Temperature Cycles: Teacher Guide

Level: Beginning

Subject: Geography

Duration: 1 hour

Type: Small group activity

Learning Goals:

- Explain how temperature affects our daily life

- Create a table and a graph of local daily temperature

- Describe the general cycle of temperature changes including maximums and minimums, average, period and amplitude

Materials:

- Access to the School2School.net website

Background:

- Our bodies are constantly sensing the environment around us. One of the conditions that we are keenly aware of is temperature. Are you warm or cool right now? Temperature influences all plants and animals and controls many processes in our weather. We want to pay attention to temperature so we know how much to water crops, how much water livestock will need to drink, whether new fruit might freeze, and so on. That is why temperature sensors are important components in our weather stations.

- The familiar thermometer pictured above is a reliable temperature sensor. It works because the colored liquid in the thin tube expands as it gets warmer. The higher the temperature, the greater the expansion. The amount of expansion is measured by a ruler next to the tube. The units on the ruler are degrees instead of mm. Other thermometers have expanding metal springs that rotate a pointer over a round dial. The temperature sensors in the TAHMO station are based on the very high sensitivity of electronic circuits to small changes in temperature.

- Let's look at what our station tells us about temperature in our location.

Discussion:

Our weather station makes several measurements of temperature, pressure, and other parameters every hour. All of the values are recorded along with the date and time on a computer. This process produces lots of information that we call data. We need methods to organize and analyze so much information. One of these methods involves putting data of interest into a table of rows and columns. Usually each column contains a different kind of information or observation. Each row presents all of the actual values of the measurements or observations at one sampling time. Below is an example of Table 1 that can be used:

Table 1. Temperatures that I "feel" at different times of the day

Column A: Some of my daily activities	Column B: Time of Day	Column C: My sensation of Temperature	Column D: Recorded Temperature
Getting up in the Morning			
Lunch time (noon)			
Going home from School			
Dinner time			
Going to bed at Night			

Students should look at the table and answer these questions about its structure on their student worksheet:

a. What are the column names? [Answer: Daily Activity, Time of Day, Sensation of Temperature, Recorded Temperature]

b. Will each column contain words or numbers? [Answer: Column B will contain number/times; Column C will contain words; Column D will contain numbers/temperatures and should include the units of Celsius]

c. What are the row names? [Answer: The row names are the list of your activities, answers may vary based on the student's individual activities]

d. What does the caption that goes with the table name tell you about the purpose of this table? [Answer: the caption tells you a summary about what the table is about and what information will be included in the table]

Table 1 is not yet very informative because most if its cells are empty. But can you see that it will be helpful in organizing some specific data about you? Let's start filling in the table.

a. Add in Column A two additional activities you have during a typical day.

b. Put the usual time of each activity into Column B.

c. In Column C, use words like "warm" and "cold" and several others to describe the "feel" of the air on your skin at each time.

Now the table says a lot about you and your evaluation of one aspect of your surroundings. Use the nicely organized information to explain it to a classmate. How does your information compare to his or hers? Write a few sentences that summarize your comparison.

We can easily get data from other sources to make Table 1 more complete. For instance, what are some actual temperature values during your daily activities? Look at the S2S website for your TAHMO station and identify the outside air temperature recently recorded by your TAHMO weather station for one day.
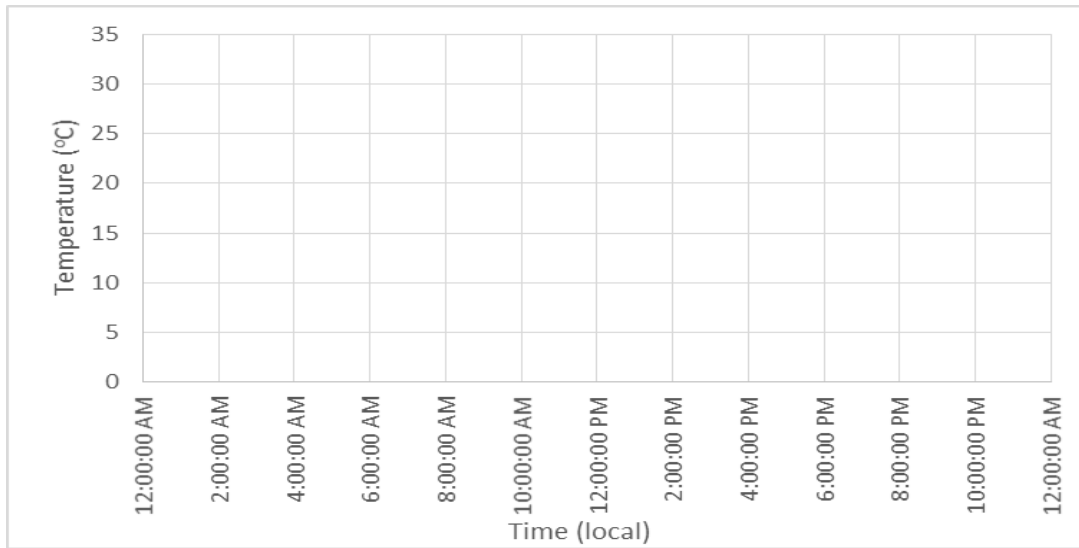
Make a new column, Column D, in Table 1 by first giving it a proper heading and then inserting actual temperature values from at the times of your listed activities.

Examine your expanded Table 1 and write brief answers to these questions:

a. What word might you use to describe how your body will feel when the thermometer reports a temperature of 35C? Why? [Answer: answers may vary, examples may include words like warm, hot, sweaty, sunny or other descriptions that indicate that the temperature is very close to the normal range of body temperatures]

a. Give an example of a thermometer reading you would expect if you felt very cold. [Answer: answers may vary based on region, typical answer may range between 0 and 15 Celsius]

b. So, generally, how do the numerical values in Column D compare to your sensory descriptions in Column B? [Answer: answers may vary, examples: yes the sensory description accurately matches the actual temperature, or no because the student feels that the temperature is actually much warmer than they expected]

c. Consult with your classmates. Is there general agreement on the range of 'comfortable' temperatures? When do most of you feel cold? Hot? [Answer: answers may vary, comfortable room temperature is generally considered to be between 20 and 30 degrees Celsius]

A table is a good way to organize related data because it allows you to quickly look up specific values. A table is not a good way to represent data if you are trying to summarize information of display patterns in the data. A better way to detect trends in the data is by graphing them: if "a picture is worth a thousand words" then a graph is the picture of a table. So, let's make a picture of the information from Table 1. Figure 1 should have simple axis of time and temperature. Note that the graph, like a table, has a unique name and a brief description of its contents. Have the students place points on the graph for their activities (between 3 and 6 points is most appropriate). The time values from Column B of Table 1 will be shown on the horizontal axis of the graph. Temperatures from Column D are indicated on the vertical axis. Transfer the time and temperature information from Table 1 to Figure 1. Put a bold dot on the graph to indicate air temperature at each time listed in your table. You are not changing the data in any way, just presenting it differently, as a picture.

Figure 1. Air temperatures at the times of some of my daily activities

When you finish your graph, compare it to one that a classmate plotted. How are they similar? Write a few sentences that describe each of the following:

a. Your "picture" of temperature over time [Answer: answers may vary]

b. Your ideas about when a table should be used [Answer: answers may vary]

c. What a graph tells you that is not apparent in a table [Answer: it is generally easier to identify trends or patterns in graphs than in tables]

If you want a precise estimate of temperature, all you have to do is read a thermometer. But that may not always be convenient, e.g. when you are sleeping. As long as they are properly cared for, the instruments of a weather station like ours will make their readings, on schedule day or night, rain or shine. And when those data are recorded over a long period of time we can learn so much more than if we have just occasional readings.

Now you will start to look at multiple days of temperature data. It is preferred that you as the teacher download a week of temperature data from the TAHMO S2S website for your own station, but an example dataset is shown in Figure 2.

Figure 2. Hourly temperature measurements for St. Scholastica in Nairobi, Kenya for 11/6-13/2015
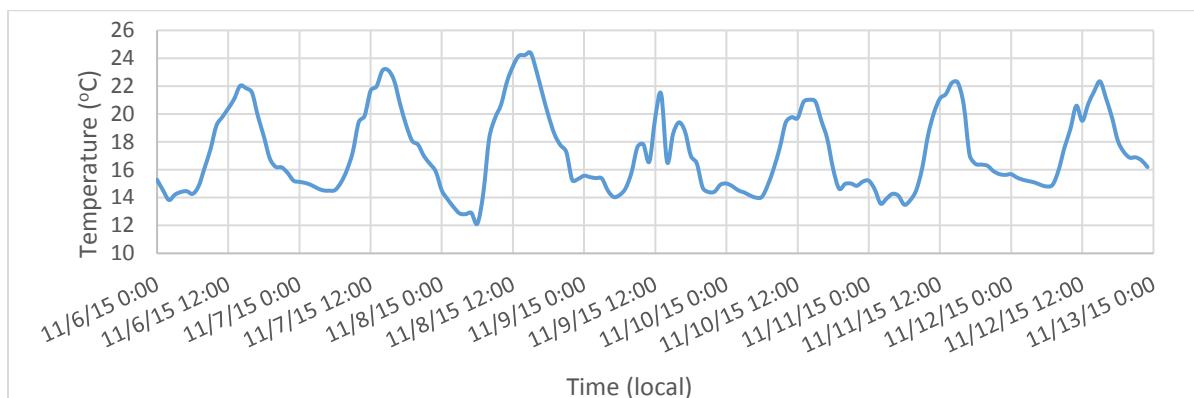
Using the week of temperature data, ask the students to look at the graph and examine is closely. Have the students write down, in their own words, their first impressions of this new graph, Figure 2:

a. What does the caption tell you? [Answer: the caption tells you about the axis (both x and y) and the location that the data is taken]

b. Next, look at the axes to determine what exactly is plotted. What is represented by the horizontal axis? What are the units and range of values? The vertical axis? [Answer: the horizontal axis, x-axis, is the local time and the axis displays both the data and the time in 12 hour increments; the vertical axis, y-axis, is the outside air temperature recorded in the units of degrees Celsius with a range from 10-26 degrees.]

c. How often was temperature recorded? For how many days? [Answer: the data is hourly data and it plotted for 7 days]

d. Did the temperature vary during a typical day? Is the variation similar to what you have observed in your Figure 1? [Answer: Yes, the temperature did vary during the day- the temperature starts lower in the morning and warms up during the beginning of the day, and then in the second half of the day the temperature beings to lower again]

Compare your first impressions with those of a classmate. Together, develop a question about temperature that can be answered by looking at this graph. Write down your question and give it to your teacher. [Teacher collects the questions and presents some to the class to practice interpreting the graph.]

Using the student questions about Figure 2, start a discussion with the class about the observations. Did any students notice that a similar temperature cycle happened every day? If no students brought up this topic, that is okay, simply start transitioning the topic to temperature cycles.

The regular up-and-down changes in temperature that occur almost every day are a cycle. There is a pattern that repeats itself – it goes round and round – every day. We can describe a cycle in specific ways. For instance, the time required for a single cycle is called its period. The range between the largest and smallest temperature values during a period is called the amplitude of the cycle.

Choose just one period of the several that appear on Figure 2. Draw and label vertical lines on the graph that mark the starting and ending times of the period. Write down your answers to these questions about that one period:

a. How did you decide where the period begins and ends? [Answer: The beginning of the period starts at midnight when the day starts and it ends at midnight. It is easy to choose this as the period because it divides the days based on date]

b. What are the highest and lowest temperatures during the period? So what is the amplitude of the period? [Answer: Generally the highest temperatures occur right after noon, and the lowest temperatures occur in the very early morning hours. During the first day (11/06/2015) the highest temperature is 22 degrees Celsius at 3pm, and the lowest temperature is 14 degrees Celsius and occurs at 2am]

c. How would describe the general cycle of temperature change for this period? [Answer: The

lowest temperature occurs after midnight and increases through the day until the highest temperature, occurring right after noon, and then the temperature decreases until midnight]

Look at the graphs of some of your classmates to see how they decided to mark the start and end of a period. Does everyone agree? Is there a single "right" way to do it? Explain to the students that there is no right way to create a period. Some students may have chosen to start and stop at noon, other at midnight, maybe some at 6am when the sun rises. All are appropriate responses as long as the period remains constant for their graph.

Get ready to compare all of the periods that appear in Figure 2. Write down what you predict to observe in the following comparisons:

a. Will all the periods be the same length of time? Why? [Answer: Yes, all periods should be 24 hours in duration because that coincides with the number of hours in a day]

b. Will all the periods have the same amplitude? Why? [Answer: no the amplitudes of each period will not be the same because the temperature changes each day]

c. Does the maximum temperature occur at the same time in each period? [Answer: Yes, generally the maximum temperature should occur at solar noon which is roughly 1-3 pm but this may vary according to latitude, season, etc.]

d. Is the "average" temperature for each period the same? [Answer: answers may vary; in general the average temperature will be similar in a series of a few day, but this may change with the weather, season, etc.]

e. Will you be able to see if the weather is getting warmer or cooler overall during the time reported by the graph? How? [Answer: You can see if the weather is getting warmer or cooler overall by finding the daily average temperatures and seeing if those change over the week. If the first day is significantly cooler than the last day (18 vs 22 degrees Celsius for example) this may indicate that the weather is getting warmer.] Draw a horizontal line through the period to indicate the "average" temperature for that period. You can estimate what you think the average temperature for the entire week is or estimate the daily average.

Conclude this lesson by asking the class to describe how temperatures change during the day. Were the predictions that they made in the beginning of the activity correct? Why or why not? Did they learn more by confirming a correct prediction or by rethinking a prediction that turned out not to be as they expected? Is making an incorrect prediction a "mistake?"

Temperature Cycles: Student Worksheet

Write down what temperature means to you and how temperature changes during the day.

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b. Will each column contain words or numbers? _____

c. What are the row names? _____

d. What does the table's caption name tell you about the purpose of this table?

   _____
   _____

Fill in Table 1. Put the usual time of each activity into Column B. In Column C, use words like "warm" or "cold" to describe the "feel" of the air on your skin at each time.

Examine your expanded Table 1 and write brief answers to these questions:

b. What word might you use to describe how your body will feel when the thermometer reports a temperature of 35C? Why?

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d. Give an example of a thermometer reading you would expect if you felt very cold.
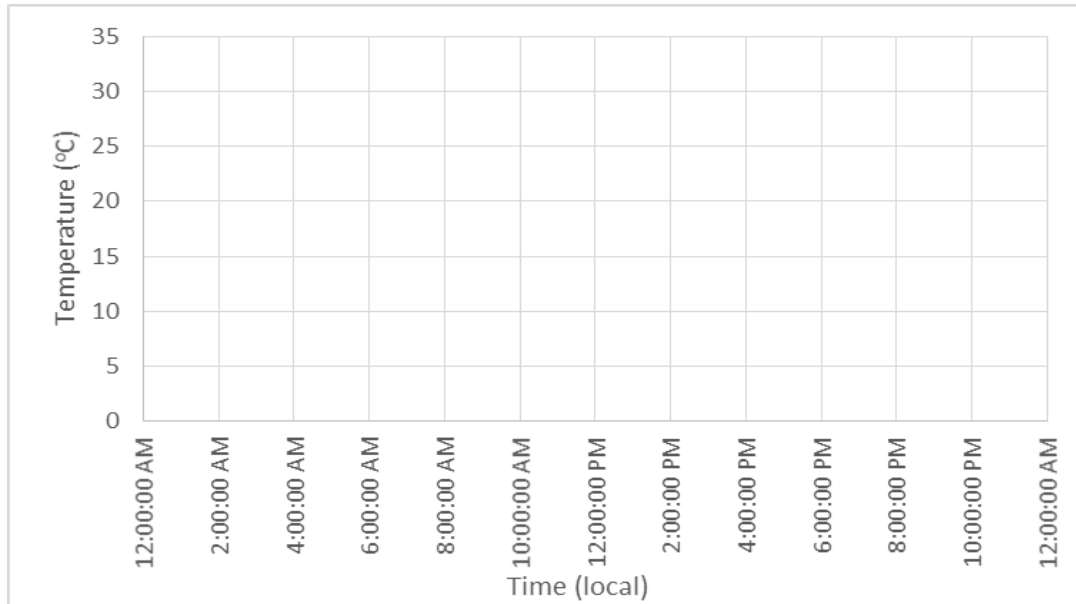
   _____

e. So, generally, how do the numerical values in Column D compare to your sensory

descriptions in Column B?

_____

_____

f. Consult with your classmates. Is there general agreement on the range of 'comfortable'
    temperatures? When do most of you feel cold? Hot?

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values. A table is not a good way to represent data if you are trying to summarize information of
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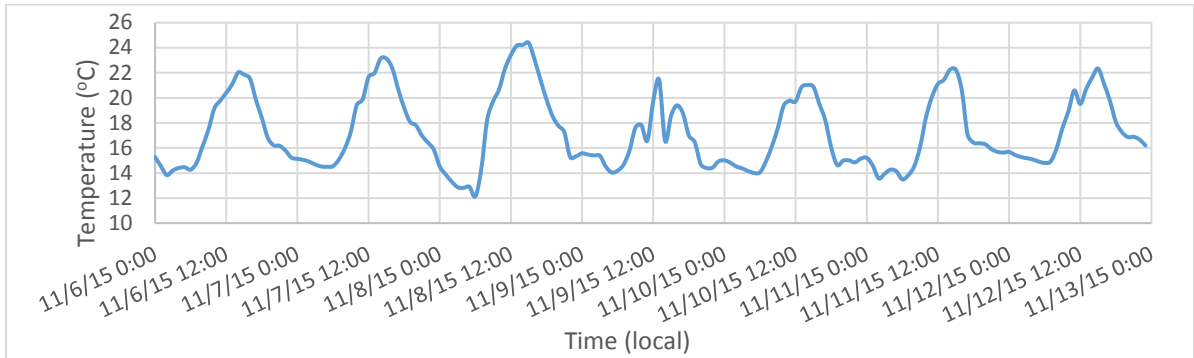
Refer to Figure 2 for the follow questions. Write down, in your own words, your first impressions of this new graph, Figure 2:

a. What does the caption tell you?

_____

_____

b. How often was temperature recorded? For how many days?

_____

_____

c. Did the temperature vary during a typical day? Is the variation similar to what you have observed in your Figure 1?

_____

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Compare your first impressions with those of a classmate. Together, develop a question about temperature that can be answered by looking at this graph. Write down your question below:

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Choose just one period of the several that appear on Figure 2. Draw and label vertical lines on the graph that mark the starting and ending times of the period. Write down your answers to these questions about that one period:

a. How would describe the general cycle of temperature change for this period?

_____

b. What are the highest and lowest temperatures during the period? What is the amplitude?

_____