Mary Ellen Graves

EMAT 6450/Summer 2013

Unit Project

Project Introduction:

This project is designed to solidify the material learned in Analytic Geometry Unit 3. Although the standards stated below are addressed the project extends beyond the standards for the students will be required to justify their estimations and processes used to find calculations and estimations. The students will also be required to explain formulas and concepts. Extending beyond the standards will not only benefit the students by improving their mathematical skills and thinking, but also the students' comprehension of the concepts will improve. This project is rigorous and challenging. The students will be allowed to use outside resources in order to complete the project. The purpose of this project is to have students apply and understand volume, area, and surface area of various shapes. Understanding does not just include calculating capabilities. Understanding means knowing *why* the formulas work and *how* to justify this knowledge mathematically.

Project: Finding Volume and Area Outside of the Classroom	
Teacher: Mary Ellen Graves	
Class: Analytic Geometry	
Course Unit: 3	
Project Title: Finding Volume and Area Outside of the Classroom	
LESSON OVERVIEW	
For this lesson students will use their knowledge of various shapes' area, surface area, and volume formulas to complete a project. They will also use knowledge outside of formulas in order to make reasonable estimations. Students will be divided into groups of four. Students will be allowed to choose their own partners since it will be necessary to work outside of class and coordinate meetings times. Each group will be assigned a particular set of shapes and given a sheet with specific guidelines. The shape sets include the following:	

- N-sided Simple Regular Polygons where $n > 4$ and Pyramids
- Triangles and Cones
- Rectangles and Rectangular Prisms
- Rectangles and Cubes
- Circles and Spheres
- Circles and Cylinders

Students will draw their set of shapes from a paper bag. From there each group will find objects physically outside of the classroom that correspond to their assigned shapes, but with varying dimensions. They will need to find three two-dimensional examples and three three-dimensional examples. Students will either have to draw a picture of each shape or print out pictures of each shape. Each group will create a poster presentation with the shapes they found, measurements, and calculations.

The groups will also have to estimate the volume of two of their three three-dimensional shapes without the use of the shape's specific formula for volume. The students will then analyze how close their estimation is to the actual calculated volume. The students will be required to write a brief explanation to justify their approach to finding the estimated value along with a brief comparison between the calculated and estimated volume. This requirement will expand the project beyond simply using the appropriate formula to calculate volume. Students will have to use what they know about volume to make estimations. Estimations are an important part of mathematics, and this portion of the project will help students not only practice estimation, but also understand the significance of estimation.

Groups will also have to calculate the surface area of one of their three-dimensional shapes. This information will be displayed on the poster board as well.

In addition each group will create a mathematical problem and display it on the poster board for the other groups to complete after the presentations. Each group will present their findings, processes, mathematical problem, and calculations during class. Each presentation will last no more than seven minutes.

Finally, each group explain three of the following five prompts. These explanations will be submitted on a separate sheet of paper. The answers do not need to be displayed on the poster board.

- *Explain why the number of triangles that can be drawn inside a regular polygon is (n – 2), where n is the number of sides of the polygon.*
- *Explain why the volume of a cone is 1/3 of the volume of a cylinder given the height of the cone equals the height of the cylinder.*

- *Explain why the volume of a prism is $L \times W \times H$.*
- *Explain why the volume of a cube is S^3.*
- *Explain why $\pi r^2 = \frac{1}{4}\pi d^2$ which both equal the area of a circle.*

Mathematical explanations are a large part of Geometry and students need to practice justifying a statement, theorem, formula, etc. The students must get beyond describing and stating steps; additionally, get beyond stating calculations. The students must explain WHY it works. Again, the students will be allowed to utilize outside resources, i.e. the Internet. However, by putting the proof into their own words I believe the information will be better understood and retained.

After the presentations are finished the individual groups will work together to answer the other groups' mathematical problems presented on each poster. Though students will work to solve the problems in groups, each student must write out his or her answers to the individual problems. Each student will answer the problems and submit them at the end of class for a portion of overall grade.

STANDARDS	Common Core Georgia Performance Standards

- MCC9‐12.G.GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.
- MCC9‐12.G.GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
- MCC9‐12.G.GPE.7 … Compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

ASSESSMENT/EVALUATION	

This project will be evaluated using the following:

Total Weight of Project: 100 points worth 15% of overall grade in class.

Project Components:

15 points - Accuracy of calculations and estimations

40 points - Explanations and justifications of methods used. This includes the proof.

20 points - In class presentation of project

10 points - Poster display/creativity

10 points - Question created for class

5 points – Other groups' questions answered correctly

I will grade the students work based on their presentations and their individual posters. Each student will receive his or her grade along with a detailed analysis of each grading component. Students will of course have an opportunity to ask questions regarding their critiques.

Materials Needed	

- Guidelines Sheet
- Shape Sets with paper bag
- Poster boards for students
- Colored pencils available for student

Finding Area and Volume in Various Shapes Guidelines Sheet

For this project you and your group members will be required to find the area of two two-dimensional shapes, the surface area of one of the three three-dimensional shapes, and the volume of three three-dimensional shapes. You will be required to show pictures of your selected figures before beginning calculations. I want to approve the shapes before you begin working. This is to save you and your group time and effort. In addition, pictures must be taken with a ruler showing measurements are as precise as possible, i.e. hold the ruler to a side of the shape measuring the length and take the picture while still holding the ruler in place.

Please indicate below by starring or circling which set of shapes your group will explore.

- N-sided Simple Regular Polygons where $n > 4$ and Pyramids
- Triangles and Cones
- Rectangles and Rectangular Prisms
- Rectangles and Cubes
- Circles and Spheres
- Circles and Cylinders

In addition your group will choose two of the three-dimensional shapes and estimate the volume using a different method. For this part of the project the group may NOT use the specific formula for volume, but will rather use another method to find and estimate the volume. You may use other formulas to make an estimate or other methods (i.e. water displacement), but the volume formula for the specific shape may not be used.

The project will also require the groups to design a problem for the rest of the class to answer. This problem will involve area and/or volume using at least one of the groups' shape set. Be creative when designing this problem, make sure to have the answer available but not displayed on the poster, and please ask for help if you need!

The final component of the project will include an explanation of three mathematical facts. You may choose three out of the five explanations expressed below. You will write your explanations down on one sheet of paper and submit it on the day of presentations. Do not display the proofs/explanations on your poster board. You may utilize the Internet for help, but make sure to rewrite the proof/explanation in your own words. This is a large component of the final project grade. DO NOT COPY A PROOF FROM THE INTERNET. You MUST put the explanation in your own words. Please ask for help if need!

- *Explain why the number of triangles that can be drawn inside a regular polygon is (n – 2), where n is the number of sides of the polygon.*
- *Explain why the volume of a cone is 1/3 of the volume of a cylinder given the height of the cone equals the height of the cylinder.*
- *Explain why the volume of a prism is $L \times W \times H$.*
- *Explain why the volume of a cube is S^3.*
- *Explain why $\pi r^2 = \frac{1}{4}\pi d^2$ which both equal the area of a circle.*

The following should be displayed on your groups' poster. I will provide poster boards for each group. Each group will present their findings to the class. Each shape should be drawn to the best of your ability or a picture may be taken and printed out to display on the poster. Be sure to state the dimensions and processes used to measure each shape. Know that your measurements will not be exact, but do your best to be precise.

1. Area of Two-Dimensional Shape #1:
2. Area of Two-Dimensional Shape #2:
3. Volume of Three-Dimensional Shape #1:
4. Volume of Three-Dimensional Shape #2:
5. Volume of Three-Dimensional Shape #3:
6. Surface Area of one Three-Dimensional Shape:
7. Estimated Volume of Three-Dimensional Shape:
8. Estimated Volume of Three-Dimensional Shape:
9. Describe and justify your approaches to estimating the volumes in part 6 and 7. Please write out your explanations in complete sentences.
10. Compare and contrast your estimated volume values found in 6 and 7 with the actual calculated volume values. Is your estimation over or under the actual value? If so, why do you think this happened? Please write your explanations in complete sentences.
11. Volume and/or Area Problem for the class.