Exercise: Tutoring Sessions

In an effort to improve the statistics skills of 10 students, a teacher provides a weekly 1-hour tutoring session for the students. A pre-test is given before the sessions, and a post-test is given after. The results are shown in the table below. At $\alpha = 0.01$, can it be concluded that the sessions help to improve the students' statistical skills?

Student	1	2	3	4	5	6	7	8	9	10
Pre-test	82	76	91	62	81	67	71	69	80	85
Post-test	88	80	98	80	80	73	74	78	85	93

Dependent Samples

Since we are comparing paired data values that correspond to specific students these samples are dependent.

Step 1

If the sessions were effective, we would expect the post-test scores to be greater than the pre-test scores.

We will calculate the differences with the orientation pre-test score minus post-test score. We would expect that difference to be negative.

We will use the notation μ_D for the mean of the differences in pre-test and post-test scores.

Step 1…

Step 1

State the hypotheses and identify the claim

H_0: $\mu_D = 0$

H_1: $\mu_D < 0$ (claim)

We will first need to assign one of the samples as Group 1 and the other as Group 2.

Assign Group 1 as the pre-test values and Group 2 as the post-test values.

Step 2

Step 2

Compute the test value.

There are three calculations we need to make.

$\overline{D}$ = Mean of the differences in matched data values for the sample

μ_D = Hypothesized population mean of the differences

s_D = Standard deviation of he differences for the matched pairs

n = Sample size

$$t = \frac{\overline{D} - \mu_D}{\frac{s_D}{\sqrt{n}}}$$

$$\overline{D} = \frac{\sum D}{n}$$

$$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}}$$

Step 2…

The first pre-test value is 82. The first post-test value is 88.

82 – 88 = -6 You will find this difference for each student. You will also square each of these differences and find the sum of each of these columns.

Pre-test	Post-test	Difference (D)	D^2
82	88	82 – 88 = -6	$(-6)^2 = 36$
76	80	-4	16
91	98	-7	49
62	80	-18	324
81	80	1	1
67	73	-6	36
71	74	-3	9
69	78	-9	81
80	85	-5	25
85	93	-8	64
Sum		-65	641

Step 2…

$\sum D$ = -65 $\sum D^2$ = 641 n = 10

$$\overline{D} = \frac{\sum D}{n} = \frac{-65}{10} = -6.5$$

$$s_D = \sqrt{\frac{n\sum D^2 - (\sum D)^2}{n(n-1)}} = \sqrt{\frac{10(641) - (65)^2}{10(10-1)}} = 4.927$$

$$t = \frac{\overline{D} - \mu_D}{\frac{s_D}{\sqrt{n}}} = \frac{-6.5 - 0}{\frac{4.927}{\sqrt{10}}} = -4.172$$

Step 3: P-value

	α						
ν	0.40	0.25	0.10	0.05	0.025	0.01	0.005
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169

$$t = \frac{\bar{D} - \mu_D}{\frac{s_D}{\sqrt{n}}} = \frac{-6.5 - 0}{\frac{4.927}{\sqrt{10}}} = -4.172$$

P-value < 0.005 < $\alpha = 0.01$

Step 4: Decision

Recall that if the P-value is less than α we should reject the null hypothesis. In this case $\alpha = 0.01$.

P-value < 0.005 < $\alpha = 0.01$

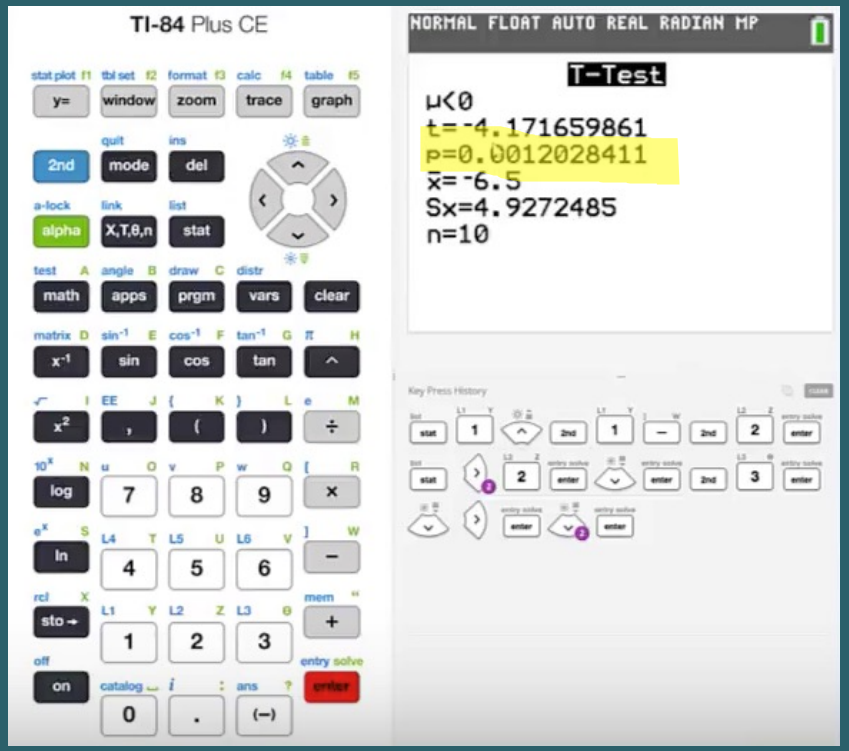
Reject the null hypothesis.

TI Calculator…

The P-value is given to us as 0.0012 when we round to 4 decimal places.

TI Calculator provides us with the *t*-test value of **-4.172**.

The P-value is **0.0012**.



Reject the Null Hypothesis

Recall that if the P-value is less than α we should reject the null hypothesis. In this case $\alpha = 0.01$.

P = 0.0012 < $\alpha = 0.01$

Reject the null hypothesis.

Conclusion

Our conclusion should be at 0.01 level of significance, there is **enough evidence to support the claim** that the sessions help improve the students' statistical skills.