WE BUILT THIS CITY, MASTERING VOLUME
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Unit Overview

During this two week hands-on unit, students master volume computation and science skills by building model cities. Students first construct 3D cubes and rectangular prisms to deepen their understanding of area within the context of volume. Then, students work cooperatively in teams to build a city and find both the volume and additive volume of their structures. Additionally, students create circuits to use as lights for their buildings to learn elements of circuits, insulators and conductors.

Standards Addressed

1. **M.5.MD.3:** Recognize volume as an attribute of solid figures and understand concepts of volume measurement.

2. **M.5.MD.4:** Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.

3. **M.5.MD.5:** Relate volume to the operations of multiplication and addition and solve real world mathematical problems involving volume.

4. **S5.CS.1:** Students will be aware of the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

5. **S5.CS.3:** Students will use tools and instruments for observing, measuring, and manipulating objects in scientific activities.

6. **S5.P.3:** Students will investigate the electricity, magnetism, and their relationship.

Essential Questions:

1. What is volume? How is it related to area?
2. How can I compare and contrast area and volume?
3. How do I find the volume of rectangular prisms and cubes?
4. How do I find the volume of two or more rectangular prisms or cubes?
5. How do I create a circuit? What is needed for a circuit to be complete?

Day One – Introduction
Standards Addressed: 1

1. To introduce the unit, have students listen to "*We Built this City*" by Jefferson Starship. As they listen, have them write a response to the following question:
    a. If you were elected mayor of a brand new city and had the opportunity to build it from the ground-up, what are the 5-7 most important buildings you would have in your city? Briefly explain your building choices.

2. Discuss answers as a large group. Ask students why they chose certain buildings and discuss the need for schools, emergency services, grocery stores, etc.

3. At the conclusion of the discussion, tell students that this unit will challenge them to build a city out of 3D cubes and rectangular prisms. They will also learn how to find the volume and additive volume of their structures.

4. Take time to assess student's background knowledge on volume computation. Review the following vocabulary words:
    - Measurement
    - Attribute
    - Volume
    - Solid Figure
    - Rectangular Prism
    - Unit
    - Unit Cube
    - Gap
    - Overlap
    - Cubic Units
    - Height
    - Area of Base

5. Have students break into small groups and review the concept of area. In their groups, have students practice finding area.

6. Once students master computing area, show students a 3D figure. Discuss the characteristics of 3D figures.
    a. Ask students how you would find the total amount of space that fills up the inside of a 3D figure.
    b. Discuss the concept of volume.
    c. Address that volume is measured in cubic units.

Day Two – Volume Computation
Standards Addressed: 1, 2, 3

1. Have students break into their small groups from the previous day. In each group, provide students with various materials to construct cubes and rectangular prisms.
    a. Material suggestions include: sugar cubes, mini marshmallows and toothpicks, snap cubes, etc.

> **A TIP FROM THE TEACHER**
> *Allow students enough time to "discover" volume before telling them the formula. To facilitate the discovery process, have students figure out the number of units in a variety of rectangular prisms.*

2. Once students construct their figures, ask them to find the volume of each figure. Walk around to each group and ask students questions related to finding volume. Allow students time to discover elements of the formula for volume.

3. As groups finish, discuss the exercise as a large group. Have students share the formulas for volume they discovered.

4. Conclude the lesson by watching the "*Volume Song*" video about the formula for volume.

Day Three – Application
Standards Addressed: 1, 2, 3
1. Have students work in groups. Provide each group with the following materials:
   - **"What's the Difference?" Activity Sheet**
   - Copy paper
   - Tape
   - Poster board
   - Newspaper
   - Grid paper
   - Rulers
   - Markers
   - Construction paper
   - Scissors
   - Measuring tape
   - Colored pencils

2. Instruct students to use their materials to construct area and volume models.
   a. Area models: 1 cm^2, 4 cm^2, 1 in^2, 4 in^2, and 1 ft^2
   b. Volume models: 1 cm^3, 8 cm^3, 1 in^3, 8 in^3, and 1 ft^3

3. As students construct their models, have them sketch and label each model. Once they have constructed all the models, have each student complete the **"What's the Difference?" Activity Sheet**. Conclude with a discussion of the activity.

Day Four and Five – Learning Stations
Standards Addressed: 1, 2, 3
1. Students will rotate through multiple learning stations to practice and reinforce the concept of volume. You may add or combine stations depending on the size of your class.

Station	Materials Needed	Description
Technology	Computers	Students visit websites associated with volume: *http://illuminations.nctm.org/Activity.aspx?id=4095* *http://www.learner.org/interactives/geometry/area_volume.html* *http://www.onlinemathlearning.com/volume-games.html* *http://www.aaamath.com/geo79_x7.htm*
Hands-On Examples	Different sized boxes Journals Pencils Rulers Yard and meter Sticks	Students work in pairs to find the volume of different sized boxes. Have students sketch and record their findings.
Working with Nets	Nets (both in and cm) Cubes Rectangular prisms Journals	Students construct 3D figures from cm and in nets. Students will then find the volume of each figure and record their findings. Nets can be downloaded from the following websites: *http://illuminations.nctm.org/Activity.aspx?id=3509* *http://www.kidzone.ws/math/geometry/nets/recprism.htm* *http://mathforum.org/alejandre/escot/cube.prism.html*
Problem Solving	**"What's it Take to Fill Me Up?" Activity Sheet**	Students work individually to solve volume problems on the activity sheet.

Day Six – Additive Volume
Standards Addressed: 1, 2, 3

1. Students learn how to compute additive volume. Present students with the following scenario:

   Apple, Inc. decided to donate three brand new computers to a classroom. We need to see if they will fit into the trunk of the teacher's car so she can transport them to school. Apple, Inc. has given the following dimensions for the boxes that hold the computers: 4ft x 3ft x 3ft. In your groups, find the total (additive) volume of the three computer boxes to see if they will fit in the trunk of the teacher's car. The teacher's trunk has 70 cubic feet of space. In your journal, use sketches, words, and numbers to solve your problem. Be sure to explain your reasoning.

2. If time permits, give each group different sized boxes. Have them compute additive volume.

Day Seven, Eight and Nine – City Construction
Standards Addressed: 1, 2, 3, 4, 5, 6, 7

1. Students begin constructing their city. Break students into six groups and assign each group a type of building(s). Possible groups can include: emergency services, businesses, education, shopping, restaurants and housing. Each group will construct buildings that fall into their assigned categories. Categories may vary depending on class size.

2. Provide each group with cube nets, rectangular prism nets, construction paper, tape, glue and markers to help create their structures. Encourage students to think about each building's scale and size. Be sure they know they can tape various cubes and rectangular prisms together to create different building shapes.

3. As they build their city, circulate around the room and teach each group how to build circuits. Have groups discuss what materials they need to build complete a circuit. Students can also discuss common reasons why a circuit may not work. Each group will need the following materials:
   - 9 volt batteries
   - 9 volt battery terminal caps
   - Canopy switches
   - Electrical tape
   - Strands of old Christmas lights than can be cut

4. Once students complete both their buildings and circuits, have each group calculate the volume of their structures. Have students sketch and label their computations. You may also create a problem solving sheet relevant to the cities in your classroom or ask students to solve the problems in groups as you ask questions orally.

Day Ten – Conclusion
Standards Addressed: 1, 2, 3, 4, 5, 6

1. Have students share their buildings and construct the final city. Discuss what they learned and what they will take from the unit.

2. Conduct a formal assessment of student's mastery of volume computation and other skills using the **Volume Assessment Activity Sheet**.