**Using *SketchUp* for Explaining Area and Surface Area**

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Drawing 2D and 3D shapes and figure using *SketchUp* is fun! It allows students to be creative and imaginative by allowing them to design real world objects. Then, use their own real world objects to explore area, surface area, and modeling questions. Having *SketchUp* really allows the students to visually see a design, which is interactive and fun.

The *SketchUp* software can also help students explore real world situations such as: how much paint it will require to cover the surface area of the house. This software has many applications that help students connect to the outside world. According to Tom Wyman, the Market Development Manager, this technology serves as a resource for “…landscape architecture, video game design, fine arts, civil engineering, wedding cake design, book illustrations, set design, film previsualization, industrial design, urban planning, woodworking, medical instrument design, coin design (one of the "state" quarters), treehouse design...”.

There are two versions of *SketchUp*: there is the *SketchUp* Pro software which requires a Statewide K-12 License Grant to access, but after a license is obtained, it is accessible to public K-12 schools at no cost. The *SketchUp* Pro includes additional features to the *SketchUp* Make, which is highly recommended for higher educational (university level) purposes. Then, there is the *SketchUp* Makes software, which is recommended for primary and secondary use. *SketchUp* Make is also free, but does not require a license. This software can be downloaded off their webpage at [http://www.*sketchup*.com/download](http://www.sketchup.com/download).

The *SketchUp* Make can build and share 3D models of anything you like, work offline (no internet connection necessary) and can be used it for many grade levels and in many subject areas from computer technology to math, geography, and science. The software creates 2D “uninteresting” models into 3D models which can help students explore area, volume, density, and more. The software allows students to create their own 3D figure and then use their knowledge of area and surface area solve design problems. In this lesson, students will calculate the surface area of a house so that a painter can know how much paint he will need.

**Using Responses from *SketchUp* to Guide Student Learning**

The teacher must first teach students how to use the *SketchUp* software to create their model, then explain how to establish the dimensions of their model. The following link demonstrates the basics of how to construct figures and use the tools of the software, which can be used as a tutorial for the teacher and students. Especially if your class contains students with learning disabilities whom struggle with written instruction. <http://www.youtube.com/watch?v=dL01iW9DAEU&list=PL2A29A6B9E312A112&index=9>

Research theory claims that this software appeals to students with special needs. Wyman mentions, “SketchUp can be an amazingly powerful tool in the hands of children with autism,” because it allows them to express their creativity using 3D modeling software.

The formative assessment process of this lesson is: the teacher evaluating the students’ capability to accurately model the design with proper geometric figures and dimensions using *SketchUp*. Students must physically show how they came up with their conclusion by finding the correct surface area of the shapes after finding their own dimensions of the figure they created. They will also submit a hardcopy of their house they created with the dimensions on the picture and then write the area, surface area, and answer to design problems on the modeling worksheet. Teachers can use this software to enhance teaching of the Common Core State Standards for Mathematics such as:

**CCSS.Math.HSG-G.MG.A.3** Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

The following math activity illustrates how *SketchUp* software can be used to provide feedback to students using 3D modeling designs activities. This activity appeals to kinesthetic and visual learners. They create the model with the computer while visually seeing how different dimensions can alter area and surface area. The worksheet and verbal instruction also guides students learning for a diverse classroom. To meet the CCSS.Math.HSG-G.MG.A.3 standard students must be able to design their own real world structure and then be able to use set dimensions to calculate area and surface area of the model.

**Math Activity: (See Modeling Worksheet Below)**

The whole class will be in a computer lab. Each student will be given a worksheet with the following formulas:

Area of rectangle: B\*H

Area of triangle: ½ B\*H

Area of circle: πr2

Surface Area of an Object: Sum of all the geometric figures

The included worksheet will include the students’ learning target: I will be able to solve design problems through the use of modeling geometric figures and then solving for their area and surface area.

Previous to this activity students will have already had the opportunity to explore *SketchUp,* all its features, and know how to make basic designs. *SketchUp* will build upon their knowledge of understanding geometric figures. The previous lesson required them to find differences between area and surface area, and compare and contrast the appearance of geometric shapes.The purpose of this lesson will be to demonstrate how the area and surface area of shapes can be used to solve design problems. The teacher will demonstrate how to make the house model that is shown above and provide step by step instructions. This way, lack in technology skills will not get in the way of learning.

Once each student has built their house, the teacher will provide the given the dimensions. Feel free to use the dimensions shown above or make your own model for the students to use. Students will then be asked to find the area of the window, door, the sides of the house, the front and back of the house, and the roof. Once this task is complete the teacher will provide a real life scenerio to the students. For example, “The painter outside the house decides that whole house needs to be painted green except the door and window. What is the total surface area the painter will have to cover?” Once students have calculated this information, there will be a class discussion on how one would go about calculating the total surface area of the house.

The teacher will ask for students’ input and guide their discussion to make sure students are on track to achiving the learning objective. Students will then work in pairs to find the surface area of their house and make sure that their answers match. During this group work the teacher will walk around the classroom and clarify any confusion, remind students how to find surface area, and ensure the students are getting the right answer. For instance, a misunderstanding for students in this lesson might be how to correctly find the surface area of the front of the house that requires painting. The teacher will guide students’ learning by explaining that students must first find the total surface area of the front of the house and then proceed by subracting the areas of the window and the door. At the end of the lesson, students will submit a hardcopy of the house they created with the dimensions on the picture and their completed modeling worksheet.

For tomorrow’s follow up lesson the students will use their creativity to design their own model using *SketchUp*. Each student will then have unique dimensions, so there is more opportunity for peer collaboration and teacher to student interaction. During the activity students will compare the ratios of the individual areas of their model, which aligns to the second part of CCSS.Math.HSG-G.MG.A.3. An example would be the ratio of the roof to the door. To conclude the lesson, students will be asked how this connects to the previous lesson and how knowing the ratios is helpful in solving design problems. Proceeding with a follow up lesson and using the same modeling technology, assists students in making clear and consistent connections.

**Reasons for using *SketchUp*:**

Students can get bored being given formulas and plugging in numbers. Students will be excited about the opportunity to create and design their own 3D model of different real-world structures. The students have the opportunity to choose their own layout, dimensions, and colors. Adding creativity and hands on opportunity keeps the students focused and engaged in mathematics. For this activity *SketchUp* acts as a visual representation. The teacher is still instructing the students and giving lessons about area and surface area, however students are participating in inquiry based learning. Students are still expected to do all the calcualtions, apply what they have learned to future lessons, and make progess towards achieving the common core standards. Students using *SketchUp* can impove their real world applications by experimenting with modeling and solving different design problems that may arise.

References

SketchUp. Web. 21 Oct. 2014 <http://www.sketchup.com/products/sketchup-pro/new-in-2013>.

Wyman, Tom. "Announcing Project Spectrum." *SketchUpdate*. 7 Nov. 2007. Web. 21 Oct. 2014.

 <http://sketchupdate.blogspot.com/2007/11/announcing-project-spectrum.html>.

**Modeling Worksheet**

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_\_\_\_\_\_\_

Learning Objective: I will be able to solve design problems through the use of modeling geometric figures and then solving for their area and surface area.

Formulas:

Area of rectangle: B\*H

Area of triangle: ½ B\*H

Area of circle: πr2

Surface area of an object: is the sum of all the geometric figures

Fill in the Blank:

Area of Window:

Area of door:

Area of the two sides of the house:

Area of front and back of the house:

Area of the roof:

Design Problem:

The painter outside the house decides that whole house needs to be painted green except the door and window. What is the total surface area the painter will have to cover?