Lunar Habitat and What's The Difference (WTD)
Teacher's Guide to Case Study 3

Instructional Curriculum

Mathematics: Grades 6-9

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Moon Math Case Studies

Introduction: This unit of instruction will consist of three case studies. Each case study will address the concepts of lunar habitat design. All three case studies will utilize WTD application in order to offer the students a deeper understanding of different lunar habitat models.

Depending on mathematical competency of the students, these units can be utilized in upper middle grades or with high school freshmen. It is not required for students to complete all three units. While it is suggested that all students complete the third unit, students familiar with the area concepts do not need to complete the first unit. Similarly, the students familiar with the volume concepts do not need to complete the second unit.

The three cases all have three levels of difficulty: A, B, and C. Level A, the beginning level, will involve multiplying whole numbers (except for π). Level B, the intermediate level, will involve multiplying decimals. Level C, the advanced level, will involve multiplying fractions.

The first case study, Case Study I, will address the concept of area by having the students calculate areas of two different lunar habitat designs. The students will also calculate area of a one-bedroom apartment and compare it with the areas of both lunar habitat designs.

The second case study, Case Study II, will address the concept of volume by having the students calculate volumes of two different lunar habitat designs. The students will also calculate volume of a one-bedroom apartment and compare it with the volumes of both lunar habitat designs.

The third case study, Case Study III, will address the concept of proportions by having the students construct scale models of a lunar habitat. Three levels of difficulty will be offered in this case study: A, B, and C. Level A, the beginning level, will ask the students to create a scale model of a simple singe-building lunar habitat. Level B, the intermediate level, will ask the students to create a scale model of a lunar habitat consisting of two structures. Level C, the advanced level, will ask the students to create a scale model of a lunar habitat consisting of three structures.

Guiding Question: How can the area and volume of a lunar habitat be calculated easily and effectively?

Main Concept: Paper-and-pencil calculations can be used to problem-solve simple calculations of area and volume, but technology is required for speed and accuracy in more complicated cases.

The students will also master the following concepts: multiplying decimals, multiplying fractions, and converting units of measure.

Prerequisite Skills: To successfully complete Case Study I, the students needs to be able to compute the areas of basic cylinders.

To successfully complete Case Study II, the students need to be able to compute volumes of basic cylinders.

To successfully complete Case Study III, the students need to be able to construct proportionate scale models of three-dimensional shapes.

Objectives: By completing these case studies the students will gain an understanding of the design requirements for a lunar habitat. The students will also become proficient in calculating area and volume of various shapes, and in creating scale models of various shapes.

NCTM Standards: Represent and Analyze (Algebra): explore relationships between symbolic expressions and graphs of lines; model and solve contextualized problems using various representations, such as graphs, tables, and equations.

Analyze Characteristics (Geometry): precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties; understand relationships among the angles, side lengths, perimeters, areas, and volumes of similar objects; create and critique inductive and deductive arguments concerning geometric ideas and relationships, such as congruence, similarity, and the Pythagorean relationship.

Preparation: Before starting work on each unit, the teacher will discuss the appropriate mathematical concepts with the students. Depending on the case study they participate in, students will be exposed to the areas and volumes of cylinders and to the construction of scale models.

Materials: Each student is expected to have a pencil, ruler, sheet of paper, and an appropriate student worksheet. Calculators are optional. The

teacher should also secure access to the computer lab and WTD application.

Time for Activity: Each case study is expected to take between one and two academic hours depending on the skills of the students. A teacher may assign more than one case study per student.

Case Study III: Creating a Scale Model of the Lunar Habitat

Engage: The lesson will begin with the teacher showing clips from a famous sci-fi film, such as *The Star Wars* or one of the *Star Trek* episodes. The teacher will pause when a spacecraft or a planetary base will be shown. The teacher will explain that these are not the full-size mockups, but the scaled models.

Explore: First, the teacher will demonstrate several floor plans of various apartments and homes. Depending on the students' mathematical background, the concepts of proportions, scaling, and mapping will be taught and/or reinforced. The class will 'walk' through several floor plans to assure the universal understanding of these concepts.

Second, the teacher will ask the students to consider the house / apartment they live in. The students will be asked to get exterior measurements of the house / apartment they live in. Then students will be asked to create a floor-plan of their house (first floor only) or the apartment they live in. The students will be instructed to use the following scale: 4 ft = 1 cm.

When the students have finished working on their floor plans, they will be instructed to exchange them with their neighbors.

Explain: The teacher will ask the class to define the key components of creating a scale model of a floor plan. The students will name such components as consistency, using the same ratio or proportion, maintaining uniform units of measure, etc. At the end of the discussion the teacher will ask the students to constructively critique the floor plans submitted by their neighbors. Modified floor plans will be posted on the classroom bulletin board.

Extend: To further students' understanding of creating scale models, the students will be asked to complete a case study worksheet (of appropriate difficulty level) where they will create scale models of two different lunar habitat designs.

Once the case studies are completed, the students will work in the computer lab where they will practice comparing different lunar habitat shapes using the WTD tool by adjusting the scale (making models appear proportionally larger or smaller on the screen). The teacher will circulate and offer individual help as needed.

Evaluate: As students complete their case studies, their finding will be presented to the class. The students will submit their Findings Sheets and they will be posted on the classroom walls. The teacher will proceed with re-teaching or enrichment as needed after analyzing students' work.

Case Study III: Level A Student Worksheet - Assignment

On a sheet of graph paper create a scale model of a single-cylinder shaped lunar habitat. Consider the following: h = 30 m, r = 4 m. Use the following scale: 1 m = 1 cm.

Case Study III: Level B Student Worksheet- Assignment

: On a sheet of graph paper create a scale model of a triple-cylinder shaped lunar habitat. Consider the following: h = 4.2 m, r = 10.8 m. Use the following scale: 1 m = 2 cm.

Case Study III: Level C Student Worksheet - Assignment

On a sheet of graph paper create a scale model of a single-cylinder shaped lunar habitat. Consider the following: h = 32.3 m, r = 4.1 m.

Also, create a scale model of a triple-cylinder shaped lunar habitat. Consider the following: h = 3 7/9 m, r = 11 3/7 m.

Use the following scale for both models: 1 m = 1.2 cm.

Case Study III: Levels A, B, C Teacher Worksheet

Please ensure that the students adhere to the appropriate proportions. Use the following conversions:

Level A: h = 30 m, r = 4 m, 1 m = 1 cm. Therefore, h = 30 cm, r = 4 cm;

Level B: h = 4.2 m, r = 10.8 m, 1 m = 2 cm. Therefore, h = 8.4 cm, r = 21.6 cm;

Level C: h_1 = 32.3 m, r_1 = 4.1 m, 1 m = 1.2 cm. Therefore, h_1 = 38.76 cm, r_1 = 4.92 cm;

h_2 = 3 7/9 m, r_2 = 11 3/7 m, 1 m = 1.2 cm. Therefore, h_2 = 4.53 cm, r_2 = 13.71 cm.

Case Study III: Findings Sheet

Name(s): _____
Level: _____
Period: _____
Date: _____

Directions: Fill out this sheet completely and turn it in with all work to your teacher.

Question	Answer	Reasoning
Question 1: What did you learn by creating a floor plan of your house or apartment?		
Question 2: What did you learn by creating a scale model of the lunar habitat?		