



Making in the Classroom

Plane Geometry

Theme

What is the theme or topic to be presented?

Manipulating three-dimensional solids with fixed volume to solve real-world problems.

Learning Objectives

Students will be able to:

- Understand the basic functionality of Tinkercad.
- Demonstrate knowledge of the properties of plane diagonals and three-dimensional geometric solids.
- Calculate the volume of various 3-D solids.
- Apply knowledge 3-D solids to solve real-world problems.

Geometry Standards, Year 12:

3.8 Analyze the concept and properties of solid diagonal, plane diagonal and diagonal plane in three-dimensional solids and apply them to solve problems.

Key Vocabulary:

Names of basic geometric shapes and their corresponding volume equations. A sample list can be found here:

http://www.vitutor.com/geometry/plane/geometry_formulas.html

Materials: (per student)

- Access to a computer with internet
- Tinkercad.com
- 3D printer (for printing of objects/creations, if desired)

Prerequisite: Students should be familiar with the basic functionality of Tinkercad. If they have not used this software before, several days of practice will be necessary. If students need additional practice with Tinkercad before this Making Activity, have them try the following beginner-level 5-step tutorial where

they are making everyday objects:

<https://projectignite.autodesk.com/app/project/5/Making-Everyday-Objects-Part-One/overview/>. See “Additional Resources” at the end of this lesson for more Tinkercad practice lessons.

Tinkercad is fairly simple software to use, and is intuitive for most students. Once students have a basic understanding of the software they can begin the modeling lesson.

Lesson Overview

Introduction/Exploration: Presenting the Problem

Ask students to identify a civil engineering problem in their community (like poor traffic patterns, water pipe placement, available public housing etc.). Ask students why each of these is an issue. Identify a single problem that can be solved by building a better structure or system, and give students the challenge of designing a solution to that problem. Let students know that after they have designed their model, they will be presenting it to the class. *Teacher’s Note: It may be helpful to give students the list of requirements for their presentation at this stage, so they can record enough information along the way.*

Students will create scale models of the area they are trying to fix using objects from Tinkercad to model their solution. The challenge is that students are only allowed a set amount of volume to work with (determined by the teacher) and cannot exceed that volume. This will require that students keep a running count of the volume they have used by continually calculating volume for the shapes they have used. You may choose to require that students must use a set variety of shapes (for example they must use cylinders, cones, rectangles and prisms).

Building Skills: Design, Test, Repeat

This exercise will take time and a lot of iteration. It is best to have students practice with Tinkercad before they undertake this problem. See “Prerequisite” and “Additional Resources” for practice lessons.

Throughout the design process, have students calculate the volume of their shapes so that they are continually engaging in the mathematical geometry of the problem. Students will find that their buildings can only take up a certain amount of cubic feet, can only be so high, etc.

Conclusion: Think and Share

Have students share their creations and present their solution. Students will create a presentation of the model of their product, explaining their calculations and the choices they made while designing and creating it. Students should address the following points in their presentations:

- Provide background information for what you knew about your community.
- Identify the problem in your community that your model seeks to mitigate.
- Explain how you used your available resources
- Explain how you used the volume available to you to maximize the space.
- Provide calculations for the volume of your model, and how much volume remains unused.

Students' presentations should include some sort of visual, whether it's their online Tinkercad model, printed screenshots of their model, or their model (or parts of it) 3-D printed for peers to manipulate.

Accommodations:

- Rather than having students determine a real-world problem to solve, provide students with a problem.
- Increase the amount of volume available, or reduce building/design restrictions.

Build Complexity:

Require that students 3-D print their models; this is an additional challenge because models must be designed in such a way that they can be successfully printed.

Additional Resources:

- There are several lessons and tutorials available for free here:
<https://www.tinkercad.com/quests/>
- For an extension of the Prerequisite activity, students can try out Making Everyday Objects Part 2, a 3-part intermediate level tutorial:
<https://projectignite.autodesk.com/app/project/6/Making-Everyday-Objects-Part-Two/overview/>