

About the Lesson

In this activity, students will load a background image of a map and use the scale on the map to estimate distances. As a result, students will:

- Use ratio reasoning to solve real-world problems.
- Measure and record pairs of values on the coordinate plane to determine distance and compare ratios.
- Use ratio reasoning to convert measurement units.
- Use technology tools to model and analyze a real-world problem.

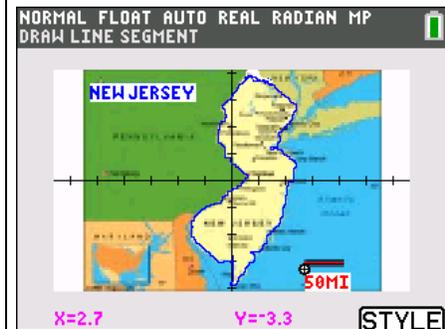
Vocabulary

- coordinate
- ratio
- units
- proportional reasoning

Teacher Preparation and Notes

This activity can help students apply ratio reasoning to solve real-world problems. Students will work with units and scale figures.

- The teacher will need to transfer the appropriate background image and color Pic1 to students' TI-84 Plus C Silver Edition or TI-84 Plus CE. This can be done while students work on question1. Color files ending with .8ca and .8ci are for the TI-84 Plus C family. A file that ends with .8xi is for the TI-84 Plus family.
- Pic2.8xi is a rough sketch of New Jersey for students using the TI-84 Plus.
- The NJ_Image0.8ca is the background image and Pic1.8ci is the picture for the color TI-84 Plus C family of graphing calculators.
- For the extension you may want to have images of other states with a clearly marked scale ready to transfer to students. You could also show students physical maps and explain how the process is similar to using rulers. The advantage to the method described in this activity is it reinforces coordinates, the distance equation, and other graphing and ratio/proportion skills.



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-84 Plus family with the latest TI-84 Plus operating system (2.55MP) featuring MathPrint™ functionality. Slight variations to these directions given within may be required if using other calculator models.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Compatible Devices:

- TI-84 Plus Family
- TI-84 Plus C Family

Associated Materials:

- Mapping_Success_Student.pdf
- Mapping_Success_Student.doc
- NJ_Image0.8ca
- Pic1.8ci
- Pic2.8xi

Students will calculate the distance from the northernmost point to the southernmost point in New Jersey. The black horizontal line in the image shows the scale of 50 miles.



1. Before you use your TI graphing calculator quickly estimate the vertical distance from the southern to the northern tip of New Jersey on the map. How did you come up with your estimate?

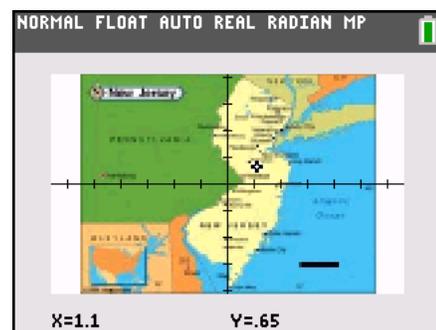
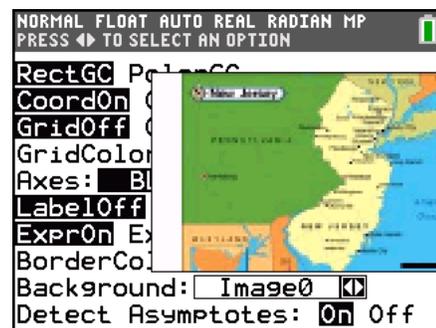
Answer: If students estimate the black bar to be two tick marks long, then they would estimate the distance to be about 200 miles from the northernmost to southernmost points. If students estimate the black bar to be 1.5 tick marks, they would get a distance of over 250 miles.

Step 1: Students will first set their devices to the default settings. To do this, have students press **[2nd]** **[MEM]** 7 Reset, 2: Defaults, 2: Reset. This will set the **[MODE]** to all the left-most settings as well as the **[2nd]** **[FORMAT]** screen.

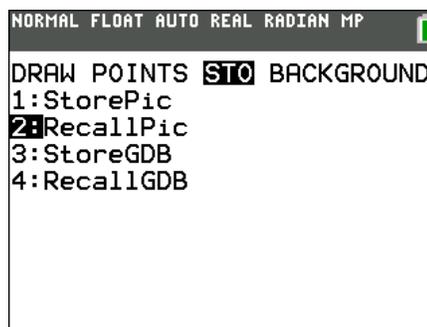
On the **[Y=]** screen, have students clear any functions, and turn off any StatPlots.

Step 2: To load the image as a background, have students press **[2nd]** **[FORMAT]**. They should move the cursor to Background. Have students use the spinner's left and right arrows until the desired image is in place.

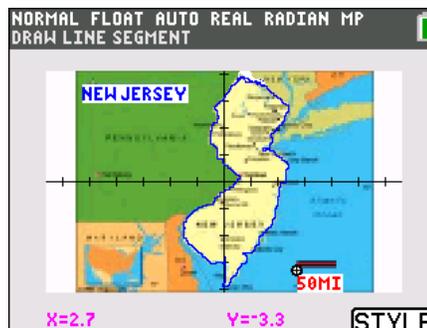
Step 3: Have students press **[ZOOM]** and then 4: ZDecimal. The graph screen will be displayed. Students can move the arrow keys to show the coordinates while they move the cursor around the screen.



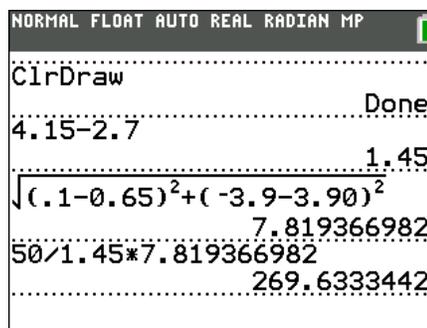
Step 4: Once the picture has been transferred to student devices, have students load Pic1 from the Draw options. Students should press $\boxed{2nd}$ \boxed{DRAW} , and then they should press the right arrow twice so that STO is highlighted. Have students choose 2:RecallPic and then select Pic1 if using the color TI-84 Plus C (select Pic2 for a non-color larger pixel picture for the TI-84 Plus).



Step 5: The length of the black bar at the bottom right of the map represents 50 miles. Students will determine how long that line is on the coordinate axes. To do this they will use the DRAW Line command to construct another bar.



To accomplish this, have students press $\boxed{2nd}$ \boxed{DRAW} 2:Line(. They should move the free trace cursor to just below the bar. The color can be changed by pressing \boxed{GRAPH} for the **STYLE** soft key.



2. Press \boxed{ENTER} to mark the endpoint of the segment. What are the coordinates of the point?

Answer: Answers will vary, but the x-coordinate will be approximately 2.7 on the color TI-84C. For example, the coordinate might be (2.7, -3.3).

Have students right arrow over to the end of the segment. They should press \boxed{ENTER} to finish the segment.

3. What are the coordinates of the endpoint?

Answer: Answers will vary, but the x-coordinate should be approximately 4.15 on the color TI-84C. For example, the coordinate might be (4.15, -3.3).

Have students select \boxed{CLEAR} to exit the Draw feature. If students are not satisfied with the length of their segment they can try again, but they should be sure to record to the new coordinates.

4. Calculate the distance between these two coordinates you recorded above.

Answer: Answers will vary but students should show their work. For example, $4.15 - 2.7 = 1.45$ units.

5. Use the ratio of these known distances to calculate the distance from the northernmost point to the southernmost point in NJ. You can use what you've learned about the Draw Line command. Show your work, and explain how you arrived at your estimate.

Answer: Answers will vary. A student might obtain coordinates of (0.1, -3.9) and (0.65, 3.9) at the southern and northern tips of NJ. Using the distance formula, they would obtain a distance of 7.82 units between the points. They can use the proportion that 50 miles is equivalent to 1.45 units on the image. Using this proportion, the distance of 7.82 units would correspond to approximately 270 miles.

Teacher Tip: Have students consider the accuracy of their calculation. In the sample answer above, a distance of 270 miles was calculated, but the approximate distance from the southernmost point of NJ to the northernmost point in NJ is 175 miles. Have students consider sources of error in this activity. Students introduce error with each measurement on the image. One way to consider this error is to estimate the error introduced when a measurement is a single pixel off from the “true” coordinate. With Zoom Decimal the resolution is 0.05. This is less than 2 miles on the map. With many measurements made, this error could add up cumulatively. Another source of error could be the scale provided on the map.

Tech Tip: Import other map images for your students so that they can explore distances in their own state. If students do not have the color TI-84 Plus C, a picture can be made using the $\boxed{2\text{nd}}\boxed{[\text{DRAW}]}$ A:Pen. Include the scale in the image. Text can be added with $\boxed{2\text{nd}}\boxed{[\text{DRAW}]}$ O:Text(. To save the picture press $\boxed{2\text{nd}}\boxed{[\text{DRAW}]}$ STO and select StorePic. Add a number to the image title (for example, “Pic2”), and press enter. This will store Pic2 so you can send it to the students.

Extensions:

1. Collect the answers to this challenge from the class and have students find the five-number summary. Have students create a box plot (and/or histogram) of this data.
2. Have students write the equation of a line that forms the northern border of NJ with New York.
3. There are six states pictured in the map. Have students write an equation of a line that passes through many states.

