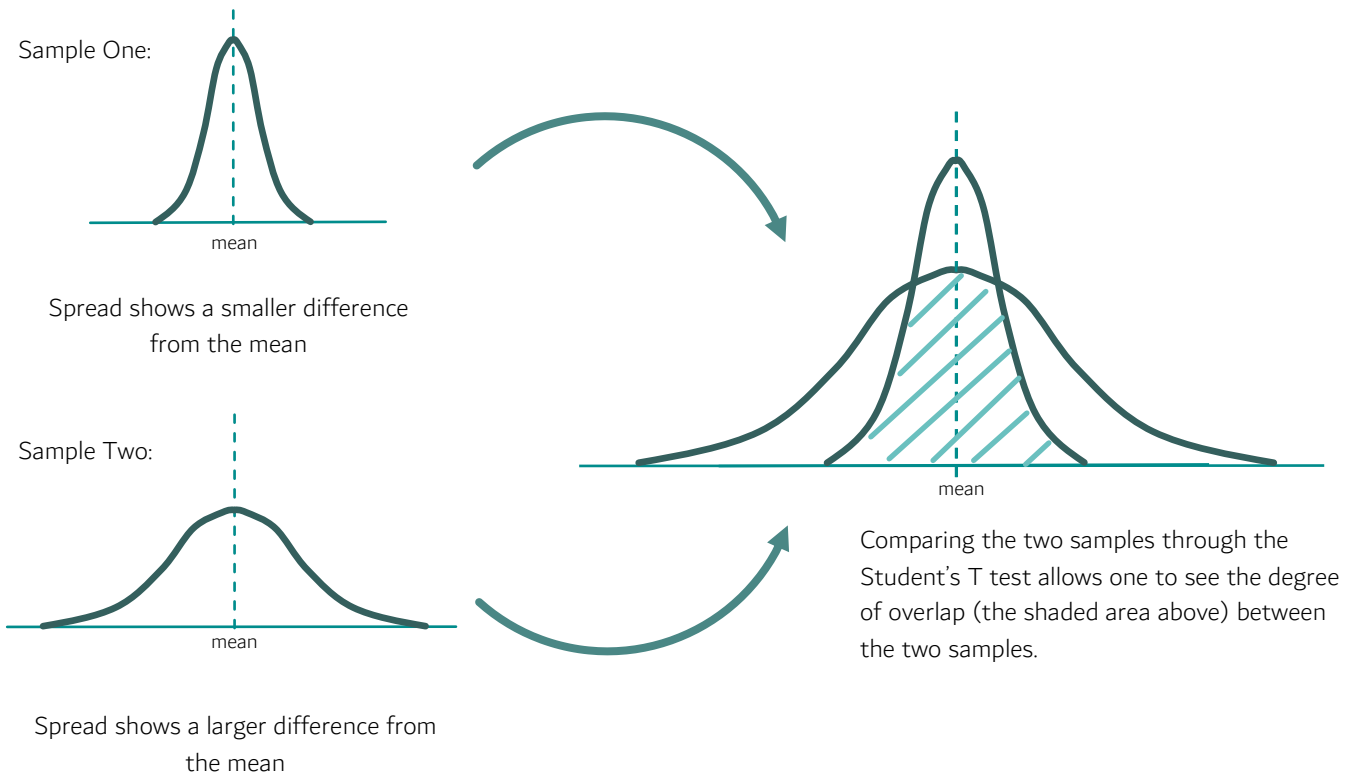# The Student's T Test

The Student's T test is a statistical test used to find out the extent to which two samples 'overlap' in the spread of their data. This is done by comparing their standard deviations. A standard deviation of a sample is how much the data values in that sample differ from the mean value. In geographical research, the Student's T test might be used to compare samples from different time frames or from different locations.

Sample One:

Spread shows a smaller difference from the mean

Sample Two:

Spread shows a larger difference from the mean

Comparing the two samples through the Student's T test allows one to see the degree of overlap (the shaded area above) between the two samples.

The Student's T test can only be used when the data in each sample can be said to be distributed normally around the mean. This means the frequency of data at different values would form a bell-shaped curve when drawn as a graph (as in the above example). The test can also only be used when there are twenty to thirty values within each sample.

Here are some examples of geographical samples one might like to compare using the Student's T test:

- Weather - the daily minimum **temperatures** experienced over a month in different years

- Population - the **age structures** of two different villages

- Urban studies - the range of **bipolar scores** given by questionnaire respondents about two locations within a town

- Development - the spread of **household income values** between urban and rural centres

- Rivers - the range of **roundness scores** of bedload found before and after a confluence

- Transport - the **distances** two samples of people would be willing to travel to access services

- Coasts - **sediment size** at different locations along a stretch of beach

- Ecology - the range of **carbon content** figures across two different types of woodland

How to carry out a Student's T test

For this example, we will look at how sediment size varied across a shingle beach. The geographical researcher wished to see if a shingle beach in a bay experienced natural sorting of its sediment. This is where wave actions 'sort' the sediment by size into different areas as a result of the strength of the wave and the angle of the beach on which the shingle is found.

From their knowledge of the beach, the patterns of wave energy and their understanding of natural sorting, the researcher believed that the eastern end of the beach would have smaller sediment than that in the west. This created the following hypothesis in the mind of the researcher:

"At the far east of the bay, there will be a significant difference in the size of the sediment compared to that in the far west of the bay."

The researcher collected the following data from two samples, one from each end of the beach:

Size of sediment (mm)																			
Sample 1 (east)	20	8	11	23	18	8	9	25	12	15	11	25	10	24	19	18	24	7	13	7
Sample 2 (west)	40	108	56	255	39	21	66	35	42	76	35	94	64	13	80	51	33	14	26	49

The researcher then found the mean ($\bar{x}$), the standard deviation* (σ) and the number of records (n) for each sample:

	$\bar{x}$	σ	n
Sample 1 (east)	15.4	6.55	20
Sample 2 (west)	59.9	52.6	20

Using the Student's T test equation, the researcher then calculated the value of t.

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{(\sigma_1)^2}{n_1} + \frac{(\sigma_2)^2}{n_2}}}$$

$$t = \frac{|15.35 - 59.85|}{\sqrt{\frac{(6.40)^2}{20} + \frac{(51.43)^2}{20}}}$$

$$t = \sqrt{\frac{44.5}{2.05 + 132.24}}$$

$$t = \sqrt{\frac{44.5}{134.29}} \qquad t = \frac{44.5}{11.59} \qquad \boxed{t = 3.84}$$

The calculated value of t does not mean anything on its own. To find out if the hypothesis can be accepted, the researcher needs to compare it with a critical value using degrees of freedom in a significance table.

The degrees of freedom (df) in the Student's T test is

$$df = (n_1 + n_2) - 2$$

Therefore, in this example, **df = 38**

If the **calculated value is greater than the critical value**, the researcher can accept the hypothesis. A full significance table for the Student's T test can be downloaded from **the island geographer** site.

In this case, to a 95% significance level, the critical value is 1.684, so the researcher can accept the hypothesis.

*(See *Guide 10 Standard Deviation* for guidance on how to calculate this figure)