Iowa's Highs and Lows: A GLOBE Data Exploration

Purpose

Students interpret a histogram of GLOBE temperature data to decide whether statements about the weather are accurate, citing the parts of the graph they used as the basis of their decision.

Overview

Students interpret a histogram of GLOBE temperature data, which shows the frequency of occurrence of high and low temperatures, and answer true or false questions about the typical weather in that location. As an optional introductory activity, students create a histogram out of one month of the data to learn how a histogram is created.

Student Outcomes

Students will be able to:

*   Interpret a graph of high and low summer temperature frequency distributions.
*   Identify which statements are supported by data for summer temperatures in this location.
*   (Optional) Understand how histograms are made.

Science Concepts

*   *Earth Systems Science*
*   *Weather and Climate*
*   *Seasons*
*   *Weather can be described with quantitative measurements*
*   *Weather changes day to day and over seasons.*

Science Practices

*   *Analyzing and interpreting data*
*   *Constructing explanations*
*   *Obtaining, evaluating, and communicating information*

Math

*   *Graph analysis*

Time

50 minutes with all parts

30 minutes without optional part (Step 1)

Level

Middle school (grades 6-8)

Materials and Tools

*   *Student Activity Sheet A* (optional)
*   *Student Activity Sheet* B

Preparation

*   Copy the *Student Activity Sheet A* for each student
*   Copy the *Student Activity Sheet B* for each student. Do not print double-sided because students will need to look at both pages at the same time.
*   Prepare to project the color version of the graph (page 8) if you wish.

Background

In this activity, students explore the distribution of high and low temperatures during the summer in Des Moines, Iowa, a small city in the American Midwest with a continental climate. The Midwest is prone to extreme heat during the summer months, which is a hazard to human health. Heat waves in the region are projected to become more of a problem as climate changes. In this activity, daily high and low temperatures measured at a GLOBE location in Des Moines, Iowa, provide a picture

of summer temperatures.

Daily high and low temperatures are collected as a part of the GLOBE Program's Atmosphere Protocols. In this case, the highs and lows are shown as a frequency distribution histogram. The low temperatures have a single peak to the curve (which is called a unimodal distribution bell curve or normal distribution) while the high temperatures have two peaks to the curve (which is called a bimodal distribution). The two peaks are quite close together, unlike some bimodal distributions, which have a distinct "valley" between the peaks, so many would consider the high temperature frequency distribution to be a bell curve as well.

Frequency distributions are used in many contexts to describe the probability of an occurrence. They give a quick visual description of the likelihood of an event. In this case, looking at the high point of the bell provides information about the most likely high and low temperatures during summer in Des Moines, Iowa.

The high temperature during a day usually occurs during the afternoon (unless there is a weather front moving through the area). The low temperature usually occurs at the end of the night after heat from the previous day has dissipated. During summer months in a continental location with strong seasonal shifts in temperature, extreme heat is a health hazard. In Iowa, the National Weather Service (NWS) generally issues heat advisories and warnings if daytime highs are over 100°F (about 38°C) or if the low temperature does not fall below 80°F (about 27°C). The NWS also takes into account the impact of high humidity, which makes the temperature feel hotter. In this activity, students look at both the most common high and low temperatures and the "tails" of the distribution to explore how often high heat affected this location over the time frame that the data were collected.

About the data: In this activity, students explore daily minimum and maximum temperature data from Des Moines, Iowa, U.S. These GLOBE Program data are from meteorological summer months (June, July, and August) over four years (2010, 2012, 2013, and 2014).

What To Do and How To Do It
Step 1. Introduction to histograms (optional)

- Hand out the *Student Activity Sheet A* and instruct students to round each high temperature to the nearest degree, count the number of occurrences of each degree, and then plot them as a histogram. Provide an orientation to the Celsius temperature scale if needed.

- Review the answers to the questions below the graph to emphasize the types of information that can be found in a histogram of temperature frequency. Students should find the number of occurrences shown in the table below.

- If students are already familiar with how histograms are made, then you may omit this part of the activity and instead provide a quick reminder, surveying student knowledge, as you introduce the next part of the activity.

High Temperature (rounded)	Number of Occurences
23°C	2
24°C	0
25°C	4
26°C	4
27°C	5
28°C	3
29°C	3
30°C	2
31°C	2
32°C	1
33°C	1

Step 2. Define daily high and low temperature and orient students to the graph.

- Tell students that in this activity they will examine high and low temperatures collected by GLOBE Program participants during summer months in Des Moines, Iowa, US. Define high and low temperature (see background section above).

- Hand out *Student Activity Sheet* B and

orient students to the graph. (There is a color version of this graph on the last page that you may want to project for students on a screen.) If you started the activity by having students create a histogram, relate this histogram to the one they created, explaining that this one includes 12 times as much data as students plotted during Step 1.

- Tell students that in this activity they will decide whether statements about the high and low temperature data are true or false using the frequency distribution histograms.

- Note to students that the graph on their worksheet includes both the frequency distribution for high and low temperatures. Review the key.

Step 3. Students use the histogram to evaluate statements about the weather in Des Moines, Iowa.

- Allow ample time for students (on their own or in pairs) to decide which statements are true, which are false, and which cannot be determined given the information in the graph.

- Emphasize that students need to explain the reasoning for each decision, circling the portion of the graph where they found information leading to the conclusion, label their circle with the number of the question, and describing in words what that information in the graph indicated.

Step 4. Class discussion

- Once students have completed their evaluation of each statement, review the statements as a class. Have students explain their rationale for decisions about whether statements are true or false and the part of the histogram where they found the information.

- Discuss what factors could impact the accuracy of this graph. What if, for example, data was not collected during August? Have students consider what questions they would like to ask about the data before they could feel confident in their answers.

Assessment
Answers for Step 1

1. FALSE

2. FALSE

3. TRUE

4. TRUE

5. FALSE

6. TRUE

7. TRUE

8. TRUE

9. TRUE

10. FALSE

Answers for Step 2

The graph on the following page (Figure 1) provides a key to the location that students should indicate where they found evidence for whether statements were true or false. Students should also be able to explain in words what that part of the graph indicates and why they determined the statement to be true or false.

To extend this activity, have students write three more statements about the high and low temperatures in Des Moines, whether each is true or false, and why. Student answers should convey whether they understand the graph. You may wish to share the true/false statements as a class.

Extensions:
Delve Deeper into GLOBE Data

Create histograms of GLOBE air temperature data from other locations to understand the frequency of values. Make sure you select data that includes multiple repeated measurements.

Download the Des Moines, Iowa, data from the GLOBE Advance Data Access Tool and use spreadsheet software to describe the mean, median and variance.

Compare the Des Moines data in this activity to the 30-year climate data from the NOAA National Climatic Data Center (ncdc.noaa. gov) and have students describe how the temperature in Des Moines typically varies

through the year.

Get your students collecting min/max air temperature data by following the GLOBE Atmosphere Protocols. Upload your data to the GLOBE website to share with schools around the world.

Check out the GLOBE Surface Temperature Field Campaign and learn how your school can get involved.

Compare air temperature data from your location between two years to explore how much weather can vary from year to year.

Credits

This activity is part of *GLOBE Data Explorations*, a collection of activities developed by the UCAR Center for Science Education (scied.ucar.edu), a GLOBE partner. Activities were reviewed by science educators and staff at GIO and field tested by teachers.
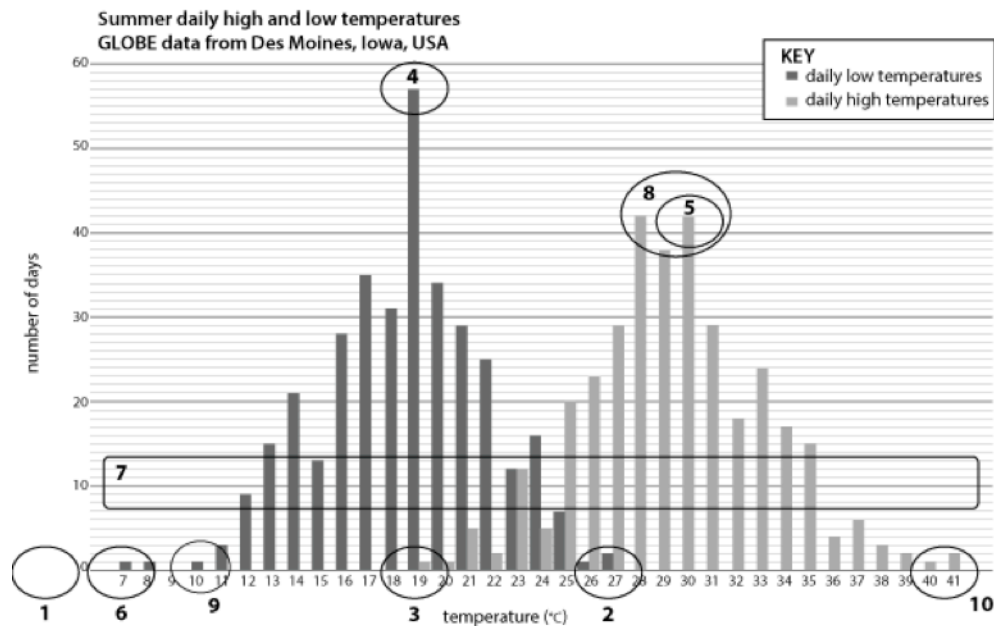

Figure 1. Locations that students should identify as the evidence for their answers (Step 2 on the *What's Up With This Weather? Activity Sheet).*

What's a histogram? A histogram is a graph that shows the distribution of numeric data. In this activity, you'll make a simple one yourself with daily high temperature data from Des Moines, Iowa, during July 2014. (Data collected by GLOBE teacher Joseph A. Toubes.)

Step 1: Round the high temperatures in the table below to the nearest whole number.
(Round up for .5 and higher, down for .4 and lower.)

Date	High Temperature	Rounded High Temperature
1 July 2014	25.3°C	
2 July 2014	26.4°C	
5 July 2014	26.7°C	
8 July 2014	31.1°C	
9 July 2014	26.6°C	
10 July 2014	27.1°C	
11 July 2014	28.3°C	
12 July 2014	28.6°C	
13 July 2014	30.3°C	
14 July 2014	30.3°C	
15 July 2014	23.3°C	
16 July 2014	22.9°C	
17 July 2014	24.9°C	
18 July 2014	26.3°C	
19 July 2014	26.7°C	
20 July 2014	27.6°C	
21 July 2014	30.8°C	
22 July 2014	32.7°C	
23 July 2014	31.8°C	
24 July 2014	27.6°C	
25 July 2014	26.0°C	
26 July 2014	29.0°C	
27 July 2014	29.4°C	
28 July 2014	24.7°C	
29 July 2014	24.6°C	
30 July 2014	26.4°C	
31 July 2014	26.6°C	

Step 2. Using the table at the left, count the number of times that each high temperature occurred in July 2014.

23°C _____

24°C _____

25°C _____

26°C _____

27°C _____

28°C _____

29°C _____

30°C _____

31°C _____

32°C _____

33°C _____

Step 3. Graph the number of occurances of each temperature below. Draw a vertical bar to the number of occurances (y-axis) of each temperature.
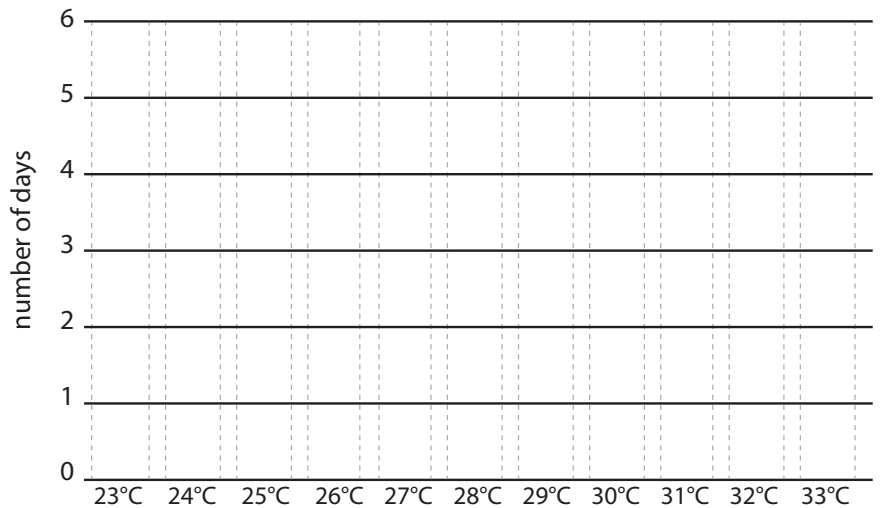
What's the most common high temperature during this month?

What's the lowest high temperature?
How many times was the high temperature that low during the month?

What's the highest high temperature?
How many times was the high temperature that high during the month?

Step 1. Decide if the following statements about summer in Des Moines, Iowa, US, over the period of time shown in the histogram on the following page are true, false, or if there is not enough information to answer.

——— 1. Three times during these four summers, the temperature dropped below freezing.

——— 2. On two days it was so hot in the summer that it only cooled off to 41°C.

——— 3. On one day the high temperature was the same as the most common low temperature.

——— 4. The most frequently occurring value is called the mode. The mode of the minimum temperatures is 19°C.

——— 5. The mode of the maximum temperatures is 30°C.

——— 6. Once, it got as cold as 7°C during these summers in Des Moines.

——— 7. Variability is a description of how much the temperatures range. The daily high temperatures have a larger variability than then daily low temperatures.

——— 8. The maximum temperatures have two modes (which is called bimodal) at 28°C and 30°C.

——— 9. The high temperature during these four summers was never 10°C.

——— 10. Extreme summer heat can be hazardous to health. The National Weather Service issues a heat advisory when the temperature is at or over 40°C. The temperature got this hot one time during this period.
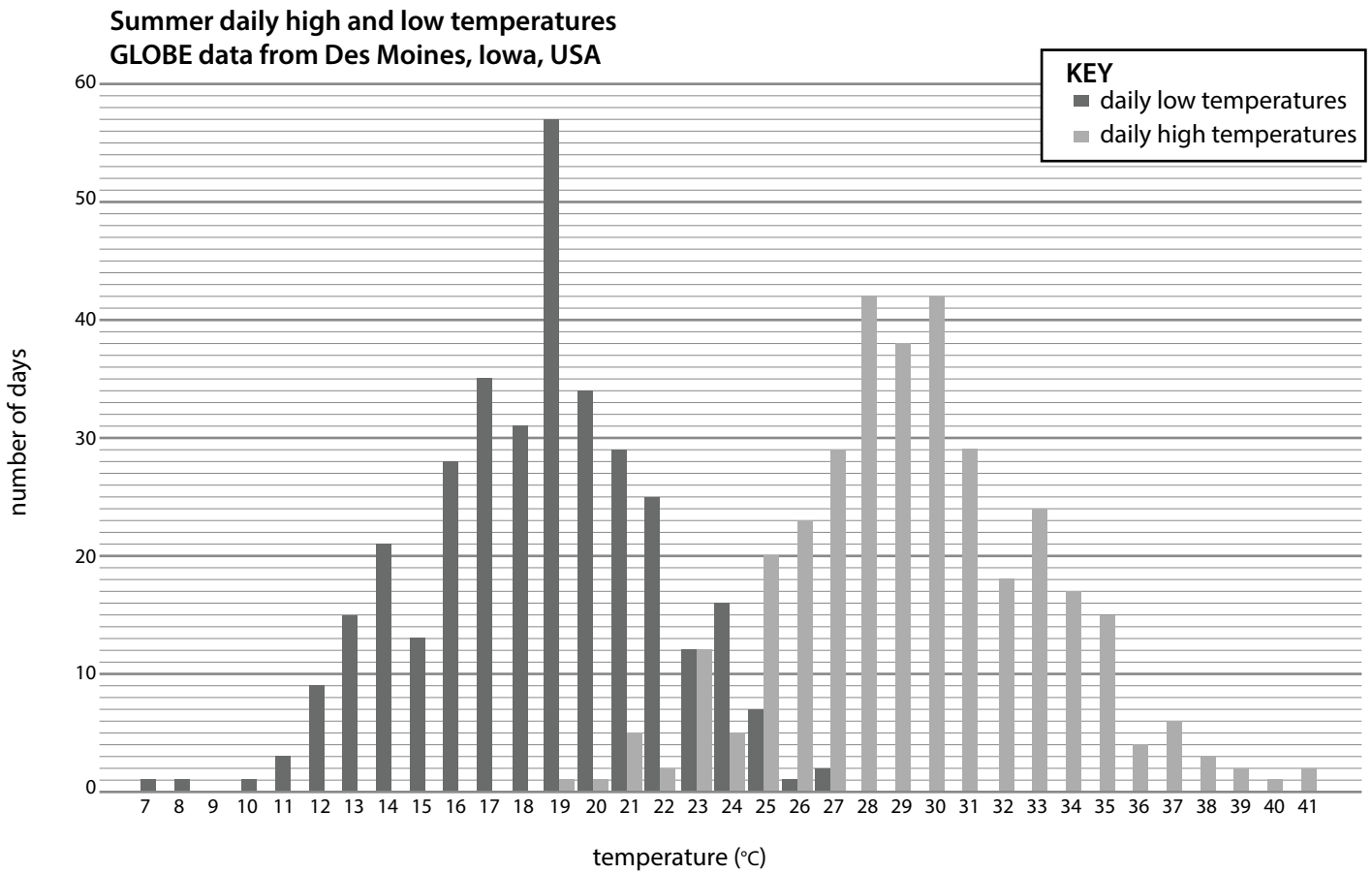
Step 2. Provide evidence from the histogram to support your answers on the previous page.

Circle the part of the histogram of daily high and low temperature that you used to make each decision.
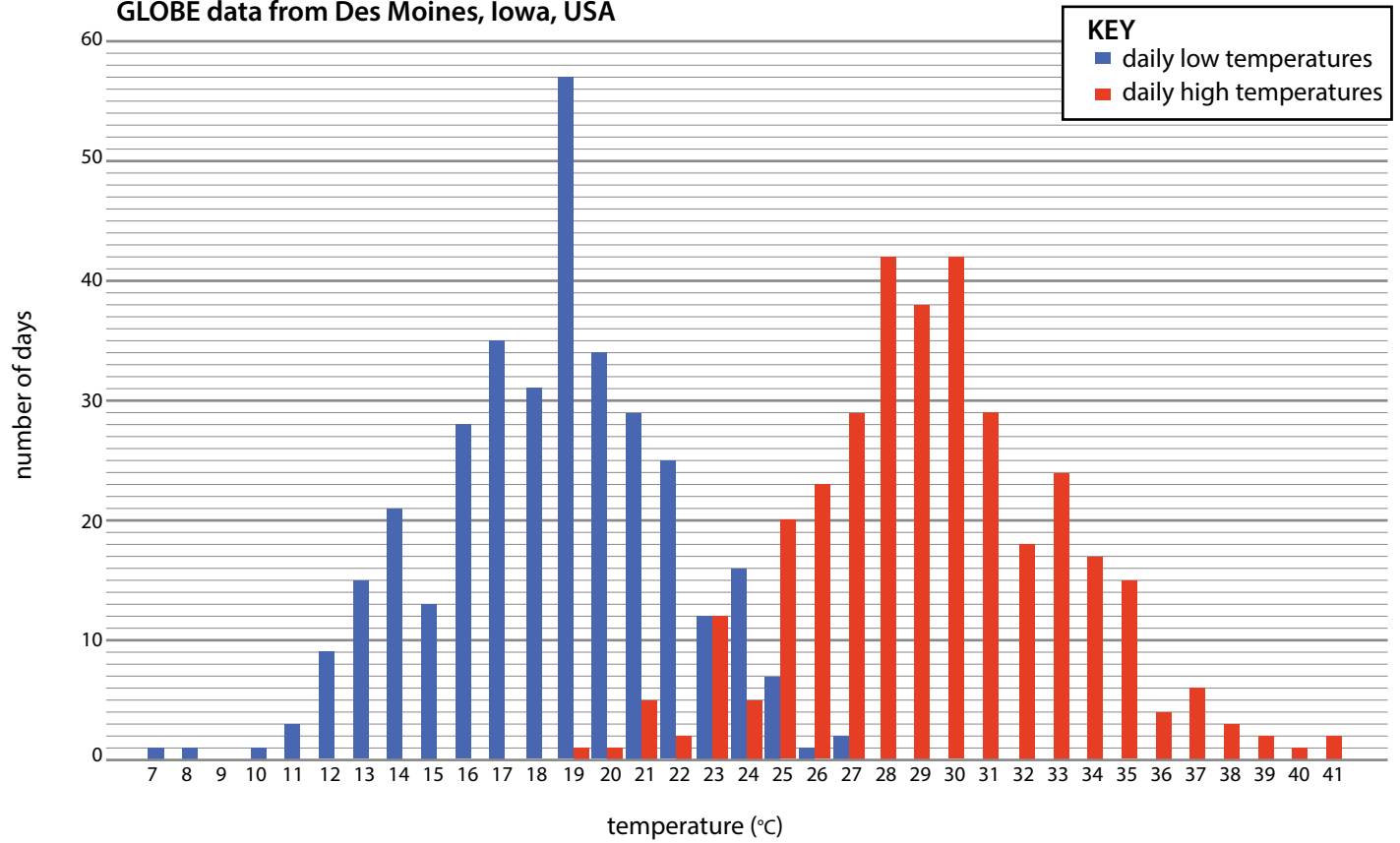
Label it with the number of the true/false statement.

Add a note about why that area of the histogram is evidence that the statement is true, false, or unknown.

**Summer daily high and low temperatures
GLOBE data from Des Moines, Iowa, USA**

KEY
■ daily low temperatures
■ daily high temperatures

y-axis: number of days
x-axis: temperature (°C)

These data are from summers of 2010, 2012, 2013, and 2014.
(Meteorologists refer to June, July, and August as the summer months.)

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