Lesson 4

What Influences Temperature?

Goal

Create a plan to model a relationship involving bivariate data.

Learning Target

I can identify different variables that affect the temperature of a place.

Lesson Narrative

In this optional lesson, students investigate how to predict the temperature of a location in North America. This question is purposefully vague and is meant for students to think critically about the variables needed to model the situation with mathematics.

Students begin by making a list of factors that influence outdoor temperatures. They then consider the effect of latitude on temperature. While these variables seem straight forward, different interpretations of them surface as students consider the statement "Temperature is a function of latitude". Next, students develop a plan to collect data to see what, if any, association there is between these variables, or if they need to choose a different variable than latitude to predict temperature for a location in North America. Finally, students create a list of locations to compare and gather data in preparation to analyze the data in later lessons.

Student Learning Goal

Let's see if we can predict the temperature.

Access for Students with Diverse Abilities

- Representation (Activity 2)

Access for Multilingual Learners

- MLR2: Collect and Display (Warm-up)

Instructional Routines

- MLR2: Collect and Display

Required Materials

Materials to Copy

- Is There an Association Between Latitude and Temperature Handout (1 copy for every 3 students): Activity 2

Activity 1:
If available, acquire a globe to demonstrate latitude as a 3D visual for students.

Lesson Timeline

10 min	10 min	25 min
Warm-up	Activity 1	Activity 2

Access for Multilingual Learners (Warm-up)

MLR2: Collect and Display
This activity uses the *Collect and Display* math language routine to advance conversing and reading as students clarify, build on, or make connections to mathematical language.

Instructional Routines

MLR2: Collect and Display

ilclass.com/r/10690754
Please log in to the site before using the QR code or URL.

Warm-up

Temperature Changes

10 min

Activity Narrative

In this *Warm-up*, students think about different factors that influence outside temperature in North America. Some are geographical (latitude, desert or sea climate, elevation), others are time of year, cloud cover, time of day, etc. This is a chance to make connections with some science concepts.

It is not important that students come up with an exhaustive list. They should just get the idea that there are many factors so that they are open to the idea that we'll have to make some choices for our model and clearly define any variables we want to consider. Making these choices is part of the modeling cycle.

Launch

Arrange students in groups of 3–4. Tell students that they are starting an investigation on how to predict outside temperature, and that these will be their groups throughout these investigations. Check that students understand the example given in the activity statement: as the time of day changes, the temperature often changes in a predictable way. They will brainstorm other factors that also influence the temperature.

Use *Collect and Display* to create a shared reference that captures students' developing mathematical language. Collect the language students use to brainstorm factors that influence the temperature outside. Display words and phrases such as "time of year," "elevation," "storms," "season," and "climate change."

Student Task Statement

What factors or variables can influence the outside temperature in North America?

a. Make a list of different factors.

b. Write a sentence for each factor describing how changing it could change the temperature.

Example: One factor is time of day. Often, after sunrise, the temperature increases, reaches a peak in the early afternoon, and then decreases.

Sample responses:

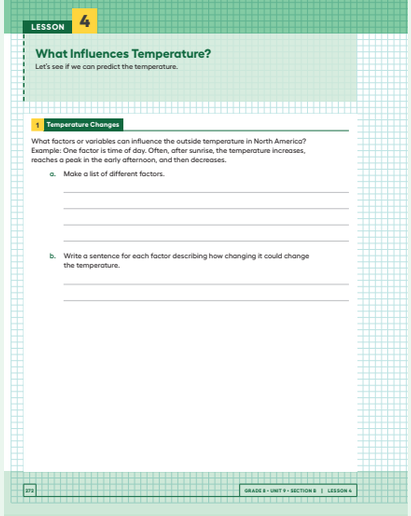
- Time of year: It is colder in the winter and warmer in the summer.
- Location: It is colder toward the poles and warmer toward the equator.
- Altitude: The higher a location, the colder it gets.
- Cloud cover: The more clouds there are, the colder it is.
- Ocean currents: The Gulf Stream brings cold or warm water to parts of the ocean and moderates temperatures that way.
- El Niño and La Niña: Moisture in the atmosphere influences temperature.
- Global climate change: Greenhouse gasses increase average temperatures.
- Volcanic eruptions: Ash in the atmosphere can lower temperature.
- Wind direction: Santa Ana winds bring warm air from inland to the coast or wind moves cold air from Canada into the central plains.

Activity Synthesis

Direct students' attention to the reference created using *Collect and Display*. Ask students to share their factors and explanations. Invite students to borrow language from the display as needed and update the reference to include additional phrases as they respond.

Invite students to share some of the factors they have come up with. Note that many of them are geographical. Point out that making a model that takes into consideration many or even all of these factors is very complex (weather forecasting is really difficult!). In mathematical modeling, we often start by fixing or disregarding (or randomizing) all but one of the factors. In the next activity, we want to pick just one—latitude—and investigate how just changing the latitude changes the temperature.

Student Workbook


LESSON 4

What Influences Temperature?

Let's see if we can predict the temperature.

1 Temperature Changes

What factors or variables can influence the outside temperature in North America? Example: One factor is time of day. Often, after sunrise, the temperature increases, reaches a peak in the early afternoon, and then decreases.

a. Make a list of different factors.

b. Write a sentence for each factor describing how changing it could change the temperature.

Activity 1
Predicting the Temperature

10 min

Activity Narrative

In this activity, students begin developing their plan to predict the temperature. First, they must clearly define the two variables they will be comparing, latitude and temperature, while limiting the impact of other factors by, for example, restricting themselves to locations within a specific geographical area. During this activity, students make sense of the ways different factors influence each other as they narrow the scope of their model.

Launch

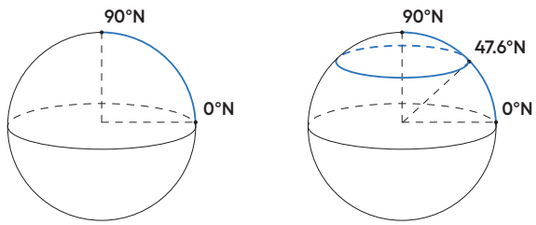
Keep students in the same groups. Tell students,

> *"Andre and Lin want a reliable way of predicting the temperature in different locations. That is, they want a function where you input a location and get an output with the temperature at that location. But what type of location should they use?"*

Ask students if they can explain exactly what latitude is. Latitude may have been discussed in the previous activity as one of the factors that can influence the temperature. Students should understand that latitude is a way to measure how far north or south of the equator a place is located. The unit of measurement is degrees north or degrees south. If possible, demonstrate latitude on a physical globe.

Draw a sphere (representing Earth) for all to see and indicate the circle representing the equator. Draw a quarter circle starting somewhere on the equator and ending at the North Pole. A location on the equator is at 0 degrees north (or south), and the North Pole is at 90 degrees north. Note that the angle made by the arc is a 90-degree angle. Since North America lies entirely north of the equator, all latitudes there have units of degrees north.

In this activity, students look at locations at 47.6 degrees north. Ask students where on the highlighted quarter circle this latitude is located. Then draw in the corresponding longitude circle (parallel to the equator) to show that there are many locations that have the same latitude.

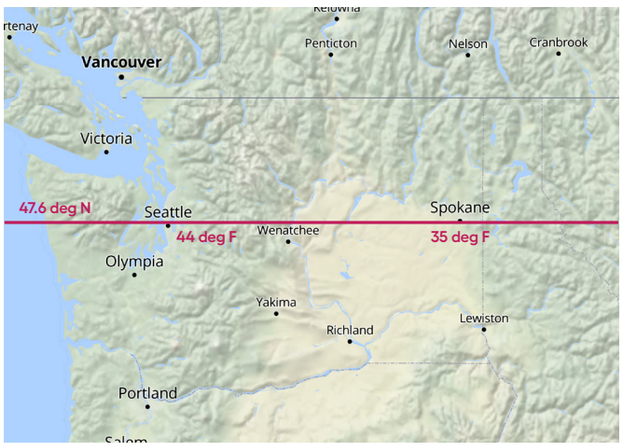


Student Task Statement

Andre says, "I think temperature is a function of the latitude of the location, as long as we keep the time the same when we are measuring the temperature. I know that the temperature varies from summer to winter and throughout the day. By fixing the time, we remove that variability."

Lin says, "Good idea to fix the time. Now what if we have 2 places with the same latitude? Look at this weather map for Washington State. Seattle and Spokane have the same latitude but different temperatures."

What do Andre and Lin mean?



Sample response: Andre is right that temperature varies with time, so time must be fixed to be able to talk about temperature as a function of location. For example, the question "What is the temperature in Seattle?" has many different answers depending on the time the temperature is measured. Lin is also right that "latitude" is not one single location. Even if a time is fixed, 2 locations that have the same latitude may have different temperatures.

Activity Synthesis

The purpose of this discussion is to establish that a first step to making a mathematical model is to define the variables and the relationship you want to model with precision.

Here are some questions for discussion:

- *"Why is it sometimes challenging to use functions to represent real-world situations?"*

  Real-world situations often have more than 2 variables involved.

- *"What are other variables we can 'fix' or standardize to be able to predict temperature from latitude?"*
  - Elevation: we could choose locations that have similar elevation
  - Ocean currents: we could choose locations in the same geographic area (like the same continent)

Remind students that models are not perfect representations of the situation. Fixing the variables we are not focusing on, like how Andre suggested to fix the time for temperature, makes it so our model for temperature and latitude will be more reliable.

Student Workbook


2 Predicting the Temperature

Andre says, "I think temperature is a function of the latitude of the location, as long as we keep the time the same when we are measuring the temperature. I know that the temperature varies from summer to winter and throughout the day. By fixing the time, we remove that variability."

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What do Andre and Lin mean?

3 Is There an Association Between Latitude and Temperature?

1 Data collection:

a. Latitude _____ b. Temperature _____

2 Complete the table to collect your data. Your table should include the cities or locations chosen, the latitude (in degrees north), and the temperature (in degrees Fahrenheit).

Learning Targets

+ I can identify different variables that affect the temperature of a place.

Access for Students with Diverse Abilities (Activity 2, Launch)

Representation: Internalize Comprehension.
Activate or supply background knowledge. Provide examples of variables that have an association for students to use as a reference. Check for understanding by selecting a few students to share other possible situations that may have an association between the variables.

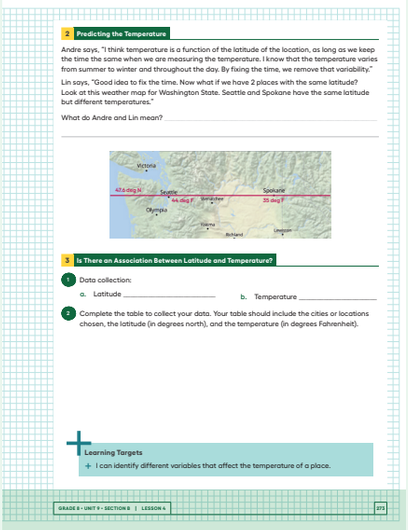
Supports accessibility for: Memory, Organization

Building on Student Thinking

If students are given a choice of continent and choose one crossed by the equator, they will need to make a choice about how to represent the latitudes above and below the equator. Consider asking:

"Can you explain how the equator impacts your data?"
"How could you represent that some latitudes are north of the equator while others are south of the equator?"

Student Workbook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What do Andre and Lin mean?

Victoria
Seattle
Spokane
Olympia
Yakima
Richland

3 Is There an Association Between Latitude and Temperature?

1 Data collection:
a. Latitude
b. Temperature

2 Complete the table to collect your data. Your table should include the cities or locations chosen, the latitude (in degrees north), and the temperature (in degrees Fahrenheit).

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Activity 2
Is There an Association Between Latitude and Temperature?

25 min

Activity Narrative

In this activity, students determine that they can assume that there is a relationship between latitude and temperature and that data can be collected to define that relationship. As an important step of mathematical modeling, they think about what data they need to collect, how they can collect it, and what methods will help them to analyze the data. This step is often done for students to save time, but it is non-trivial and worthwhile for students to complete this step.

Launch

Keep students in the same groups. Discuss the following questions as a class.

- *"Is temperature a function of latitude? Why or why not?"*

  No, temperature is not a function of latitude because multiple locations on the same latitude can be different temperatures even when other variables, like time, are fixed.

- *"Is it reasonable to assume that there is a relationship between temperature and latitude?"*

  Yes, since latitude is a measure of how far a location is from the equator, and generally the farther a location is from the equator, the lower the temperature.

Depending on the time available, for the first question either tell students to pick a continent for their latitudes and a month for average temperatures to collect data for or assign a specific continent and month. The following instructions assume the continent of North America and average temperature in September were chosen.

Once a choice of continent and month is made, give a copy of the data collection sheet to each group. As a class, develop a list of 20–30 cities or locations in North America to gather data. Make sure the cities are from a variety of latitudes, since that is what is being analyzed.

Student Task Statement

1. Data collection:

   Sample response:

   a. Latitude North America, from 0°–90° **b.** Temperature the average temperature in September

2. Complete the table to collect your data. Your table should include the cities or locations chosen, the latitude (in degrees north), and the temperature (in degrees Fahrenheit).

   Answers vary.

Activity Synthesis

The goal of this discussion is to make sure students understand the next steps in analyzing their data. Here are some possible discussion questions:

- *"What can we do with our data to see if there is an association?"*

  We can make a scatter plot and fit a trendline to the data.

- *"What are some things we kept in mind when we chose our cities?"*

  We chose many cities so there would be enough data. We selected cities from a variety of locations to have varied values.

Remind students that while real-world data does not always fit the definition of a function, modeling the situation with a function is a useful way of analyzing the data and seeing trends.

In the next lesson, students will analyze the class data or the provided data to see if there is an association.