# Introduction to Applied Statistical Methods

## Practical Session 5 - Solutions

**Please download and open the SPSS Data file "Practical 5 data.sav" from KEATS**

*Background:*
The data set consists of a sample of *n*=154 students attending three postgraduate programmes (affective disorders AF, clinical neuropsychiatry CN, and mental health studies MH), at the IoPPN in 2017. In this dataset you will find the following variables:

- **programme**: the programme the students were attending (1: AF, 2:CN, 3:MH)
- **group**: the teaching group (1: AF and CN, 2: MH)
- **anx**: the scores on the 'anxiety related to statistics' scale, which the students completed during the first week of Term 1.
- **catgrade**: the ability category (with respect to statistics) at which each student belonged at the beginning of the term, based on the Prior Knowledge Quiz (1: Low, 2: Sufficient, 3: Good, 4: High).
- **quiz1**: the grades on the practical quiz 1, which the students completed on KEATS
- **quiz2**: the grades on the practical quiz 2, which the students completed on KEATS

## Task 1

First, identify the type of each variable in the dataset.

| | | |
|---|---|---|
| **programme** is | **a categorical nominal** | variable |
| **group** is | **a categorical nominal (binary)** | variable |
| **anx** is | **a numerical continuous** | variable |
| **catgrade** is | **a categorical ordinal (4 points)** | variable |
| **quiz1** is | **a numerical continuous** | variable |

| | | |
|---|---|---|
| **quiz2** is | **a numerical continuous** | variable |

## Task 2

Fill in the blanks to appropriately describe the data, giving your answers to one decimal place.

In the sample, there are 19 (12.3 %) students from the affective disorders programme, 28 ( 18.2 %) students from the clinical neuropsychiatry, and 107 ( 69.5 %) students from the mental health programme. With respect to their prior knowledge in statistics, 13 ( 8.4 %) students started their training with *low* prior knowledge, 56 ( 36.4 %) students started with *sufficient* prior knowledge, 53 ( 34.4 %) students started with good prior knowledge, 15 (9.7 %) students started with *high* prior knowledge, and 17 ( 11.0 %) students did not take the test.

Regarding the '*anxiety related to statistics*' scale, the students' scores were normally distributed with mean anxiety = 35.2 (sd= 16.4, min= 0 , max= 70). The scores for both Progress Quizzes were negatively skewed, with most students scoring towards the upper end of the distribution. Specifically, the median for first Quiz was 75.0 (min= 15.9 - max= 95.5) and the median for second Quiz was 82.5 (min= 12.5 - max= 100.0).

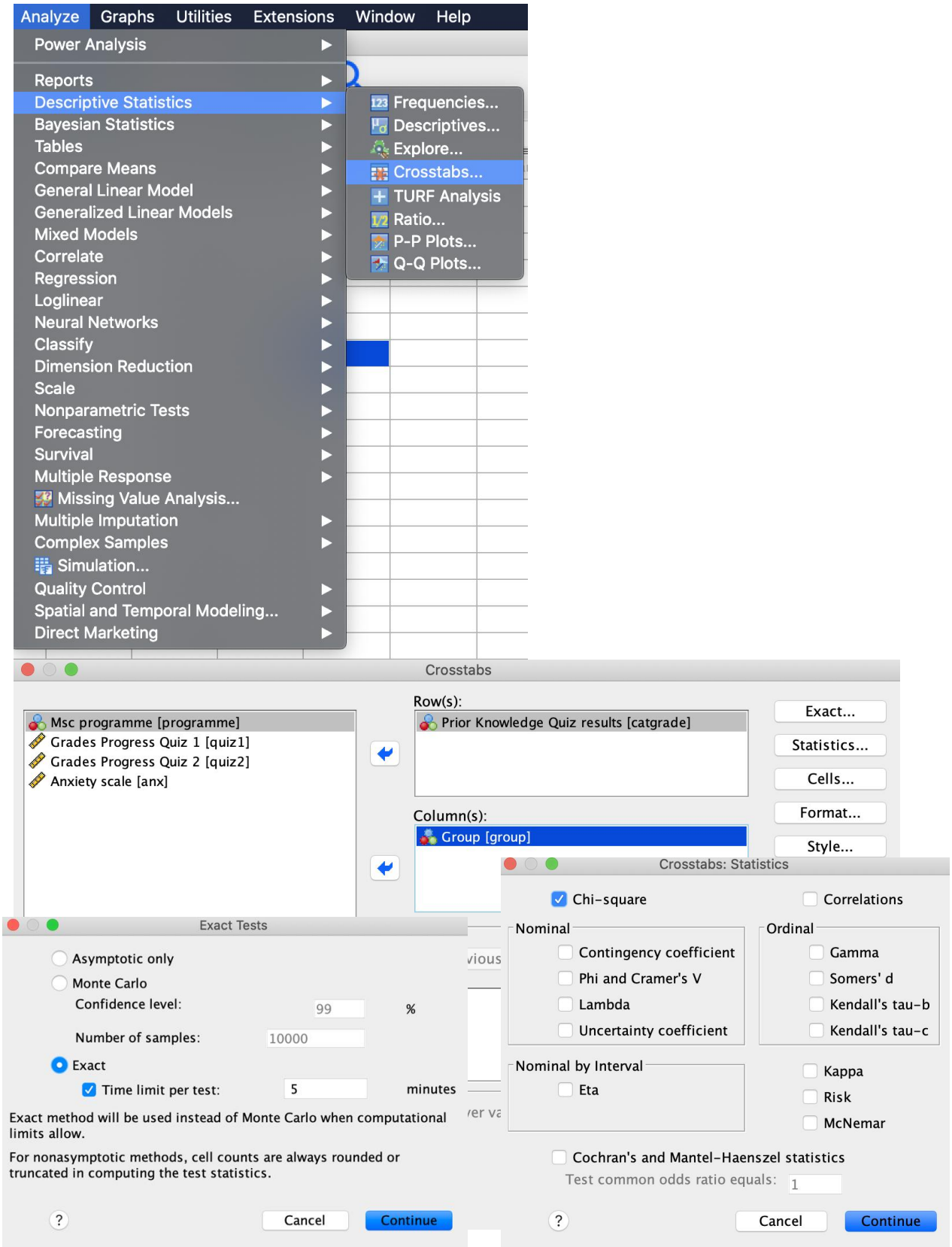
## Task 3

Based on the summary, for which of the variables you would use parametric and for which non-parametric tests?

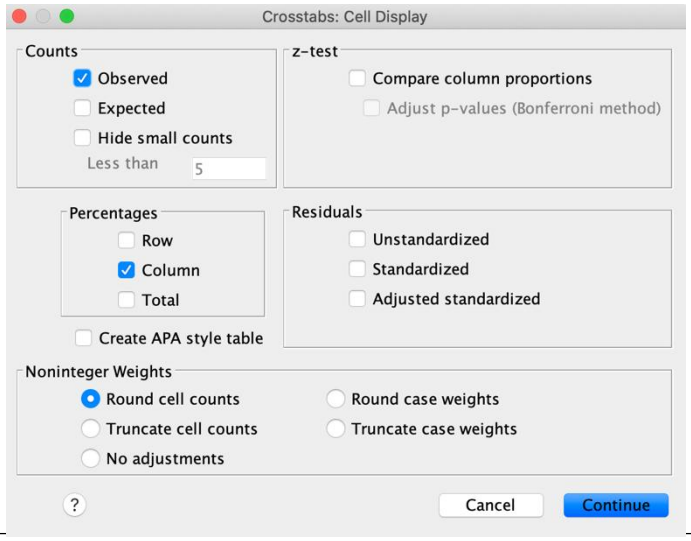
| |
|---|
| parametric tests: **anxiety scores** |
| non-parametric tests: **quiz 1 and quiz 2 scores** |

# Task 4

Use the appropriate test to see if there are statistically significant differences between the two teaching groups (*AD&CN and MH*) in the percentages of students belonging to each of the 'prior knowledge' categories (*low, sufficient, good, high*). Report on the results.



Output:




| Prior Knowledge Quiz results * Group Crosstabulation | | | | | |
|---|---|---|---|---|---|
| | | | Group | | Total |
| | | | AD and CN | MH | |
| Prior Knowledge Quiz | Low | Count | 4 | 9 | 13 |

| | | | | | |
|---|---|---|---|---|---|
| results | | % within Group | 10.80% | 9.00% | 9.50% |
| | Sufficient | Count | 11 | 45 | 56 |
| | | % within Group | 29.70% | 45.00% | 40.90% |
| | Good | Count | 18 | 35 | 53 |
| | | % within Group | 48.60% | 35.00% | 38.70% |
| | High | Count | 4 | 11 | 15 |
| | | % within Group | 10.80% | 11.00% | 10.90% |
| Total | | Count | 37 | 100 | 137 |
| | | % within Group | 100.00 % | 100.00 % | 100.00 % |

| Chi-Square Tests | | | | | | |
|---|---|---|---|---|---|---|
| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) | Point Probability |
| Pearson Chi-Square | 2.935[a] | 3 | 0.402 | 0.412 | | |
| Likelihood Ratio | 2.978 | 3 | 0.395 | 0.421 | | |
| **Fisher-Freeman-Halton Exact Test** | **3.069** | | | **0.393** | | |
| Linear-by-Linear Association | .535[b] | 1 | 0.465 | 0.481 | 0.27 | 0.072 |
| N of Valid Cases | 137 | | | | | |
| **a 2 cells (25.0%) have expected count less than 5. The minimum expected count is 3.51.** | | | | | | |
| b The standardized statistic is -.731. | | | | | | |

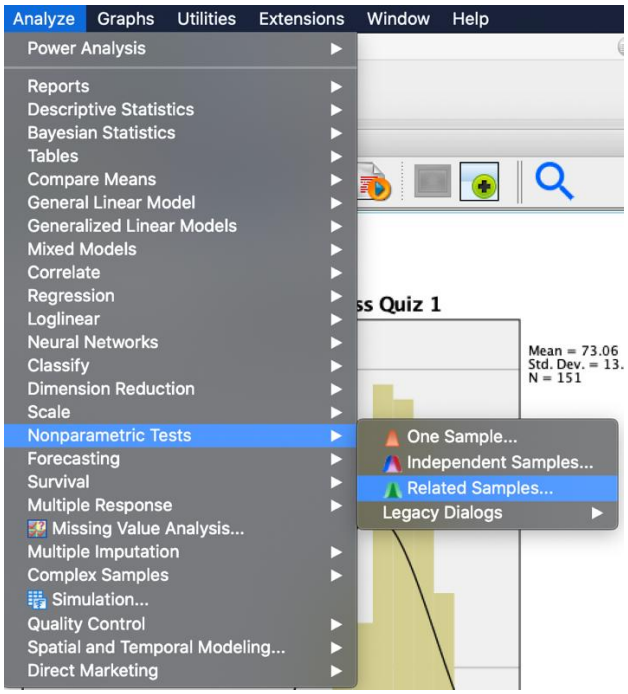
**For two independent groups, the appropriate test is Pearson's chi square, provided the assumptions of the test hold. However, the assumptions did not hold, so we report instead on the Fisher's exact test.**

**The was no association between the group membership and the level of prior knowledge in statistics (Fisher's exact test p=0.393).**

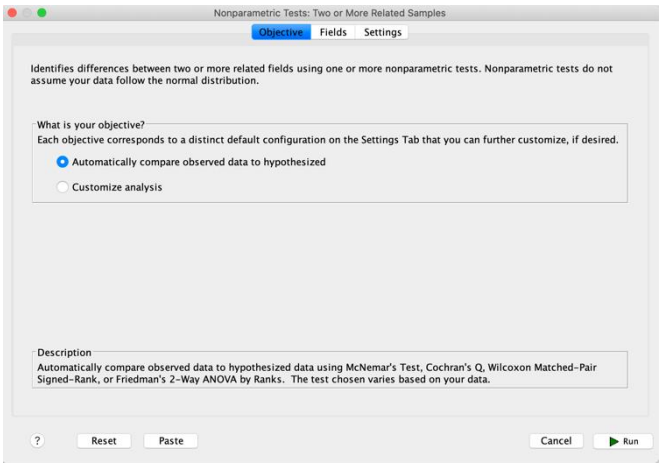
## Task 5

Use the appropriate test to see if there are statistically significant differences between the student's results on Progress Quiz 1 and Progress Quiz 2. Was there any improvement?

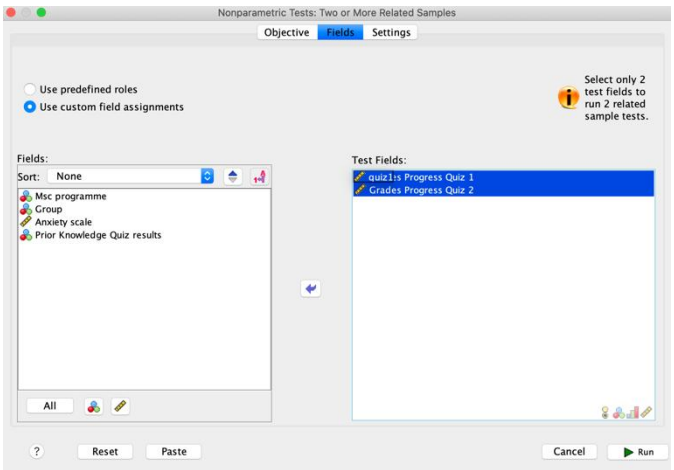
**We can see from the histogram (not shown) of the difference between the two variables of interest (Progress Quiz 1 and Progress Quiz 2) that the distribution of the difference has a skewed distribution. Therefore, we use the Wilcoxon signed rank test instead of a repeated measures t-test.**

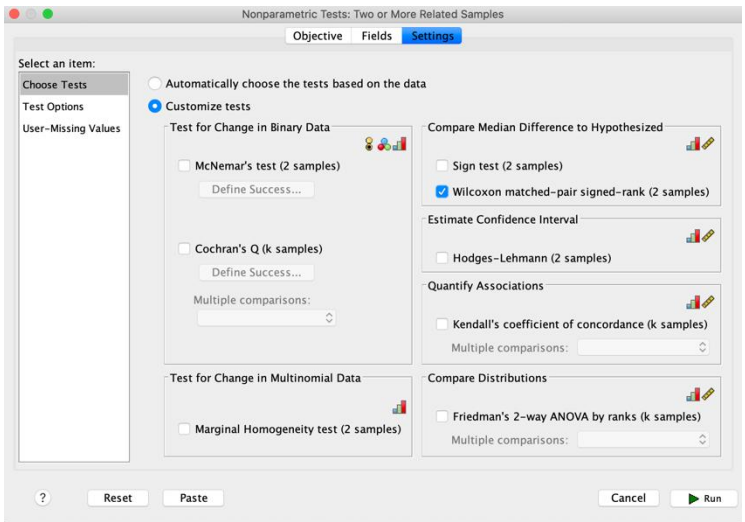



1.




2.




3.

Output:

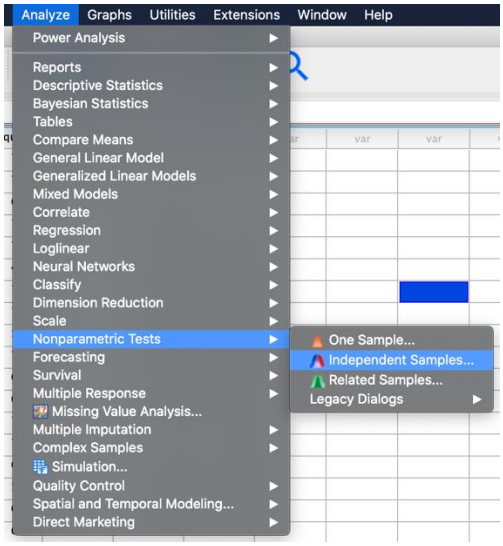
| Hypothesis Test Summary | | | | |
|---|---|---|---|---|
| | Null Hypothesis | Test | Sig.[a,b] | Decision |
| 1 | The median of differences between Grades Progress Quiz 1 and Grades Progress Quiz 2 equals 0. | Related-Samples Wilcoxon Signed Rank Test | 0 | Reject the null hypothesis. |
| a The significance level is .050. | | | | |
| b Asymptotic significance is displayed. | | | | |

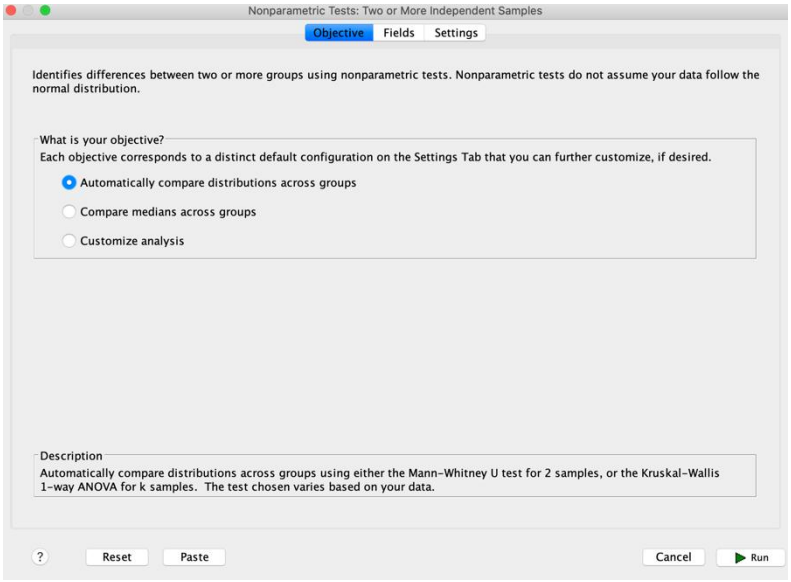
| Related-Samples Wilcoxon Signed Rank Test Summary | |
|---|---|
| Total N | 122 |
| Test Statistic | 5700 |
| Standard Error | 391.37 |
| Standardized Test Statistic | 4.979 |
| Asymptotic Sig.(2-sided test) | 0 |

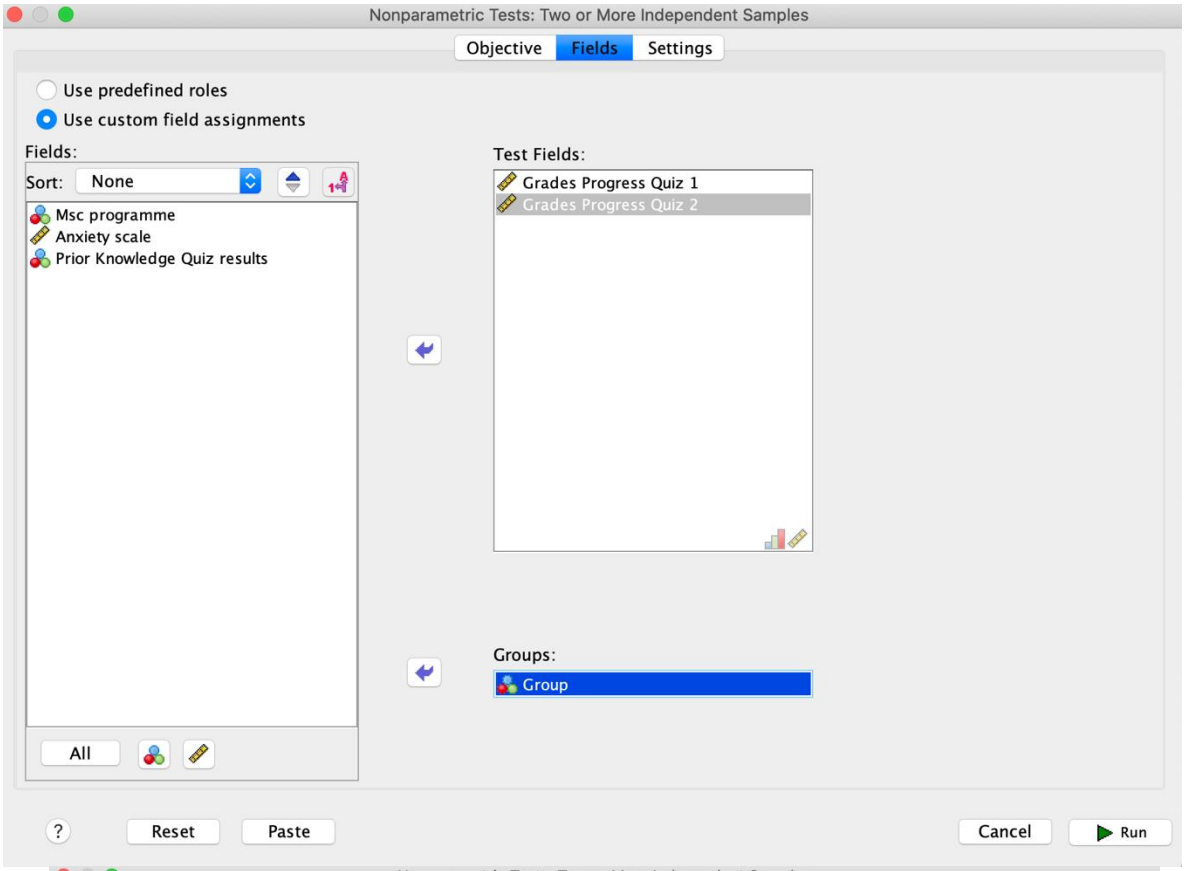
**The students scored higher in Quiz 2 than Quiz 1 (Quiz 1 median= 75.0; Quiz 2 median=82.5). This was a significant difference, according to the Wilcoxon signed rank test (Z=4.979, p<0.001).**

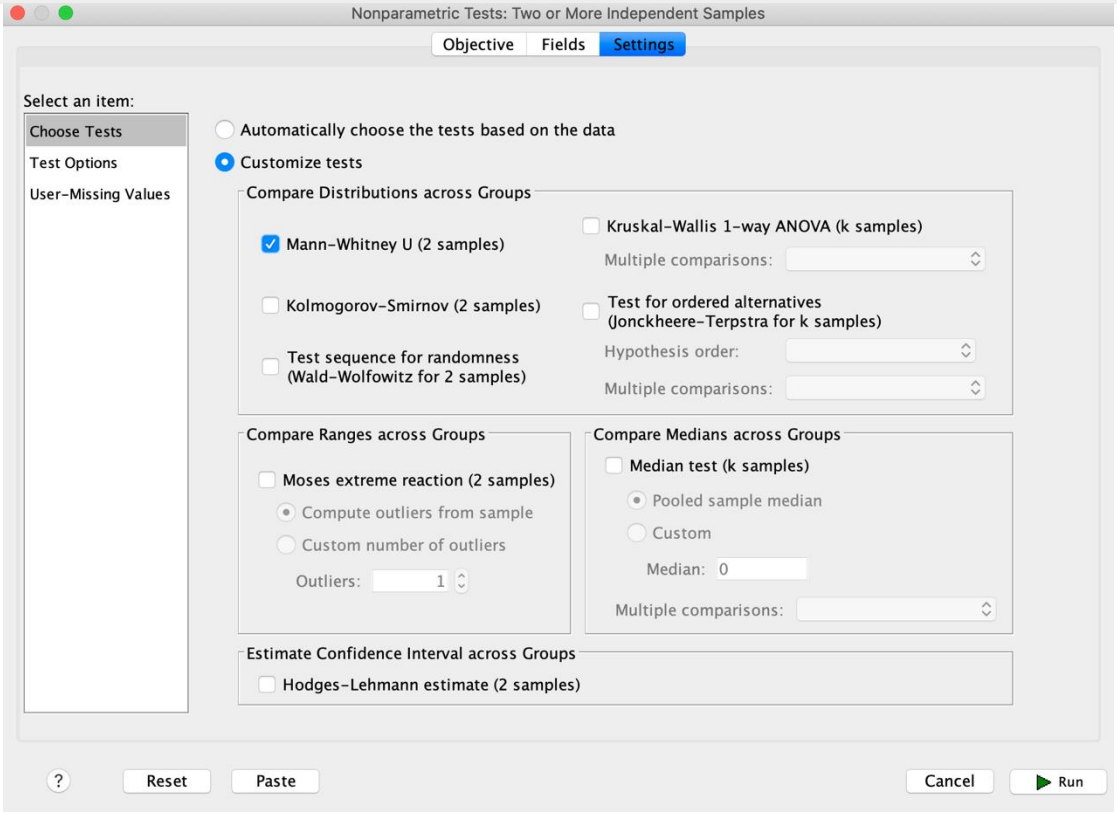
## Task 6

Use the appropriate test to see there were statistically significant differences between the two teaching groups with respect to their performance in the progress quizzes.



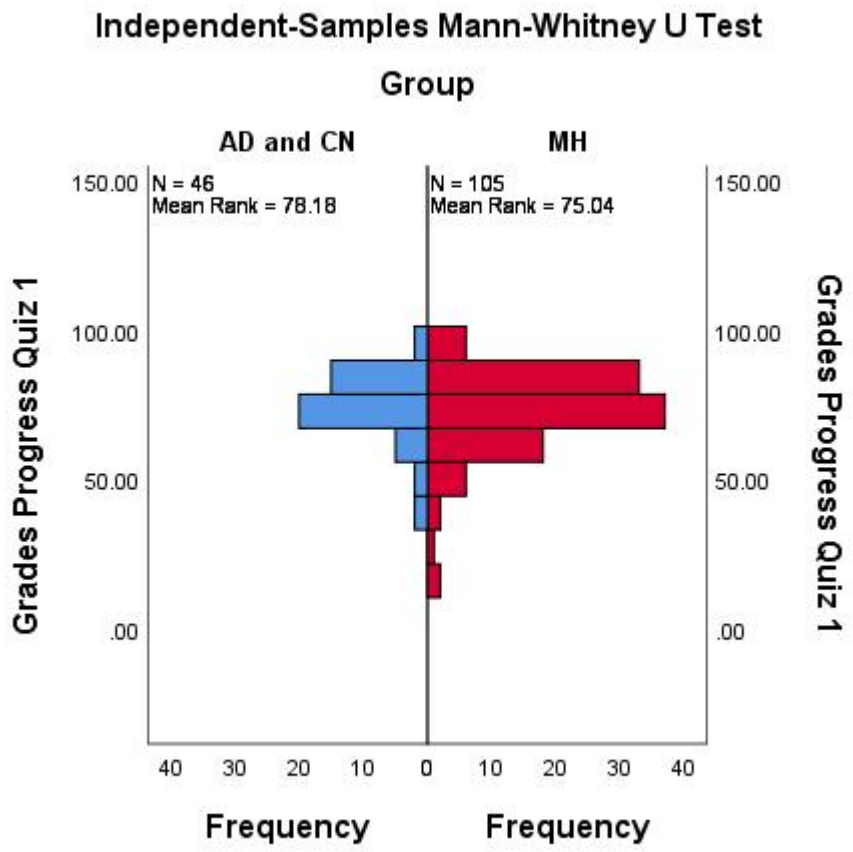

Nonparametric Tests: Two or More Independent Samples
Objective
Fields
Settings
Use predefined roles
Use custom field assignments
Fields:
Sort:
None
Msc programme
Anxiety scale
Prior Knowledge Quiz results
All
Test Fields:
Grades Progress Quiz 1
Grades Progress Quiz 2
Groups:
Group
Reset
Paste
Cancel
Run


Nonparametric Tests: Two or More Independent Samples
Objective
Fields
Settings
Select an item:
Choose Tests
Test Options
User-Missing Values
Automatically choose the tests based on the data
Customize tests
Compare Distributions across Groups
Mann-Whitney U (2 samples)
Kruskal-Wallis 1-way ANOVA (k samples)
Multiple comparisons:
Kolmogorov-Smirnov (2 samples)
Test for ordered alternatives (Jonckheere-Terpstra for k samples)
Hypothesis order:
Test sequence for randomness (Wald-Wolfowitz for 2 samples)
Multiple comparisons:
Compare Ranges across Groups
Moses extreme reaction (2 samples)
Compute outliers from sample
Custom number of outliers
Outliers:
1
Compare Medians across Groups
Median test (k samples)
Pooled sample median
Custom
Median:
0
Multiple comparisons:
Estimate Confidence Interval across Groups
Hodges-Lehmann estimate (2 samples)
Reset
Paste
Cancel
Run

Output:

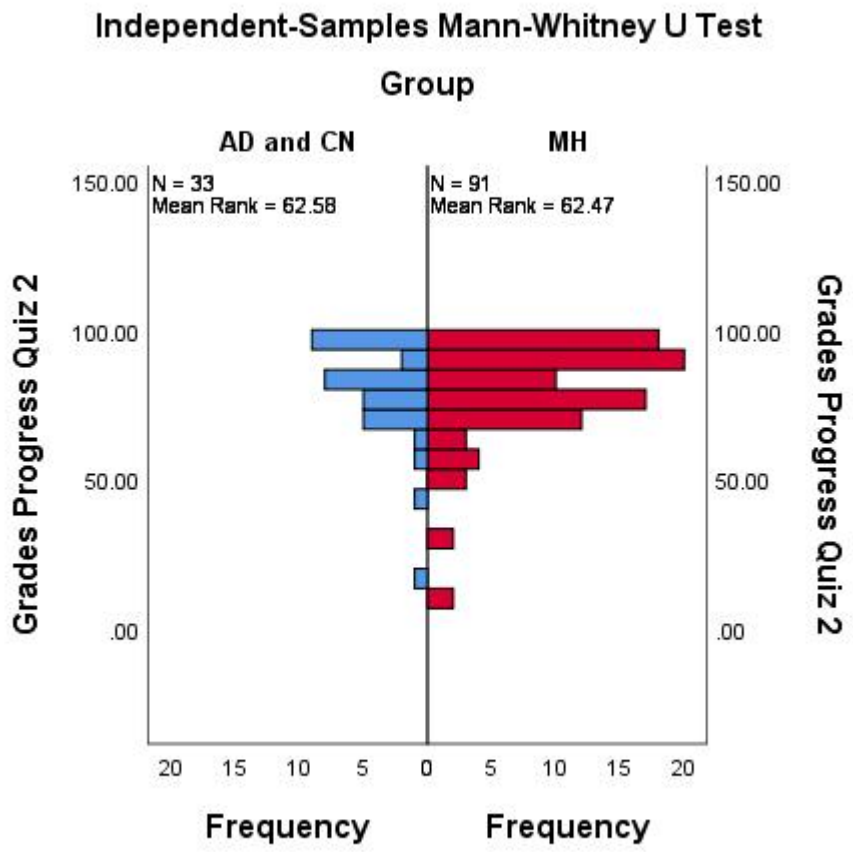
| Hypothesis Test Summary | | | | |
|---|---|---|---|---|
| | Null Hypothesis | Test | Sig.[a,b] | Decision |
| 1 | The distribution of Grades Progress Quiz 1 is the same across categories of Group. | Independent-Samples Mann-Whitney U Test | 0.684 | Retain the null hypothesis. |
| 2 | The distribution of Grades Progress Quiz 2 is the same across categories of Group. | Independent-Samples Mann-Whitney U Test | 0.989 | Retain the null hypothesis. |
| a The significance level is .050. | | | | |
| b Asymptotic significance is displayed. | | | | |

<u>Grades Progress Quiz 1 across Group</u>




| Independent-Samples Mann-Whitney U Test Summary | |
|---|---|
| Total N | 151 |
| Mann-Whitney U | 2314.5 |
| Wilcoxon W | 7879.5 |
| Test Statistic | 2314.5 |
| Standard Error | 246.733 |
| Standardized Test Statistic | -0.407 |
| Asymptotic Sig.(2-sided test) | 0.684 |

Grades Progress Quiz 2 across Group




| Independent-Samples Mann-Whitney U Test Summary | |
|---|---|
| Total N | 124 |
| Mann-Whitney U | 1499 |
| Wilcoxon W | 5685 |
| Test Statistic | 1499 |
| Standard Error | 176.441 |
| Standardized Test Statistic | -0.014 |
| Asymptotic Sig.(2-sided test) | 0.989 |

**There were no statistically significant differences in progress quiz scores between the two groups, according to the Mann-Whitney U test (Quiz 1: U=2314.5, p=0.684; Quiz 2: U=1499.0, p=0.989).**