

Example 5

10 employees of a health insurance company are sent to a training program about new developments in health insurance law. Each employee is given a proficiency test to measure their expertise in new developments in health insurance law before the training program and after the training program, to determine whether his/her knowledge of new developments in health insurance law has increased as a result of the training.

Employee	Exam Score Before Training List L4	Exam Score After Training List L5	Differences: After – Before L6 = L5 – L4
Ali	72	91	19
Binh	44	58	14
Carol	65	55	-10
Daria	72	86	14
Eduardo	82	94	12
Farah	65	83	18
Geraldo	48	65	17
Harry	62	81	19
Iris	85	70	-15
Juna	73	85	12

Assume the population of differences in exam scores is normally distributed.

At a 5% level of significance, is the training program effective at increasing the average health insurance law exam score?

This problem is a hypothesis test comparing two means, using paired (matched, dependent) samples.

It is paired because each person has two test scores; the two test measurements for each person create a pair of data.

You will find the differences and use a one sample t – test on the differences.

Hypotheses: μ_1 = average insurance law exam score for students before training
 μ_2 = average insurance law exam score for students after training
 $\mu_d = \mu_2 - \mu_1 = \mu_{\text{after}} - \mu_{\text{before}}$

Ho: $\mu_d = 0$ **Ha:** $\mu_d > 0$

Use $\alpha = 0.05$

Because the data are paired, we use a one sample T-test on the differences.

Input data into lists in your calculator as indicated above. Use list L6 to calculate differences. (Arrow up to highlight the title for L6 and then enter L5 – L4 and press enter to make the calculator find the differences for you.)

Use the T-test, as you did in ch. 9, indicating that data is available

Use the differences in list L6 as your data.

The value for the null hypothesis is 0, and the alternate hypothesis is one tailed to the right.

The calculator finds the test statistic $t = \frac{\bar{x}_d}{s_d / \sqrt{n}} = 2.592$

$\bar{x}_d = 10$ is the average of the differences, displayed by your calculator as \bar{x} .

$s_d = 12.20$ is the standard deviation of the differences, displayed by your calculator as s_x

n is the number of pairs, $n = 10$

The p-value is 0.0146.

If the null hypothesis is true and the average difference in exam scores (after minus before training) is 0, then the probability of getting a sample average difference of 10 is 0.0146

Graph was shown in class; technical problems getting it into this document right now.

Decision is to reject null hypothesis because $p\text{-value} < \alpha$

Conclusion: At a 5% level of significance the data show that the average insurance law exam score is higher after training than before training.

What happens if you don't do this as a paired test?

If you use the wrong method and do a 2 sample t test, telling the calculator that you have data for the two samples in lists L4 and L5, **the p-value is calculated as 0.0574, which causes you to NOT reject the null hypothesis.**

Using the correct method of paired samples, the correct decision is to reject H_0 .

The reason why the 2 sample t test gives the wrong conclusion is that it can't distinguish between the people who know a lot of insurance law (working in the law department, perhaps Eduardo), those who know some insurance law (maybe Dina working in customer service), and those who don't know much about insurance law (maybe Binh, who programs computers to keep track of customer information but does not actually need to know much insurance law to do his job.)

The 2 sample t test gets confounded by the variation in insurance law knowledge between the employees, which gets confused into the variation between before and after.

Using paired techniques finds the differences first, and filters out the variation in knowledge of different employees.