



**BOSTON PUBLIC LIBRARY
MATHEMATICS AND MAPS
TITLE: MEASURING DISTANCES ON A MAP**



Essential Question: How do we measure distances on a map?

Grade Range: Grade 2 - 4

Time Allocation: 15-30 minutes per lesson

Overview:

Scale is the relationship between distances on a map and the corresponding distance in the real world. Scale can be represented in three different ways: in an equation form, graphically and using a representative fraction.

Type of Scale	Example
Equation	<i>1 inch = 20 miles</i>
Graphical	
Representative Fraction	$\frac{1}{1,267,200}$

In this lesson, students will explore ideas related to lengths and repeated lengths to understand properties of addition using the graphical scale.

Objectives:

1. Students will measure distances on a map using the graphical scale.
2. Students will add smaller lengths to determine longer distances.
3. Students will determine how much longer one distance is than another.

Common Core Curriculum Standards:

Grade 2 – Measurement and Data

1. Measure lengths using measurement tools such as rulers, yardsticks and measuring tapes; understand that these tools are used to find out how many standard length units span an object with no gaps or overlaps, when the 0 mark of the tool is aligned with an end of the object.



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2. Understand that when measuring a length, if a smaller unit is used, more copies of that unit are needed to measure the length than would be necessary if a larger unit were used.
3. Understand that lengths can be compared by placing objects side by side, with one end lined up. The difference in lengths is how far the longer extends beyond the end of the shorter.

Grade 3 – Number—Operations and the Problems They Solve

Understand that multiplication of whole numbers is repeated addition.

Procedure:

Lesson 1: Introduction

1. Hand out the map of the Massachusetts (<http://maps.bpl.org/id/12581>) and show this using a projector or on a computer screen. Have students answer the following questions as a class:
 - a. What location is shown on this map?
 - b. Where is Boston? What other cities do you know? Have students label other cities that they can identify.
 - c. Point out the town of Williamstown in the northwestern corner of Massachusetts. Suppose your family and you were planning to travel to Williamstown. How could we use the map to find out how far away it is?
2. Explain that the map scale tells us how the measurements on the map relate to actual miles in the real world. Every map has a scale. Point out the scale on this map and its meaning.

Lesson 2: Measuring Distances using the Graphical Scale

1. Pass out yarn to each student. Using the scale on the map, have them cut the yarn the same length as the 30 mile mark on the scale bar. They should repeat this process until they have 12 pieces of yarn of the same length. Explain that one yarn length on the map represents 30 miles in the real world.
2. As a class, count the number yarn lengths it takes to get from Boston to Williamstown by repeatedly laying yarn lengths out on the map. Walk around to verify that students are following the process accurately. For this activity, all distances should be measured as straight line distances.

Note: Since the projector will create a larger scale version of the map, this can also be shown using the projected scale bar and the projected map if yarn lengths are cut to the length of the projected scale bar.



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3. It is approximately 4 yarn lengths from Boston to Williamstown. Have students convert this to an addition problem: Since each yarn length represents 30 miles, $30 + 30 + 30 + 30 = 120$ miles to the western edge of the state and complete their handout.
4. As practice, show the students the following cities on the map and have them label with a dot and name them on their map: Providence, Northampton and Albany. They should then find their distance in miles by laying down yarn lengths and creating and solving an addition problem, completing the handout as they go along. They should share their answers with the class.
5. As another practice, have students find two different locations that are 60 miles from Boston. Have students in the class show their solutions using the projected map.

Lesson 3: Comparing Distances

1. Have students label Worcester and Provincetown. Lead them through how to find out how much farther it is from Boston to Provincetown by completing the handout and comparing numbers of lengths.
2. Have students compare distances and calculate differences between the following routes:
 - a. Boston to Providence and Boston to Northampton
 - b. Providence to Albany and Providence to Provincetown

Lesson 4: Comparing Unit Lengths

1. Have students explore what happens when the unit length changes. They should cut new unit lengths – this time having the yarn represent only 15 miles of our graphical scale. Have students create 12 yarn lengths that represent 15 miles on the map. Have students use a different color of yarn to emphasize the difference in the lengths.
2. Repeat the measurements from Boston to Providence, Northampton and Albany. Have students compare the number of lengths to each city using the 15 mile yarn versus the 30 mile yarn. Emphasize the conclusion that the smaller the unit, the more of them you need to make up a distance.

Lesson 5: Extension to Multiplication

1. Model for students how the repeated adding of lengths can also be represented using multiplication. Have students find the distance from Provincetown to Albany. Suppose it is 8 of the 30 mile yarn lengths. Note that students can find the total distance using both addition and multiplication.

Repeated Addition: $30 + 30 + 30 + 30 + 30 + 30 + 30 + 30 = 240$ miles

Multiplication: $8 \text{ lengths} \times 30 \text{ miles each} = 240 \text{ miles}$



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2. Have students find the distance between other cities and represent the distances in terms of repeated addition and multiplication. Review the solutions as a class.

Lesson 6: Assessment

1. Have students complete the assignment on finding distances on the Newburyport map (<http://maps.bpl.org/id/12846>).
2. Collect the assignments and review answers.

Materials Needed:

- Maps Used:
 - Map of Massachusetts <http://maps.bpl.org/id/12581>
 - Map of Newburyport <http://maps.bpl.org/id/12846>(Note: Maps are replicated at the end of the handout – they would be easier to use if printed in landscape form instead of portrait.)
- Yarn in two different colors
- Markers (for labeling cities/locations on the map)
- Scissors
- Pencils



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Date _____

Part 2: Measuring Distances using the Graphical Scale

The map scale tells us how the measurements on the map relate to actual miles in the real world. Every map has a scale. Highlight the scale on your map.

- Using the map scale, cut yarn the same length as the 30 mile mark on the scale bar. Repeat this process until you have 12 pieces of yarn of the same length.

One Yarn Length on the Map = _____ Actual Miles

- Count the number of yarn lengths it takes to get from Boston by laying yarn lengths out on the map using a straight line distance. Complete the following:

Distance	Number of Yarn Lengths	Addition Problem	Total Actual Miles
Boston to Williamstown			



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3. Label the following cities on your map with a dot: Providence, Northampton and Albany. Find the distances by laying down yarn lengths and creating addition problems. Complete the table below.

Distance	Number of Yarn Lengths	Addition Problem	Total Actual Miles
Boston to Providence			
Boston to Northampton			
Boston to Albany			

4. Using your yarn lengths, try this: find two different distances that represent 60 actual miles. Complete the table below.

Distance	Number of Yarn Lengths	Addition Problem	Total Actual Miles
			60 miles
			60 miles



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Lesson 3: Comparing Distances

1. Label Worcester and Provincetown. How much farther away from Boston is one city compared to the other? Follow along with the class to find the answer below.

Distance	Yarn Lengths
Boston to Worcester	
Boston to Provincetown	

2. Draw your conclusions below:

- Which city is farther from Boston? _____
- How do you know? _____
- How many more yarn lengths is the farther city from Boston? _____
- How many miles farther is this city from Boston? _____
- Complete the following:

_____ is _____ miles farther from Boston than _____.

3. Compare distances and find differences between the following routes:

- Boston to Providence and Boston to Northampton

Distance	Yarn Lengths
Boston to Providence	
Boston to Northampton	

_____ is _____ miles farther from Boston than _____.



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b. Providence to Albany and Providence to Provincetown

Distance	Yarn Lengths
Providence to Albany	
Providence to Provincetown	

_____ is _____ miles farther from Providence than _____.



Measuring Distances on a Map

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Lesson 4: Comparing Unit Lengths

What happens if the length of our yarn changes? Follow the steps to find out.

1. Using the scale bar, cut yarn lengths that represent 15 miles instead of 30 miles. Cut 12 of these lengths. Use a different color piece of yarn.
2. Now find the distance by using the 15 mile length pieces of yarn. Complete the table below.

Distance	Number of Yarn Lengths	Addition Problem	Total Actual Miles
Boston to Williamstown			
Boston to Providence			
Boston to Northampton			
Boston to Albany			



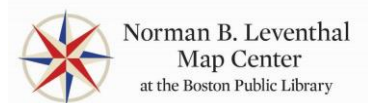
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3. Using your table from Part 2 and the table above, compare the number of yarn lengths needed for each distance when using the 30 mile yarn length and the 15 mile yarn length.

Distance	Number of 30 mile Yarn Lengths	Number of 15 mile yarn lengths
Boston to Williamstown		
Boston to Providence		
Boston to Northampton		
Boston to Albany		

4. Review the table above. What happened when you used smaller yarn lengths?





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Lesson 5: Extension to Multiplication

To find actual distances, we repeatedly add miles based on the number of yarn lengths. The idea of adding the same number repeatedly is the basis for multiplication.

- Using the 30 mile yarn length, find the number of yarn lengths needed to travel from Provincetown to Albany.

Distance	Number of Yarn Lengths	Repeated Addition	Multiplication
Provincetown to Albany			

- Complete the table to practice writing repeated addition as multiplication. Refer to the table in Lesson 4 to help you.

Distance	Number of Yarn Lengths	Repeated Addition	Multiplication
Boston to Williamstown			
Boston to Providence			
Boston to Northampton			
Boston to Albany			



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Lesson 6: Assessment

Review the map of Newburyport. Since it is difficult to read parts of at the $8\frac{1}{2}$ by 11 inch size, mark the following information given by your teacher:

- The cemetery in the bottom right corner of the map
 - The school in the middle of the left side of the map
 - The graphical scale represents an actual length of 1500 feet
1. Using the roads on the map, highlight two different routes between the cemetery and the school. Use a different color for each route.
 2. Cut pieces of yarn to represent the graphical scale.

One Yarn Length on the Map represents _____ Actual Miles

3. Determine the length of each route between the cemetery and the school. Complete the table below.

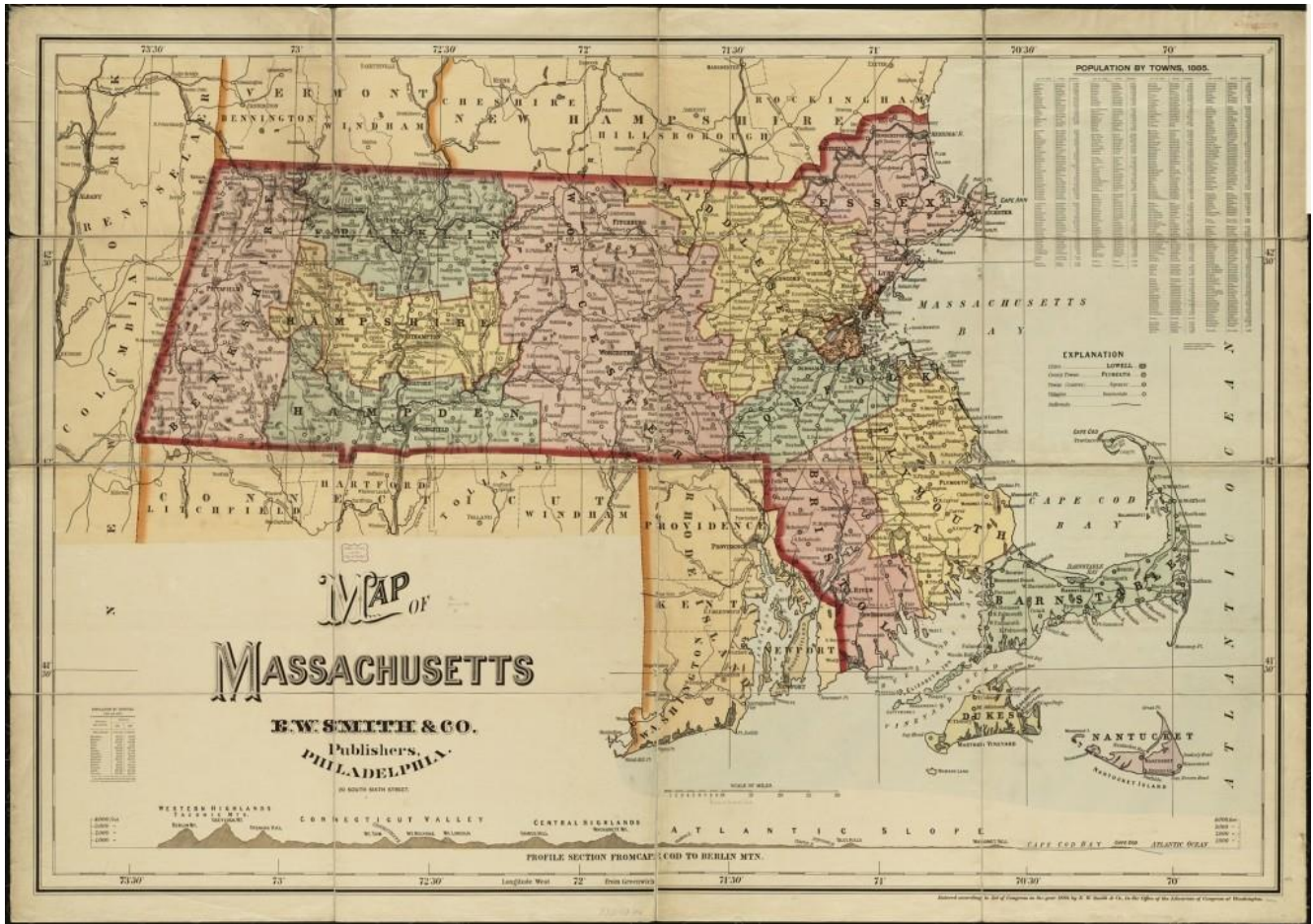
Distance	Number of Yarn Lengths	Repeated Addition	Multiplication
Route 1 between Cemetery and School			
Route 2 between Cemetery and School			

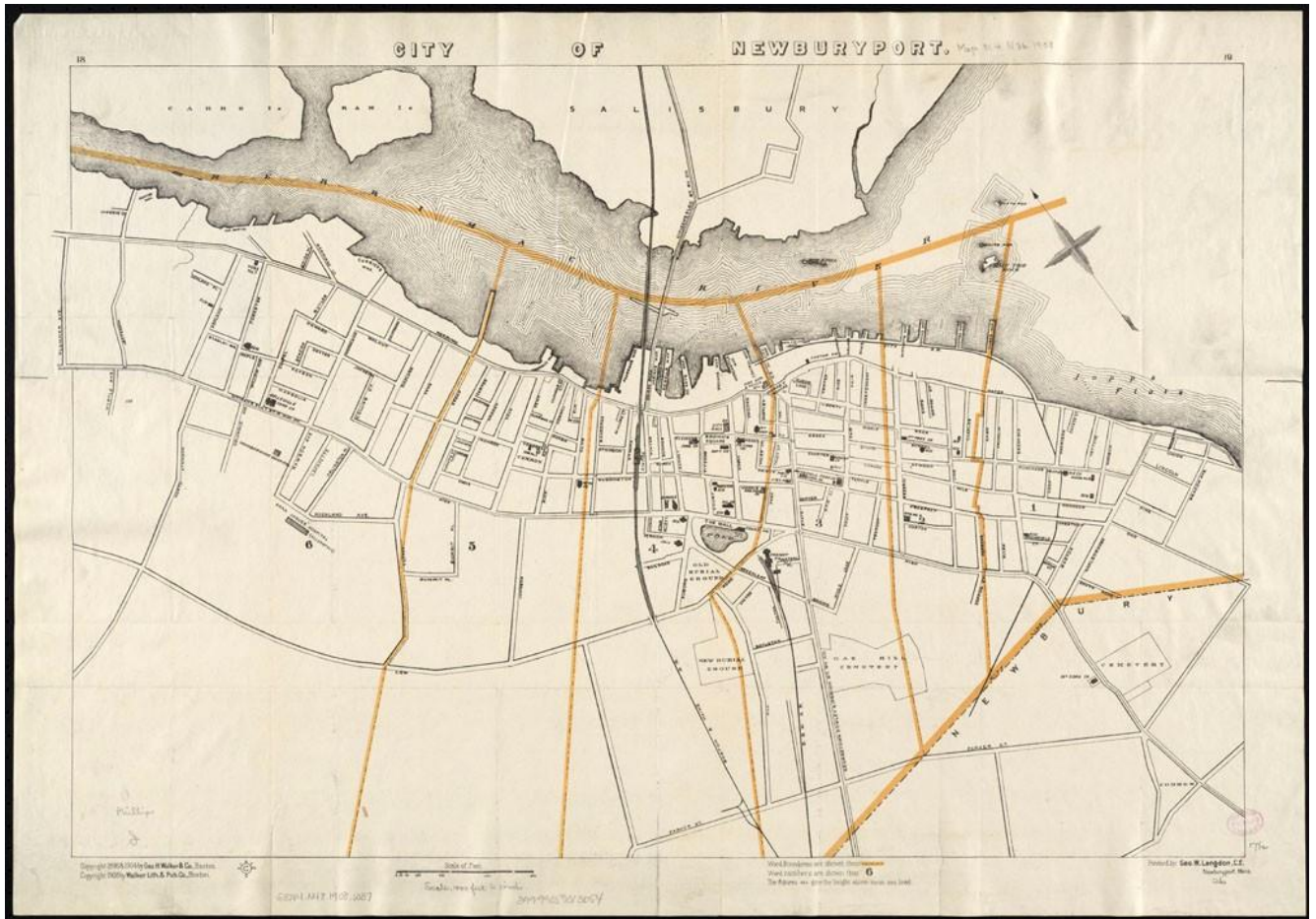
4. Compare the two routes between the cemetery and the school.
 - a. Which route is longer? _____
 - b. How many more yarn lengths is the longer route? _____
 - c. How many feet longer is the longer route? _____
5. Suppose you cut your yarn to represent only part of the scale, for example, suppose you made each piece of yarn represent 3000 feet instead of 1500 feet. What would happen to the number of yarn lengths for the distances above? Why?



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