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Lesson Title: Great Wall of China and Materials Engineering

Class and Grade level(s): 3rd- 5th grades

Goals and Objectives

The students will be able to:

- define engineer
- observe and describe earth materials when they are dry, wet, and shaken
- make a prediction on the mixture of earth materials that will produce the sturdiest mounds
- design and create a wall using earth materials which are chosen by a team, analyze the strengths and weaknesses of the team's wall, and come up with the ways to improve their design

Curriculum standards addressed: for Kansas Science Standards:

STANDARD 1: SCIENCE AS INQUIRY – The student will develop the abilities to do *scientific inquiry*, be able to demonstrate how *scientific inquiry* is applied, and develop understandings about *scientific inquiry*.

Benchmark 1: The student will demonstrate abilities necessary to do the processes of *scientific inquiry*.

Benchmark 3: The student will analyze how science advances through the interaction of new ideas, scientific investigations, skepticism, and examinations of evidence of varied explanations

STANDARD 5: SCIENCE AND TECHNOLOGY – The student will demonstrate abilities of technological design and understandings about science and technology.

Benchmark 1: The student will demonstrate abilities of technological design.

Time required/class periods needed: 4 class periods

Primary source bibliography:

- Pictures of the Great Wall of China

Secondary source bibliography:

- Ortiz, A., Cunningham, C. M., & Lachapelle, C. (2004). Yi Min Materials Engineering and the Great Wall of China. Boston: Museum of Science.
- <http://www.walkthewall.com/index.html>

<http://rubens.anu.edu.au/student.projects97/castles/building/page2.html>
<http://www.jsce-int.org/Publication/CivilEng/2000/civil.pdf>

Other resources used:

* Engineering is Elementary: Designing Walls by Museum of Science, Boston

Required materials/supplies:

Session 1: world map/globe, two skinny tree branches as “chopsticks”

Session 2: (For Each Group) water, 7 paper cups, 7 plastic bowls, ½ cup soil, ½ cup gravel, ½ cup sand, and ½ cup clay powder
(For Each Student) ruler, hand lens, a copy of “Observing Properties of Earth Materials ” chart, a copy of “Observing Mud Mounds” chart, a copy of “Using Earth Materials for a Wall” worksheet

Session 3: Ice cube trays, earth materials chosen by each team

Session 4: a tennis ball

Extension: an access to the Internet

Vocabulary:

Engineering

Materials Engineering

Problem & Solution

Hang-Tu Method

Properties

Sand

Clay

Gravel

Procedure:

Session 1

1. Show a picture of the Great Wall and encourage students to tell you everything they know about it and list them on the board. Make sure to use a map to show the students where the Great Wall is located and talk about the purpose of the Great Wall.
2. Ask students what they think an engineering is and list their ideas on the board.
3. Give an example of a simple materials engineering to the students such as chopsticks.
4. Tell students that there is always a problem before an engineer starts creating something.
5. Introduce the book, Yi Min: Materials Engineering and the Great Wall of China, to the students and read it aloud to them. Tell them to pay attention to the problems and the solutions people had in the story. List each problem and the solution on the board along with the materials and the methods used.

6. Tell the class that they will actually design and create their own wall in this unit.

Session 2

1. Review the previous lesson with the class.
2. Review the materials ancient Chinese people used to build the Great Wall.
3. Tell the class that they are to test a variety of earth materials today to choose the possible materials for their brick wall.
4. Pass out the materials to each group, have each student observe the properties of each material, and record the observations on the "Observing Properties of Earth Materials" worksheet.
5. Then, have each group make a mud mound for each material by adding water and record the observation on the "Observing Mud Mounds" worksheet. The students are to observe the mounds when they are wet, dry, and after they are shaken. (It will take a few days for the mounds to get dried.)
6. As a class, discuss the results and make a class chart.
7. Then, tell the class that they are to combine 2 materials to make a mixture mound to find the strongest brick they can possibly make using the given earth materials. Have them record their findings for "wet", "dry", and "shaken" on the observation chart.
8. Have each student fill out the "Using Earth Materials for a Wall" worksheet.

Session 3

1. Using the information the students have gathered from the previous experiment, have each group choose the kind of earth materials they would like to use for their bricks to build a wall.
2. Create bricks in ice cube trays using the chosen materials. Let them dry for a few days.
3. Have each group design their own wall.

Session 4

1. Have each group build a wall according to the design they came up with during the previous lesson.
2. Test the wall by rolling a ball against it.
3. Discuss the results as a group and then as a class.
4. Have students improve their design or materials to create a new wall.

Extension

1. Have the students take a virtual tour of the Great Wall on the internet at <http://www.walkthewall.com/index.html>.
2. You can also have students do a research on Japanese castle walls and the Great Wall of china, and compare and contrast the structures and/or construction of both kinds of walls by going to the websites, such as <http://rubens.anu.edu.au/student.projects97/castles/building/page2.html> and <http://www.jsce-int.org/Publication/CivilEng/2000/civil.pdf>.

Assessment/evaluation:

*Student observation charts and worksheets

Name: _____ Date: _____

Observing Properties of Earth Materials

* Try to use as many senses as you can during your observation!

Material	Dry	Wet
Gravel		
Sand		
Soil		
Clay		

