TEACHING WITH PRIMARY SOURCES—MTSU

Lesson Plan: Calculating Volume using Architectural Drawings

Grade: 5th and 6th
Subject: Math
Time required: 1-2 class periods
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OVERVIEW
Students will use real world examples of mathematics to determine the volume of historic Tennessee buildings.

UNDERSTANDING GOAL
Using images of architectural drawings from the Historic American Buildings Survey collection at the Library of Congress, students will be given measurements to determine the volume of buildings.

OBJECTIVES
- Students will calculate the volume of a building using appropriate units of measurement.
- Students will determine the difference between area and volume in the context of buildings.

INVESTIGATIVE QUESTIONS
How to architects use and depict area and volume measurements? Can two buildings have the same areas (square units) but different volumes (cubic units)? Why or why not?

TENNESSEE CURRICULUM STANDARDS
- 5.MD.C.5 Relate volume to the operations of multiplication and addition and solve real-world and mathematical problems involving volume of right rectangular prisms.
- b. Know and apply the formulas \( V = l \times w \times h \) and \( V = B \times h \) (where \( B \) represents the area of the base) for rectangular prisms to find volumes of right rectangular prisms with whole number edge lengths in the context of solving real-world and mathematical problems.
- c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real-world problems.
- 6.G.A.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. problems.

LIBRARY OF CONGRESS RESOURCES
- Historic American Buildings Survey/Historic American Engineering Record/Historic American Landscape Survey
- 7. West facade HABS TENN, 19-NASH, 1-C - State Capitol, State Capitol Boulevard & Cedar Street, Nashville, Davidson County, TN [1934]
- HABS TENN, 19-NASH, 1- (sheet 8 of 23) - State Capitol, State Capitol Boulevard & Cedar Street, Nashville, Davidson County, TN [1934]
- HABS TENN, 19-NASH, 1- (sheet 2 of 23) - State Capitol, State Capitol Boulevard & Cedar Street, Nashville, Davidson County, TN [1934]
- HABS TENN, 19-NASH, 1- (sheet 3 of 23) - State Capitol, State Capitol Boulevard & Cedar Street, Nashville, Davidson County, TN [1934]
**Step 1**
From the link to the bibliographic page for each primary source, click on the icon for “drawings” on the left. You will see a series of thumbnail images of the architectural drawings for each building. Click on a thumbnail for a closer look at a drawing, and then select an option to view as a larger, higher resolution picture. (Note: The letters and numbers are all legible from the TIFF file.) Download and print out the six larger images. To see photographs of the buildings, click on “photos” from the bibliographic pages.

**Step 2**
Review area and volume with your students, including the formulas for the area of a rectangle and the volume of a rectangular prism. What is the difference between the two? Reveal to your students that the term “square footage” is another way to say “area” in units of feet, particularly with buildings. It is a term that architects often use. Review that volume is measured in cubic units.

**Step 3**
Distribute copies of the four photographs of the Tennessee State Capitol building or project them on a screen. Ask students to make observations about the building. What is this building’s purpose? What materials do you recognize? Using information from *The Tennessee Encyclopedia of History and Culture*, provide your students with an overview of the history of the building.

**Step 4**
Explain to your students that the class will be finding the volume of different rooms in the Tennessee State Capitol. What information would your students need to find the volume of a room? Introduce your students to the three architectural drawings (front elevation, first floor plan, second floor plan) from the *Historic American Buildings Survey/Historic American Engineering Record/Historic American Landscapes Survey*. What are these drawings showing? How are we able to identify which level or story of the building we’re looking at? Can you identify the measurements the architect made?

**Step 5**
Distribute the “Calculating Volume using Architectural Drawings” worksheet and the three architectural drawings that accompany it. Distinguish between the two floor plans and the one elevation. Explain what a floor plan is and that it is a representation of the “footprint” of the building, drawn to scale. Remind students that an elevation of a building is also drawn to scale, but shows the outside, or “façade,” of the building. Distribute the class highlighters and calculators and review the directions to the worksheet. Students may share the three drawings and work in pairs or individually as they complete the worksheet.
Step 6  Once the worksheets have been completed, review the answers and address any questions from students. Explain to students that they have completed work that many architects do every day: find the volume (or cubic units) of a building. What was difficult about these worksheets? What have you learned about architectural drawings and what they can tell us? How do architects use building measurements? How to architects use and depict area and volume measurements? Can two buildings have the same areas (square units) but different volumes (cubic units)? Why or why not?

**EVALUATION**

Student grades should be based on

1) the accuracy of their measurements (30%),
2) the accuracy of their volume calculations (50%), and
3) the thoughtfulness of their class participation (20%).

**EXTENSION**

Find out more about the history and visitor information for the Tennessee State Capitol building by visiting the following Web sites:

- The Tennessee Encyclopedia of History and Culture: [Tennessee State Capitol](https://tennesseeencyclopedia.net/)
- Visiting the Tennessee State Capitol: [https://tnmuseum.org/state-capitol](https://tnmuseum.org/state-capitol)

Students can examine photographs of the inside and outside of the Tennessee State Capitol building from the Web sites listed above can compare them to the historic photographs listed on the surveys for each building. Have the buildings changed at all? You could even take a field trip to downtown Nashville, so that students can compare the drawings to the pictures and the actual site!
CALCULATING VOLUME USING ARCHITECTURAL DRAWINGS

Use the three architectural drawings to answer the questions below. Don’t forget to show your work and to use the correct units for each question. Round each measurement to the nearest foot (for example, 5’3” would round to 5’).

FORMULA REVIEW
Use your notes to complete the formulas on the right. These will be important when you begin calculating your measurements!

What units would you use if you were measuring the area of a rectangle in feet? __________

What units would you use if you were measuring the volume of a rectangular prism in feet? __________

VOLUME OF THE FIRST FLOOR OF THE TENNESSEE STATE CAPITOL BUILDING
Use the elevation and first floor plan drawings to calculate the volume of the first floor. Use your highlighter on the drawings to show which measurements you’ll need. Use the formula below to help you find out the volume:

____________________   x   ___________________   x   ___________________   =   _______________
(length of the first floor)           (width of the first floor)           (height of the first floor)           VOLUME

The volume of the first floor of the Tennessee State Capitol Building is ___________________________.

[HINT: Use the overall Terrace measurements for length and width. Don’t forget to use the correct units!]

VOLUME OF THE SECOND FLOOR OF THE TENNESSEE STATE CAPITOL BUILDING
Use the elevation and second floor plan drawings to calculate the volume of the first floor. Use your highlighter on the drawings to show which measurements you’ll need.

____________________   x   ___________________   x   ___________________   =   _______________

The volume of the second floor of the Tennessee State Capitol Building is ___________________________.

[HINT: Don’t include the Portico in your measurements. Don’t forget to use the correct units!]