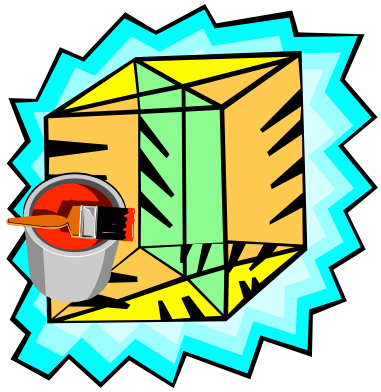
Lesson Plan Title: Area, Surface, and Volume

Local School District: Adams County/Ohio Valley School District

Grade Level: 9th Grade

Teacher Name: Julie Roush



Estimated Total Time: 450 minutes (7.5 hours)
Daily Time Allocation: 90 minutes
Duration: approximately 5 sessions

Goal: The overall goal is for students to demonstrate application of area, surface, and volume in the world around us. Students will apply formulas to a model of the classroom so they can determine the volume and surface area of the room.

Students will be able to do the following:

1. Calculate area of 2-dimensional geometric shapes. (e.g., rectangle.)
2. Calculate volume of 3-dimensional geometric shapes. (e.g., rectangular prism.)
3. Calculate surface area of 3-dimensional geometric shapes. (e.g., rectangular prism.)
4. Estimate how many cans of paint are needed to paint a room.
5. Estimate how many boxes can be stored in a room.

Outcomes:

Students will create a presentation to share and exhibit their process of determining the surface area and volume of the classroom. The presentation will include digital pictures of the model as it is being developed, formulas, and calculations. Additionally, students will research paint prices and include information about the paint they would use to paint the classroom, as well as anticipate the price for the overall project.

National Standards:

NCTM (http://standards.nctm.org/document/index.htm)

In Grades 9–12, all students should: (http://standards.nctm.org/document/chapter7/geom.htm)	• Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools. • Use geometric models to gain insights into—and answer questions in—other areas of mathematics. • Use geometric ideas to solve problems in—and gain insights into—other disciplines and other areas of interest such as art and architecture.

International Society for Teacher Educators (ISTE)
Performance Indicators For Technology—Literate Students (NETS)
(http://cnets.iste.org/students/s_profile-912.html)

Prior to completion of Grade 12, students will:	Collaborate with peers, experts, and others to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models, and other creative works.

Benchmarks:

Use Measurement Techniques and Tools

- Ohio 8–10: (http://www.ode.state.oh.us/academic_content_standards/word/Math_Benchmarks_and_Indicators_by_Grade_Level.doc) Use conventional formulas to find the surface area and volume of prisms, pyramids and cylinders and the volume of spheres and cones to a specified level of precision.

- Ohio 8–10: (Measurement) Estimate and compute various attributes, including length, angle measure, area, surface area, and volume, to a specified level of precision.

Spatial Relationships

- Ohio 8–10: (Geometry and Spatial Sense E.) Draw and construct representations of two-and three-dimensional geometric objects using a variety of tools, such as straightedge, compass, and technology.

Grade Level Indicators:

Use Measurement Techniques and Tools

- Ohio 8-3: Use appropriate levels of precision when calculating with measurements.
- Ohio 8-9: Demonstrate understanding of the concepts of perimeter, circumference, and area by using established formulas for triangles, quadrilaterals, and circles to determine the surface area and volume of prisms, pyramids, cylinders, spheres, and cones. (Note: Only volume should be calculated for spheres and cones.)
- Ohio 9-2: Use unit analysis to check computations involving measurement.
- Ohio 9-5: Solve problems involving unit conversion for situations involving distances, areas, volumes, and rates within the same measurement system.

Mathematical/Scientific Processes:

- Ohio 8–10 Apply mathematical knowledge and skills routinely in other content areas and practical situations.
  a) Use a variety of mathematical representations flexibly and appropriately to organize, record, and communicate mathematical ideas.
  b) Write clearly and coherently about mathematical thinking and ideas.

Key Vocabulary:

- Total surface area: (http://encarta.msn.com/encyclopedia_761572708_/Area_(mathematics).html) The size of an enclosed region, given in terms of the square of a designated unit of length. Formulas for the areas of simple geometric figures include a^2 for a square, where a is a side; and ab for a rectangle, where a and b are two adjacent sides.
- Volume: (http://www.infodotinc.com/steelworker2/137.htm) The amount of space taken up by a three-dimensional object.
- Square units: The unit that is most often squared or cubed is the length unit.
- Cubic units: The unit that measures space or volume.
- Scale: The method of constructing a representation model of a much larger object. Using similar proportions of length to the original object.
- Faux finish: A painting technique that makes the surface appear to look like something else.

Preassessment:

1. Given an empty box and cubes, the students will make predictions about how many cubes will fit in the entire box.
2. Upon being asked, students will orally identify memorized area formulas for a rectangle, surface area formulas for rectangular prism, and volume of rectangular prisms.
3. Teacher and students will work together to develop a table that will list known formulas as well as indicate which other formulas still require instruction.

Scoring Criteria: Teachers will use the following rubric to evaluate students' work:

	Unacceptable	**Acceptable**	**Exceptional**
Content	Students failed to apply appropriate **formulas** and as a result had errors in the final **calculations**. The **process** was undefined.	Appropriate **formulas** were applied, most of the final **calculations** were correct. The simple **process** was demonstrated.	Appropriate **formulas** were used so that the final **calculations** were correct. The **process** was described **sequentially** and could be easily followed and replicated.
Layout	The **model** was not complete. **Presentation** was missing elements.	**Presentation** was simple but contained the essential elements: digital pictures, formulas, and a description of the process. The **model** represented the details of the room.	**Presentation** was very professional and included images, formulas and descriptions. **Scale** was used to create model.
Technical	No attempt made to create and/or present the slide show.	Technology was used to take **digital pictures** and insert them into the **presentation**.	Technology was used as a **tool** for developing the model, searching the **Web** for further resources in addition to taking digital **pictures** and creating a **presentation**.

Material and Resources Needed:

- ☐ Shoebox
- ☐ Ruler or tape measure
- ☐ Paint
- ☐ Art supplies
- ☐ Scissors
- ☐ Glue
- ☐ Computers with Internet access
- ☐ Projector
- ☐ PowerPoint program
- ☐ Digital camera
- ☐ Calculator
- ☐ Computer lab
- ☐ Inspiration software

Procedures:

Day 1:

1. Complete preassessment by each student.
2. Discuss as a large group possible techniques for estimation of measurement.
3. As a class, estimate the length, width, and height of classroom.
4. Review reading a tape measure.
5. Students will record the calculations of the area of all four walls, ceiling, and floor on a form.
6. Explain to the students that they will be building a model scalable to a room.
7. Hand out a box to each pair of students.
8. Students will measure the box.
9. Review the formula for determining volume of a cube.
10. Students will calculate the volume for both the classroom and the box. **Remind students that they will need to subtract windows and door areas from the total surface area when calculating both surface area and volume.**
11. Students will record their work.
12. Review the formula for determining surface area of a cube.
13. Students will calculate the surface area for both the classroom and the box. **Remind students that they will need to subtract windows and door areas from the total surface area when calculating both surface area and volume.**
14. Teacher will reinforce the process by also working the formulas on the board.
15. Students can check their work.

16. Work with individual students who require assistance.
17. Inform students that this activity will provide the information they need to paint the classroom.
18. Using a projector and a computer, go to the Home Depot Web site so that you demonstrate the use of a paint calculator. *
    http://www.homedepot.com (paint calculators)
    * One can of paint will cover 200 square feet.
19. On the board, the teacher will then show how the surface area formula also facilitates a similar pattern to the Web site.
20. Students are instructed to identify a room they might want to paint (they will not really be painting the room!).
21. For homework, the students will use the worksheet to record the length, width, and height of the room.

Day 2:

1. In class, students will present the measurements of the room they selected for the project.
2. Individually, they should calculate total surface area to be painted in the room they have chosen.
3. The students should calculate the volume of the room.
4. Students will then estimate how many cans of paint are needed to paint the room. (One can of paint covers about 200 square feet.)
5. The students will calculate the number of 12 X 24 X 9 inch boxes that could fit in the room, if the room is used for storage.
6. Students should visit the Home Depot calculator to see if their estimation is correct.
7. Set out art supplies so that student can begin constructing their scale model of the room.
8. Demonstrate how to use digital cameras to take pictures.
9. Demonstrate how to insert images into PowerPoint.
10. Remind students that they will be documenting this model development through the use of images and should take pictures as they are working.

Day 3:

1. Working in the computer lab, students will individually begin working on their PowerPoint presentations.
2. Demonstrate how to use the formula creator to insert formula symbols onto a slide.
3. Demonstrate design techniques such as transitions, templates and animation.
4. Demonstrate how to capture images from the Web to insert into a presentation.
5. Discuss copyright issues.

Day 4:

1. Independently, students can complete the presentations in the computer lab.
2. Students can complete the models using the classroom craft supplies.

Day 5:

1. Students will present their models and presentations to the class.
2. Using Inspiration® software brainstorm with the class other applications of these formulas in real life situations.
3. Close the class with a discussion about the importance of spatial and geometric knowledge in the world around us.

Differentiated Instruction Strategies:

(http://www.teachnology.com/tutorials/teaching/differentiate/bottom_line/)
Intervention: Students will be able to use a calculator. Resource room available as needed. If needed, teacher will assist student with room measurements.

Enrichment: Students will create furniture to same scale as shoebox model. Students experiment by working formulas for some Extreme homes (http://www.hgtv.com/hgtv/pac_ctnt_lnb_gutter/text/0,,HGTV_3938_6720,00.html) that are irregular in shape.

Postassessment:

Upon completion of this project, students will demonstrate their knowledge about measurement in geometry and spatial sense by:

- Creating a model that is representative of the classroom. This model will indicate the surface area the room as well as its volume. Geometric shapes and lines should be represented appropriately. This model will serve as a representation to answer the following questions:
    - If the classroom was half-full of boxes that are XXXX in size, how many boxes would there be?
    - If the classroom walls need to be painted, how much paint would we need?
- Developing and presenting a PowerPoint slide show which will include:
    - A description of the room.
    - Digital pictures of the classroom before and after this project.
    - A description about how they created the scale to create the model.
    - The formulas used in calculations (when used and why used).
    - A description of the process they went though to construct the model to scale and solve the problems.

Extension:

- Look through the job section of the newspaper to find different job opportunities that require knowledge about calculations and/or building experience.
- Extend lesson to other three-dimensional figures—cylinder, pyramid, and cone.

Interdisciplinary Connections:

- Social Sciences: Invite a Home Depot expert to the classroom to share their experiences with using measurement every day.
- History: After learning about ancient Egypt, student can calculate the volume and surface area of pyramids and study the architecture of the structures.
- Consumer Economics: Make soft-serve ice cream. After calculating the volume of the cone, determine the amount of ice cream needed to fill the cone.

Homework Options and Home Connections:

- Students will measure the length, width, and height of a room at home.
- Paint and complete scale models.
- Discuss with their parents instances when they measure items for calculations (share with the class in a mind map).

Research Connections:

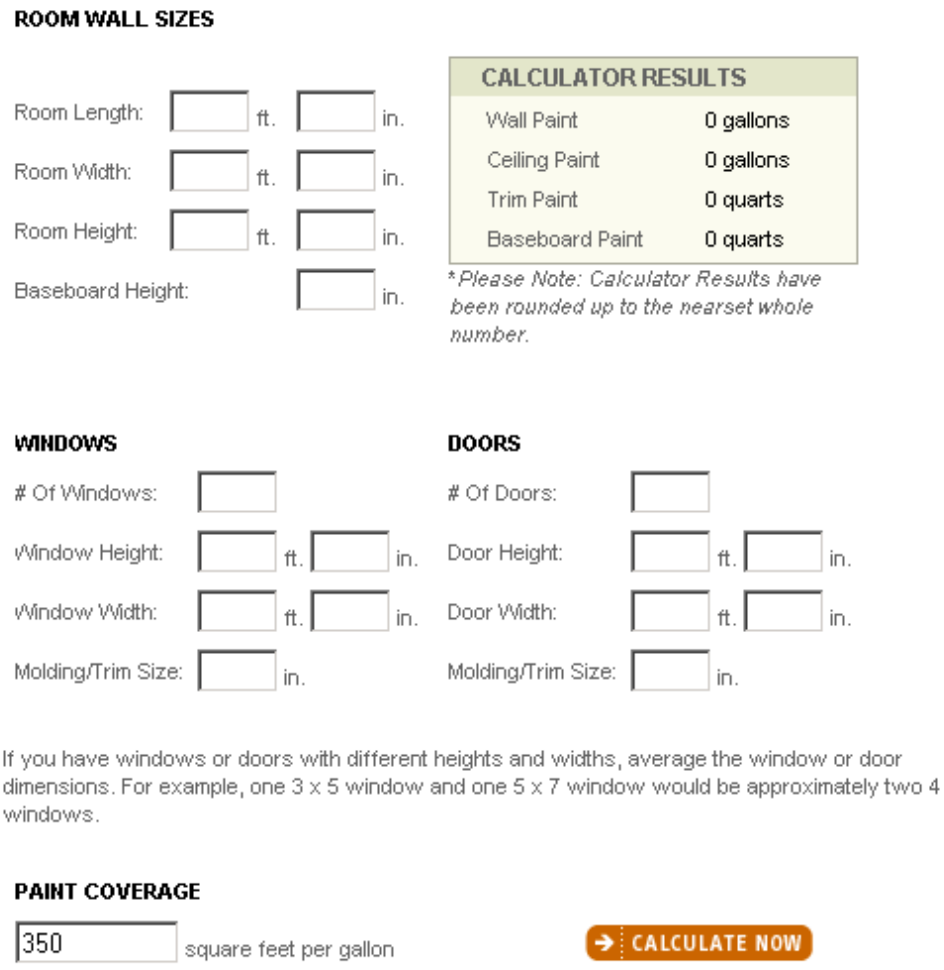
Sutton, J., & Krueger, A. (2002). What roles can assessment play in mathematics teaching and learning? pp. 34-35. *EDThoughts: What we know about mathematics teaching and learning.* Aurora, CO: McREL.

Sutton, J., & Krueger, A. (2002). How does classroom curriculum connect to the outside world? pp. 58-59. *EDThoughts: What we know about mathematics teaching and learning.* Aurora, CO: McREL.

Resources:

HGTV Web site http://www.hgtv.vom
Home Depot Web site http://www.homedepot.com

Figure 1: Home Depot Paint Calculator (http://www.homedepot.com)



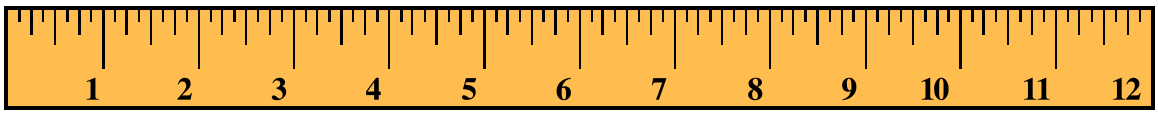
NAME:

DATE:

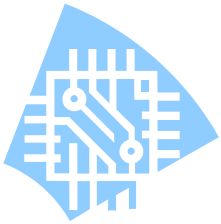
Worksheet

Scale drawings:

1. A length of 15 miles is represented on a scale drawing by a line segment 2 centimeters long. If a line segment is 4.5 centimeters, how many miles is represented?

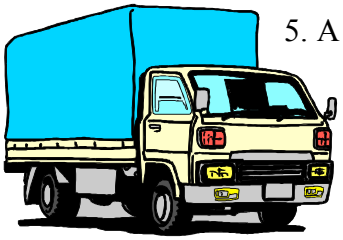


2. The width of an island that is actually 50 miles wide is represented on a map by a line segment 3 inches long. If a line segment represents the length 5 inches long, how wide is the island?



3. A computer chip is ¼ inch wide and ½ inch long. The diagram for the chip is 24 inches long. How wide is the diagram?

4. A model airplane has a wingspread of 9 inches and length of 11 inches. If the wingspread of the actual plane is 27 feet, what is the length?



5. A truck is 32 feet long and 8 feet tall. In a photograph, the length of the truck is 5 inches. How high is the truck in the photograph?

NAME: **Quiz**

DATE:

Be sure to show your work!

1. What is the surface area of a rectangular prism with a length for 11 centimeters, a width of 6 centimeters, and a height of 50 millimeters?
   a. 170 square cm
   b. 132 square cm
   c. 60 square cm
   d. 320 square cm

2. A swimming pool is 8 feet deep, 25 feet long, and 4 yards wide. The pool is filled up but stops 2 feet from the top of the pool. Show how you would find the volume of the swimming pool.

3. A semi-truck trailer is half full. The dimensions of the trailer are 8 feet x 15 feet x 9 feet. There are 1000 boxes that still need to be loaded. The boxes dimensions are 20 inches x 12 inches x 8 inches. Will all the boxes fit in the trailer? Why or why not?

NAME:

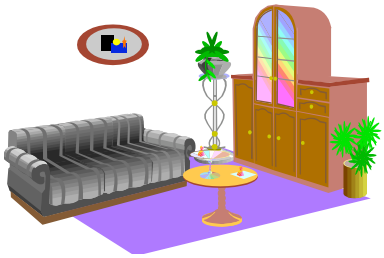
DATE:

Worksheet

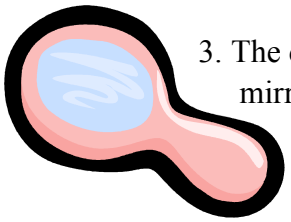
AREA and VOLUME

Be sure to show your work!

1. A living room is 14 feet long and 12 feet wide. What is the area of the room?

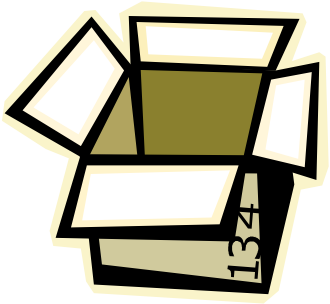


2. How many feet of molding are needed to go around the ceiling of the room in problem 1?

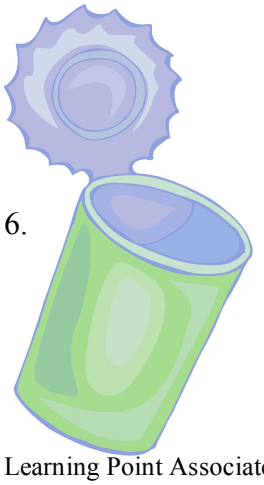


3. The diameter of a circular mirror is 8 inches long. What is the area of the mirror?

4. What is the circumference of the mirror in problem 3?



5. A box is 28 inches long, 24 inches wide and 12 inches high. What is the volume of the box?



6. A can is 5 inches high and has a diameter of 3.5 inches. What is the volume of the can?