

10.3.1: More Practice! Changes in Mindset

Let's try this full process, starting with a table of raw scores, and moving through the steps and the formula to analyze paired Mindset Quiz scores. Check out the [section on growth mindset](#) at the beginning of chapter 7 to refresh yourself on what that idea means.

Scenario

Dr. MO's student research group conducted a study in which one English faculty member tried to use journaling to improve growth mindset in a class that was one level below college-level English (so, remedial or basic skills English) at a community college. The Mindset Quiz was completed by students at the beginning of the semester, and then again at the end of the semester. We had complete data (both pretest and posttest scores) for 10 students (N=10).

Context

? Exercise 10.3.1.1

Answer the following questions to understand the variables and groups that we are working with.

1. Who is the sample?
2. Who do might be the population?
3. What is the IV (groups being compared)?
4. What is the DV (quantitative variable being measured)?

Answer

1. The sample is the group of 10 students who completed the Mindset Quiz at the beginning and the end of the semester (twice).
2. The population might be all community college students who haven't passed college-level English, although the specific population that you think this sample represents might be slightly different.
3. The IV is before and after the survey, the time periods. This can also be said as the pretest and post-test.
4. The DV is the Mindset Quiz.

Now that we know a little bit more about who and what we are working with, let's develop some hypotheses!

Step 1: State the Hypotheses

Without knowing the means yet, we should just hope that the journaling intervention improved mindset. With this assumption, develop the hypotheses.

? Exercise 10.3.1.2

Develop the research hypothesis, in words and symbols. Then, determine the null hypothesis in words and symbols.

Answer

- Research Hypothesis: The average score will be higher on the Mindset Quiz at the end of the semester (Time 2, posttest) than the average score at the beginning of the semester (Time 1, pretest).
 - Symbols: $\bar{X}_{T2} > \bar{X}_{T1}$
- Null Hypothesis: The average score will be similar to the Mindset Quiz at the end of the semester (Time 2, posttest) than the average score at the beginning of the semester (Time 1, pretest).
 - Symbols: $\bar{X}_{T2} = \bar{X}_{T1}$

In this case, we are hoping that the changes we made will improve mindset scores, so we will use a one-directional research hypothesis.

Step 2: Find the Critical Values

Our critical values will once again be based on our level of significance, which we know is $\alpha = 0.05$, the directionality of our test, which is one-tailed, and our degrees of freedom.

? Exercise 10.3.1.3

For our dependent-samples t -test, what is the critical t -score from the the [same \$t\$ -table](#) from when we learned about one-sample t -tests (or going to the [Common Critical Values Table page](#))?

Answer

For our dependent-samples t -test, the degrees of freedom are still given as $df = N - 1$ in which N is the number of pairs.

$$\text{Degrees of Freedom} = N - 1 = 10 - 1 = 9$$

With a Degrees of Freedom of 9, the critical t -score is 1.833 from the critical t -score table.

Step 3: Calculate the Test Statistic

You can use the information in Table 10.3.1.1 to calculate the mean and standard deviation for the pretest and posttest. To complete the dependent t -test equation, additional columns will be needed to find and sum the difference, and to square and sum each difference.

Table 10.3.1.1- Pretest and Posttest Mindset Quiz Scores

Participant	Mindset Quiz Pretest	Mindset Quiz Posttest
A	38	33
B	43	39
C	35	32
D	36	37
E	47	51
F	39	45
G	49	55
H	47	54
I	31	39
J	42	52
Σ	$\Sigma = 407$	$\Sigma = 437$

Although not required right now, you might be interested in the actual means for the Mindset Quiz at the pretest and posttest, and now you can calculate them!

For the pretest:

$$\frac{\Sigma X}{N} = \frac{407}{10} = 40.70$$

This score means that the students had many growth mindset ideas, but still held some fixed beliefs.

For the posted:

$$\frac{\Sigma X}{N} = \frac{437}{10} = 43.70$$

This score also shows that the students had many growth mindset ideas, but still held some fixed beliefs. However, scores of 45 or higher are considered having only growth mindset beliefs, so the posttest group was close!

? Exercise 10.3.1.4

Use the dependent t-test formula to calculate a dependent t-test.

Answer

To use the dependent t-test formula, you will need to calculate the Difference scores between each participant's pretest and posttest, find how different those Difference scores are from the mean of the difference, and square how different the Difference scores are from the mean of the difference. Table 10.3.1.2 is provided to help complete this step for each participant. The sum for each column is provided so that you can check your subtraction, squaring, and adding, but try to do it yourself so that you know how!

Table 10.3.1.2- Mindset Quiz Pretest and Posttest Scores with Columns for Calculating

Participant	Pretest	Posttest	Difference (Posttest minus Pretest)	Difference minus Mean of Difference	Square of the Difference minus Mean of Difference
A	38	33			
B	43	39			
C	35	32			
D	36	37			
E	47	51			
F	39	45			
G	49	55			
H	47	54			
I	31	39			
J	42	52			
Σ	$\Sigma = 407$	$\Sigma = 437$	$\Sigma = 30$	$\Sigma = 0.00$	$\Sigma = 262.00$

Based on this table, we have what we need to complete the dependent t-test formula:

$$t = \frac{\left(\frac{\Sigma D}{N} \right)}{\sqrt{\left(\frac{\Sigma (X_D - \bar{X}_D)^2}{(N-1)} \right)} / \sqrt{N}}$$

So we fill in all of the numbers. Notice that the all of the sums were computed on the Table 10.3.1.2 We are just plugging them into the equation here.

$$t_{numbers} = \frac{\left(\frac{30}{10}\right)}{\sqrt{\left(\frac{262}{(10-1)}\right)/\sqrt{10}}}$$

Then we start calculating each set of parentheses:

$$t_{Parentheses} = \frac{3}{\sqrt{\left(\frac{262}{9}\right)/3.16}}$$

And a few more parentheses:

$$t_{ParenthesesAgain} = \frac{3}{(\sqrt{29.11})/3.16}$$

Then a square root:

$$t_{SquareRoot} = \frac{3}{(5.40/3.16)}$$

And then some simple division!

$$t_{Division} = \frac{3}{1.71}$$

$$t_{TheEnd!} = 1.75$$

Again, when Dr. MO used Excel to calculate this, the final division was a little higher ($t = 1.76$), even though all of the prior calculations looked the same as when she used a hand calculator. Both answers are correct! The difference is based on rounding (Excel keeps hundreds of numbers after the decimal point, rather than just two, which affects the two numbers after the decimal point at the end of the calculation).

Step 4: Make the Decision

The the critical t-score from the table (based on either decision rule) from Step 2 is larger than the calculated test statistic of $t = 1.75$.

(Critical < |Calculated|) = Reject null = means are different = $p < .05$

(Critical > |Calculated|) = Retain null = means are similar = $p > .05$

? Exercise 10.3.1.5

Based on the critical value from the table and the calculated t-score, should we reject the null hypothesis? Does this mean that the means are similar or different?

Answer

Critical(1.833) > |Calculated(1.75)| = Retain null = means are similar = $p > .05$

We retain (fail to reject) the null hypothesis, and state that the means are similar to each other.

Write-Up

What should the conclusion look like? This is sorta tough because the Posttest mean is higher than the Pretest mean, but the significance test shows that the means are similar.

✓ Example 10.3.1.1

Write up a conclusion for the mindset data using the [four required components](#) from the [Reporting Results section](#) in the one-sample t-test chapter.

Solution

I hypothesized that the average Mindset Quiz Posttest ($\bar{X} = 43.70$) would be higher than the average Mindset Quiz Pretest ($\bar{X} = 40.70$) after the journaling intervention. This research hypothesis is not supported; the means are not different enough (too similar) to state that they are from different populations ($t(9)=1.75, p>.05$). It appears that the journaling intervention did not statistically improve mindset scores for this sample of 10 community college students in an English course below college-level.

How are you feeling?

If you didn't quite get it yet, keep trying! Maybe check out the [Learning \(Statistics\) section](#) the very first chapter?

And when you do get the right calculation, interpret it correctly, and have a complete write-up, celebrate!

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