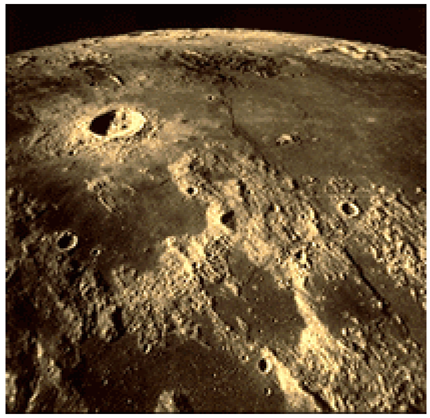


Narrative

The year is 2015. Humans have not been to the Moon since 1972. In the Apollo missions, twelve men walked on the Moon. Now NASA has determined that it is time to “Return to the Moon” and set up a permanent lunar base.
Once the lunar base is set up we will be able to study the geological history of the Moon. This will help us to better understand the geological history of our own planet. Unlike Earth, the geological features of the Moon are intact; the geological processes of weathering and erosion have not altered them.
Because the study of craters on the Moon will help us to better understand how craters on earth were formed, it is important to paleontologists who are studying the extinction of dinosaurs. Dinosaurs were believed to have disappeared when a large impactor hit the Earth 65 million years ago. Chicxulub Crater in southern Mexico is believed to be the site of this impact. Chicxulub Crater is no longer visible as it has been covered with layers of sediment due to geological processes on Earth.

Problem

You are a member of a team of NASA engineers who have been asked to develop a system or method to replicate the formation of the craters on the Moon.

Learning Standards

Physical Science	Earth Science	Technology/Engineering
Differentiate between properties of objects (e.g., size, shape, weight) and properties of materials (e.g. color, texture, hardness)	Give examples of how the surface of the earth changes due to slow processes such as erosion and weathering, and rapid processes such as landslides, volcanic eruptions, and earthquakes	Identify materials used to accomplish a design task based on specific property i.e. weight, strength, hardness and flexibility. Engineering design requires creative thinking and strategies to solve practical problems generated by needs and wants.

Research the Need or Problem

These are some websites that each group can use to find information about impact craters and how they were formed.

http://www.lpl.arizona.edu/SIC/impact_cratering/intro/

http://www.lpi.usra.edu/expmoon/science/craterstructure.html

http://www.enchante dlearning.com/subjects/astronomy/moon/Craters.shtml

http://www.tlonh.com/impact_crater_structure.asp

Materials

Pan
Flour
Tempera paint
Steel spheres - different sizes
Paper
Elastic bands
Wood
Glue
Ruler
Pebbles
String
Cocoa
Balance
Protractor
Water
Straws
Masking tape
Plaster of Paris

Brainstorming

Each team will be comprised of 3 to 5 students. They will use the ***Cubing Brainstorming Activity*** to develop ideas for a device that will replicate impact craters.

Best Possible Solution

Each team will present to the entire class the results of their brainstorming including their plan of how they would replicate crater formation. Each presentation should be verbal and include a sketch of the replication device. A facilitator will make a chart of the ideas generated during brainstorming.
As a result of this brainstorming activity each team should have an understanding of

- What they know about the formation of impact craters on the Moon
- What they don't know about the formation of impact craters
- What they need to know about the formation of real impact craters on the Moon that will help develop a device to replicate these craters

You will now develop a plan for a prototype and define the process they will be used to construct the replication device. It should be a valid system/method that can be replicated with ease. In order to develop and construct this replication device, the best ideas from each team will be combined.

Construct a Prototype

- Define work area
- Select materials
- Build the prototype

Test and Evaluate the Solution

The prototype will be tested to simulate impact craters on the Moon. The features that result from the simulated lunar impact craters will be compared to pictures of the features of real impact craters on the Moon.
You should now reread the Technology/Engineering Learning Standards and determine if you achieved these standards.

Communicate the Solution

The group will make a presentation of their prototype. You will demonstrate how the device replicates lunar impact craters. You will also present the test results and evidence that the device does what it was designed to do.
The Impact Crater Formation Engineering Design Process rubric will be used to evaluate the process that you used to develop the impact crater replication device.

Redesign

As a result of testing this device, are there changes that could be made to make this device better?

Impact Crater Formation
Cubing Brainstorming Activity
Best Possible Solution Activity
(Teacher Page)

Background:

Cubing is a technique for *swiftly* considering a subject from 6 points of view. The emphasis is on ***swiftly*** and ***6***.

The process of cubing is one that writers use when they can't get going on a topic. It forces the writer to look at a subject from different perspectives in a 3 to 5 minute time period and then move quickly to another perspective. It is simply a technique.

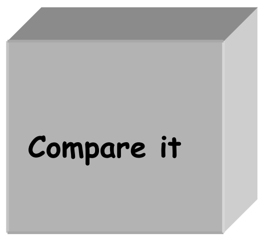
The topic we will focus on in this activity is Impact Crater Formation. The goal is to have students brainstorm and focus on how impact craters were formed from a variety of different perspectives. They must describe, compare and analyze, associate, apply, sketch, and make an argument to support their theory of the formation of impact craters.

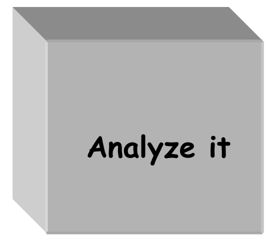
Students will be divided into groups of three to five students. Each group will be given some photographs of impact craters and a cube with six perspectives on the sides. Students will follow the **Rules for Cubing** on their activity page.

Upon completion of the cubing/brainstorming activity, groups should be encouraged to share their perspectives with the whole class.

As a result of this brainstorming activity, students will have had an opportunity to express their prior ideas about how impact craters were formed from a many different perspectives.

Impact Craters Formation
Cubing Brainstorming Activity





RULES FOR CUBING

1. Use all six sides of the cube in any order.
2. Move fast. Don't allow yourself more than 3 to 5 minutes on each side of the cube.
3. Jot down your ideas as you progress from side to side.

For the cubing technique, you need to use all six sides. This is not an exercise in describing, analyzing, or arguing. It is a brainstorming technique to help you look at impact craters from different perspectives. There are no wrong answers in a brainstorming activity.

- Describe it. Look at the images of the impact craters closely and describe what you see. Colors, shapes, sizes, and so forth.

- Compare it. What is it similar to? What is it different from?

- Associate it. What does it make you think of it? Just let your mind go and see what associations you have with these impact craters.

- Analyze it. Tell how you think it was made or formed.

- Apply it. Tell what you can do with it. How can it be used?

- Argue for or against it. Go ahead and take a stand. Make an argument based on how you think the craters were formed.

Now go back and reread the notes you have jotted down and prepare to share your team's perspectives with the rest of the class.

Sketch it. Draw a quick sketch of how you think the craters in the images were formed.

Impact Crater Formation Engineering Design Process

	Literal	Developed	In-depth	Sophisticated
Step 1: **Identify the need or problem - Cubing**	Limited perspective, many inaccuracies	Generally accurate assessment, but lacks perspective and/or accurate supportive information	Accurate and generally revealing, but needs more perspective from differing points of view	Clearly and accurately identifies problem verified by using differing perspectives
Step 2: **Research the need or problem - Evidence of Research**	Limited examination of the current state of the issue and current solutions	Generally accurate assessment, but lacks perspective and/or accurate supportive information	Thorough and accurate assessment, but needs more supportive evidence	Thorough and accurate assessment supported with strong evidence
Step 3: **Develop possible solutions**	Limited perspective and limited academic disciplines explored	Limited brainstorming for possible solutions, and consideration of math or science	Good solution(s) and articulation of solution(s) in 2-3 dimensions, some use of math and science	Refined possible solution(s),articulated best solution in 2-3 dimensions, meaningful use of math and science
Step 4: **Select the best possible solutions Presentation Verbal and Visual**	Unclear about the relationship between the original requirements and the solutions	Clear understanding of the problem and the solutions, but insufficient data to determine the best solution	Good hypothesis, but lacks enough evidence even though data is extensive	Determination of best solution verified by evidence, trial and/or argument in relation to the original requirements
Step 5: **Construct a prototype**	Solutions remain in abstraction	Solution(s) can be modeled in limited dimensions	Good solution(s),but they are unable to be modeled in 2-3 dimensions	The selected solution(s) can be modeled in 2-3 dimensions
Step 6: **Test and evaluate solution(s)**	The prototype meets none of the original design constraints	The prototype meets some of the original design constraints	The prototype meets most of the original design constraints	The prototype meets the original design constraints
Step 7: **Communicate the solution(s) Comparision to pictures**	Weak presentation of how the solution best meets the needs of the problem, no inclusion of societal impact	Fair presentation of how the solution best meets the needs of the problem, some inclusion of societal impact	Good presentation and discussion of how the solution best meets the needs of the problem, societal impact and trade-offs	Excellent engineering presentation including discussion of prototype, societal impact and trade-offs
Step 8: **Redesign and Self-Assessment**	No revision, and/or little or no information	Incomplete revision, little information	Good revision, needs more information	Excellent revision based on information gathered during the tests and presentation