

Temperature vs Relative Humidity: Teacher Guide

Level: Intermediate

Subject: Geography and Mathematics

Duration: 50 mins

Type: class room activity

Learning goal:

- To determine the relationship between temperature and humidity using statistical analysis functions of TAHMO weather stations in MS Excel spreadsheets

Materials:

- A computer with access to internet and MS Excel
- Access to school2school.net to download hourly humidity and temperature data

Methods:

PART 1:

Go to the school2school website and select one of the stations you prefer, or use data from your local station if applicable. Click on temperature and humidity icons to open the data. Check at several temperature and relative humidity values measured at different times. Ask the class what they notice? Are the humidity values the same or different at different temperatures? These questions forms the base of our activity. Our activity will be trying to answer these questions.

Now that you have noted that the humidity changes with the temperature tell the students to give reasons as to what might be the cause of this scenario. The good thing about asking your students to give these reasons is to challenge them to think harder about this particular topic and also you are able to know their level of awareness in this area. Their answers will create the hypothesis to our activity. The correct hypothesis is that humidity is inversely proportional to the temperature. That is, as temperature increases humidity decreases and the inverse is also true.

Throughout the activity, the classroom will be testing the hypothesis they developed. To test the hypothesis you need the humidity and temperature data and therefore tell your students to collect and record several values of the two parameters and I would recommend that you to record the data in an excel spreadsheet. Record the data in two different columns and name them.

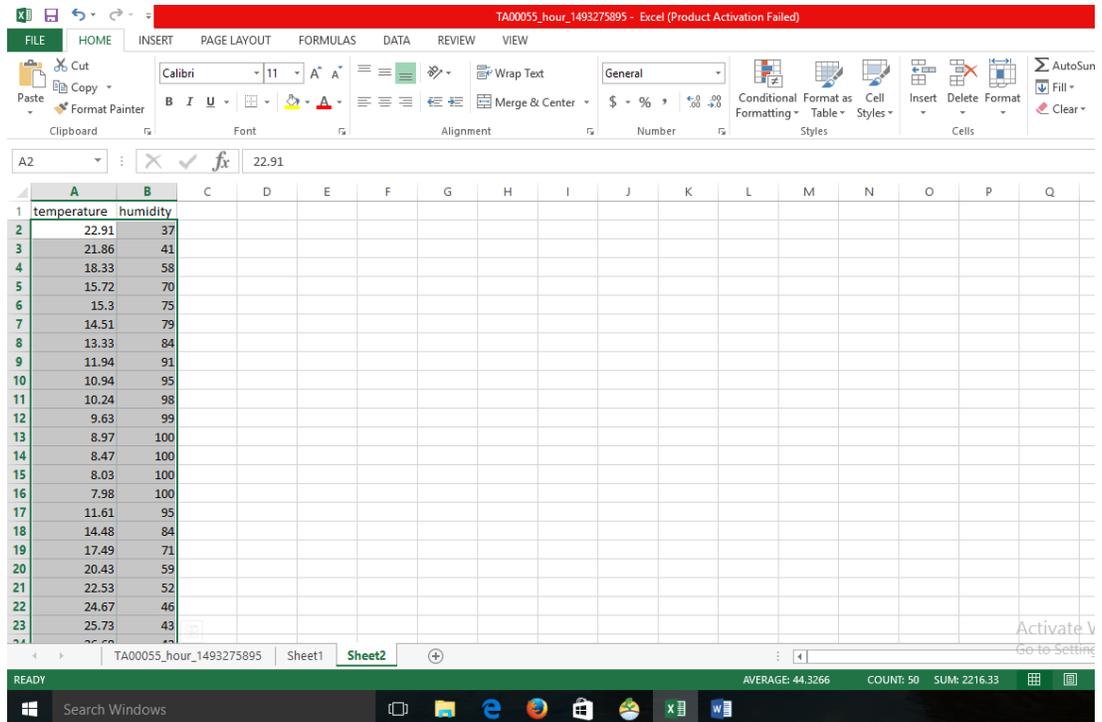
As this point the students should start working on their student handout. In the student handout, instructions are given for creating a table of data, plotting the data by hand, and calculating the correlation coefficient by hand (use of calculator are encouraged). These hand plots will be verified and compared with Excel plots in the following steps. Before moving onto the Excel portion, a few discussion questions might be useful:

- In our hand calculations, we only included 10 data points. When we plot all of the data points using Excel, do we expect it to show similar trends? (Answer: Yes, because the 10 data points we used are a subset of the total data we do expect the trends to be similar but not exact)
- What are some advantages of making the plots and calculation by hand first before using Excel? (Answer: we can better understand the process if we do the plots and calculations ourselves, that way when Excel gives us an answer we can understand and interpret it correctly)

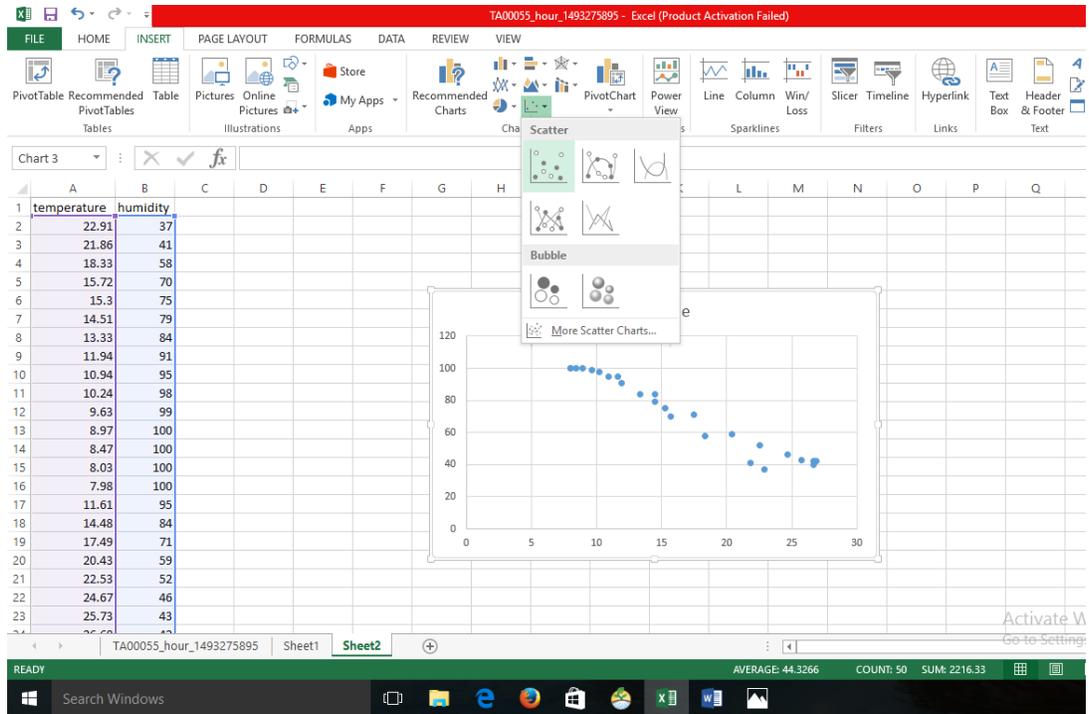
PART 2:

Now that the students have a better understanding of the correlation coefficient and know how to calculate it, we will duplicate this process using Excel. Using excel, plot the values you have on a chart (scatter plot). This chart makes it easier to see how one variable is affected as the other one changes. To accomplish this follow these steps:

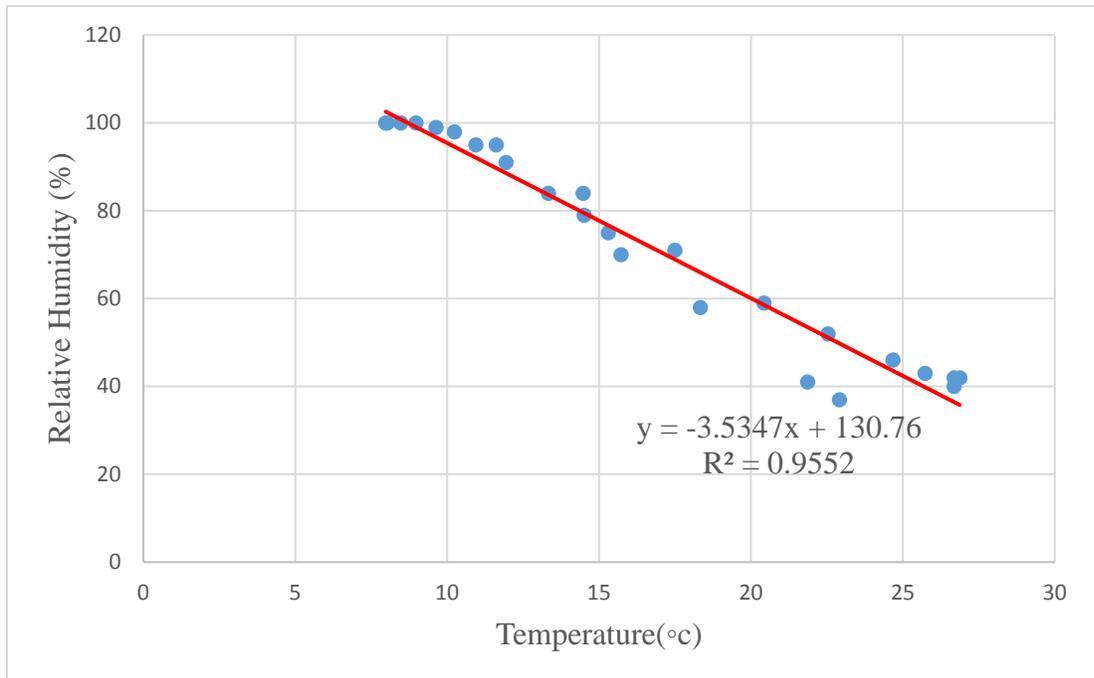
1. Highlight both columns containing temperature and humidity. (The following screenshots and calculations are based on data from TA00055 and should be taken as references only)



2. Open the insert tab on the main menu. Navigate to charts and select the scatter plots. A graph of the plotted data will be displayed.



- To see the trend, click an icon with a shape of a plus sign on the top right side of the chart and scroll down to trend line and select. A line will appear on the charts slanting on the direction of the change.



To calculate the strength of the relationship between your two parameters commonly referred to as correlation coefficient. The correlation coefficient determines the strength of the relationship between the two parameters. To accomplish this in Excel, follow these steps:

1. Click on any cell in your sheet. Enter an equals '=' sign. Immediately behind the equals sign type the word 'corr', excel will immediately below bring an icon with the word 'correl' Double click on it. It will inside your working cell write "correl" (and just below it 'CORREL (array 1, array2). Array is the data sets you want to perform the correlation. The number 1 and 2 indicates that you have two data sets that you want to perform the correlation.
2. So to perform the correlation click on "correl" (inside your working cell, highlight your first column and insert a comma "," then highlight the second column and close the bracket, then press enter. A correlation value should appear. That tells you the strength of the relationship between the parameters. Correlation coefficient for this dataset is calculated to be -0.97736114. A correlative coefficient above 0.80 is said to be strong, a value below 0.5 is said to be very weak. The following pictures shows the procedure described above:

SUM		✕ ✓ <i>fx</i>		=CORREL(
	A	B	C	D	E	F
1	humidity	temperature				
2	37	22.91	=CORREL(
3	41	21.86	CORREL(array1, array2)			
4	58	18.33				

A2		✕ ✓ <i>fx</i>		=CORREL(A2:A26		
	A	B	C	D	E	F
1	humidity	temperature				
2	37	22.91	=CORREL(A2:A26			
3	41	21.86	CORREL(array1, array2)			
4	58	18.33				

C2		✕ ✓ <i>fx</i>		=CORREL(A2:A26,B2:B26)		
	A	B	C	D	E	F
1	humidity	temperature				
2	37	22.91	=CORREL(A2:A26,B2:B26)			
3	41	21.86				
4	58	18.33				

C3		✕ ✓ <i>fx</i>				
	A	B	C	D	E	F
1	humidity	temperature				
2	37	22.91	-0.97736			
3	41	21.86				
4	58	18.33				

Discussion

From the hand drawn plot and the Excel plots you created, what is the direction of the slope (Positive slope = / or negative slope + \)? [Answer: The slope is negative]

What does the slope direction tell you about the relationship between relative humidity and temperature? [Answer: A negative slope tells you that the two parameters are inversely proportional. This means that an increase in one parameter leads to a decrease of the other, and vice versa]

We have identified a relationship from the above. The question you should ask now is, how did we mathematically measure the relationship? [Answer: Correlation coefficient. Using our spreadsheet we are able to define how strongly our parameters are related by use of the correlation coefficient (it is a term mostly used in statistics to show the strength of relationship between variables). From the analysis correlation coefficient is -0.97736114, which means they are strongly related but in the opposite direction, that is as one changes the other one also changes but in the opposite direction. The R-squared value is 0.9552 or 96% which indicates that 96% of humidity in the air is controlled by temperature.]

Why is humidity inversely proportional to temperature? [Answer: If the water vapor content stays the same and the temperature drops, the relative humidity increases. If the water vapor content stays the same and the temperature rises, the relative humidity decreases. This is because colder air doesn't require as much moisture to become saturated as warmer air.]

Temperature vs Relative Humidity: Student Worksheet

Materials:

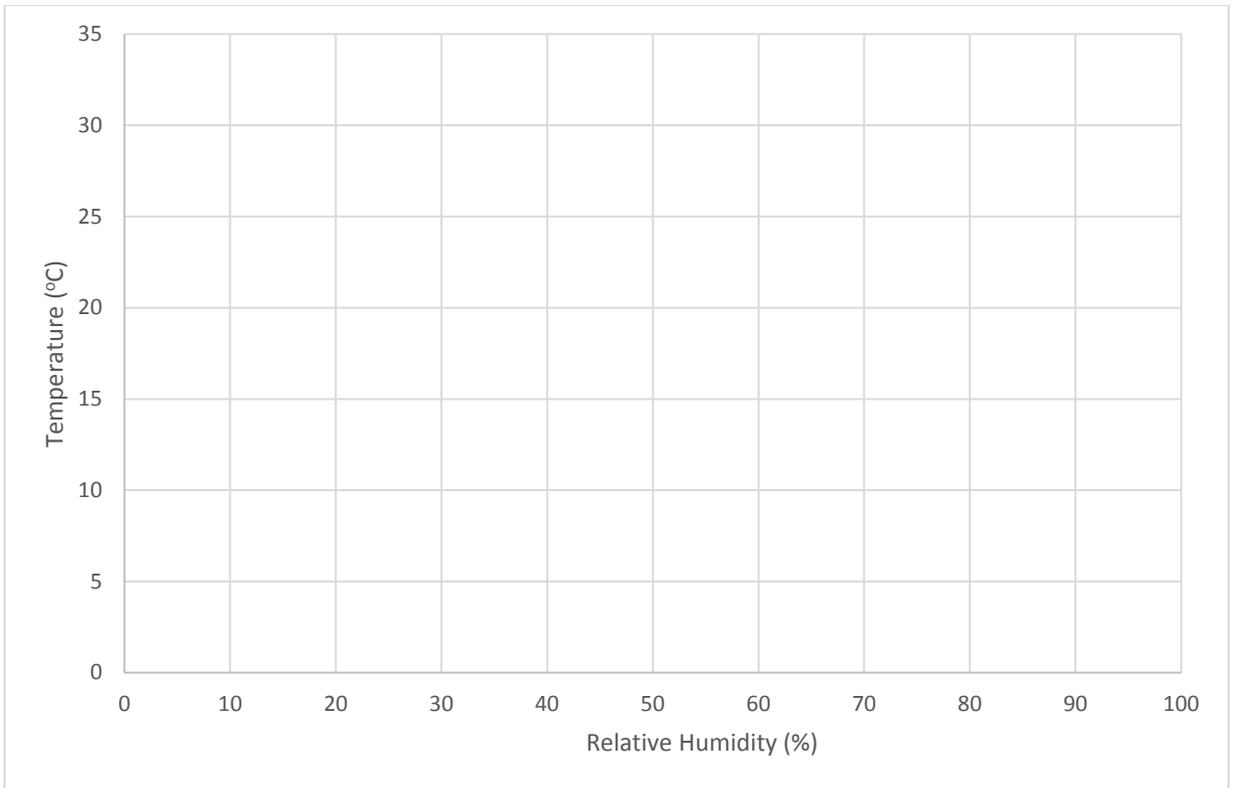
- Pen
- Calculator
- Computer with MS Excel and internet access

Methods:

Download the data from your local TAHMO weather stations from the School2School.net website. Open the hourly data in an Excel spreadsheet. Please note that the time in the downloaded file is given in Coordinated Universal Time (UTC) and not local time. In the table below, record the first ten hourly data for temperature and their corresponding relative humidity data from the Excel.

Time	Temperature(°c)	Relative Humidity (%)

Using the completed table above, by hand make a plot with temperature as the y-axis and humidity as the x-axis. Draw a line of best fit.



Calculation of correlation coefficient:

X(temperature)	Y(humidity)	x^2	y^2	$x*y$
Total=	Total =	Total =	Total =	Total =

Use the following formulae to determine the strength of the relationship between temperature and humidity:

Where n = total number of variables in our case (20) and Σ is the summation.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

Correlation coefficient = _____

Discussion:

What are the units for relative humidity? What is the range of possible values (minimum and maximum)?

From your graph what is the direction of the slope (Positive slope = / or negative slope + \)? Using the words temperature and relative humidity, explain the significance of a slope in that direction.
