How Big is That?

Unit: Henry as Mathematician
Topic: Measurement

Thoreau Quotation

"I have lately been surveying the Walden woods so extensively and minutely that I now see it mapped in my minds' eye – as, indeed, on paper…"

—*Journal*, January 1, 1858

Background

Many people know Thoreau only as an author and an advocate for Nature. Henry was skilled in a lot of trades, however and made his living, in part, as a surveyor. Surveyors measure the land and make maps that are used to keep track of property lines between parcels of land and the size of different pieces of property. Careful measurement and precise recording is critical to a good survey.

Objectives

1. Students will determine and record the dimensions of an area (3rd grade), estimate angles of the area (4th grade), and calculate a volume (5th grade).
2. Students will understand the importance of precise and accurate measurements.

Method

Students will measure an area by pacing and record the data.

Time Required

30-45 minutes

Materials

- Clipboards
- Pencils
- Drawing paper
- Graph paper (4th graders only)
- Yard stick (5th graders only)

Procedure

1. Mark the corners of the square or rectangular area that is to be measured (for 4th graders you may want to make the angles something different than 90°). Select an area to measure that is at least 15 feet square; this can be inside or in the school yard or students can be asked to find a place at home to measure.
2. Students should work in pairs or small groups, as appropriate.

3. Starting at one corner, the "measuring" student will walk the perimeter and should count the number of paces to each corner (1 pace = two natural steps), recording the length of each side in paces. Students will need to walk the entire perimeter (or only two sides of the rectangle if students are using the area formula). The "recording" student should also count and then record the number of paces the "measuring" student took to reach each corner. If the pacing ends in is less than a full pace, have the students estimate how much of a pace it was (¼, ½, etc.). As a full pace equals two natural steps, remind students that one step would then be ½ of a pace, half of a step would be ¼ of a pace, etc.
4. Now have the "measuring" student swap places with the "recording" student and measure the area again as they did in step 3.
5. Have each student calculate the area based upon their pace.
6. For 4th graders, ask them to draw out the area using graph paper and estimate the angles of the area. For 5th graders have them calculate the volume, if they assume that the area now also has a thickness to it that is 8 ft. (how tall Henry's cabin ceiling was) or 70 ft (as tall as a Honey Locust tree, which Henry documented in his journal). For the volume, have the students measure one student's pace to determine how many feet that would be and use that student's pace to determine the area in feet.

Reflect and Explain

- Record all the different areas on the board (or piece of paper). Did each student arrive at the same area? Why are the areas different?
- Explain how today we use units of measurement that are based on the exact same length every time (feet or meters) and therefore are both more accurate (everyone comes up with the same area) and more precise (it's hard to determine a fraction of a pace if it's anything other than a whole or ½ of a pace). If their family was building a new house, which method would they want to use for determining the size of their room? Why?

Extensions

1. Using a magnetic compass or similar tool, create a survey map of the measured area. Starting from one point, record the compass direction and distance, measured in paces, to each successive point along the perimeter. Why is precision more important when attempting to create this map?

Vocabulary

accuracy - freedom from mistake or error

area – the size of a shape or figure.

distance – an amount of space between two things or people; can be measured in different units.

measurement – a size, length, or amount known by measuring something.

pace – two footsteps of a person; unique to each person.

perimeter – the boundary of a closed plane figure; the outside edge of an area or surface.

precision – the quality of being exact.

unit of measure – a quantity used as a standard of measurement, i.e., miles, feet, or meters are used to measure distance.

Common Core Standards

English Language Anchor Standards (all grades)
- CCSS.ELA-LITERACY.CCRA.SL.4
  Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
- CCSS.ELA-LITERACY.CCRA.L.6
  Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

Math Practice Standards (all grades)
- CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.
- CCSS.MATH.PRACTICE.MP6 Attend to precision.

Grade 3 Content Standards
- CCSS.MATH.CONTENT.3.MD.C.5
  Recognize area as an attribute of plane figures and understand concepts of area measurement.
- CCSS.MATH.CONTENT.3.MD.C.6
  Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).
- CCSS.MATH.CONTENT.3.MD.D.8
  Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

Grade 4 Content Standards
- CCSS.MATH.CONTENT.4.MD.A.3
  Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the*

flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.

- CCSS.MATH.CONTENT.4.G.A.1
  Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

Grade 5 Content Standards

- CCSS.MATH.CONTENT.5.MD.C.5
  Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

- CCSS.MATH.CONTENT.5.G.B.3
  Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.