W is the smaller of the two rank sums in the table earlier.

SPSS returns the critical z-score for large samples. In addition, SPSS calculates the two-tailed significance using two methods. The asymptotic significance is more appropriate with large samples. However, the exact significance is more appropriate with small samples or data that do not resemble a normal distribution.

Based on the results from SPSS, the ranked reading comprehension test scores of the two methods were significantly different ($U = 7$, $n_1 = 7$, $n_2 = 7$, $p < 0.05$).

The sum of ranks for method 1 ($\sum R_1 = 70$) was larger than the sum of ranks for method 2 ($\sum R_2 = 35$).

Mann-Whitney Test

Ranks

	Method	N	Mean Rank	Sum of Ranks
Score	Method 1	7	10.00	70.00
	Method 2	7	5.00	35.00
	Total	14		

Test Statistics[a]

	Score
Mann-Whitney U	7.000
Wilcoxon W	35.000
Z	-2.236
Asymp. Sig. (2-tailed)	.025
Exact Sig. [2*(1-tailed Sig.)]	.026[b]

a. Grouping Variable: Method

b. Not corrected for ties.

SPSS OUTPUT 1

Next, we analyzed the data with the Kolmogorov–Smirnov two-sample test.

SPSS Output 2 provides the most extreme differences, $D_{max} = 0.857$. The second output table provides the Kolmogorov–Smirnov two-sample test statistic, $Z = 1.604$, and the two-tailed significance, $p = 0.012$.

Two-Sample Kolmogorov-Smirnov Test

Frequencies

	Method	N
Score	Method 1	7
	Method 2	7
	Total	14

Test Statistics[a]

		Score
Most Extreme Differences	Absolute	.857
	Positive	.143
	Negative	-.857
Kolmogorov-Smirnov Z		1.604
Asymp. Sig. (2-tailed)		.012

a. Grouping Variable: Method

SPSS OUTPUT 2

The results from the Kolmogorov–Smirnov two-sample test ($D = 0.857$, $p < 0.05$) indicate a significant difference between the two methods.

Therefore, we can state that the data support the pull-out program as a more effective reading program for teaching comprehension to 4th-grade children at this school.

SUMMARY

In this lecture, we described how to perform and interpret the Mann–Whitney U-test and the Kolmogorov–Smirnov two-sample test using SPSS. We demonstrated a small samples for each test.