Build an Astronaut Base - Moon

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Subject: Mathematics, Research, Science
Grade Level: 7-9

VITAL INFORMATION

Mission Scenario: Moon

Application to Mission Preparation: Students will learn general information about the Moon to serve as background information for their mission.

Whole Group/Small Group/Individual: Students will work in small groups to complete this activity.

Summary: This lesson provides a chance for students to investigate characteristics of the Moon as an inquiry activity. Students will become familiar with the Moon and the challenges of living there by designing and building a prototype of an astronaut base that can survive there. Then, students will complete the scientific process by designing experiments that will test their prototype.

LESSON AT A GLANCE

Objective: As a result of this lesson, students will be able to:

(1) List and describe several facts and characteristics about the Moon and its environment.
(2) Describe possible methods for dealing with each characteristic in a lunar astronaut base setting.
(3) Identify and explain a problem.
(4) Design a solution for a problem and build a prototype of that solution.
(5) Design and construct a scale model.
(6) Design and execute experiments that will test the success of a prototype.
(7) Draw conclusions about the success of the prototype based upon experimental results.

Time Required: 5 class periods. 50 Min. per class.

Essential Question: What elements must go into the design for an astronaut base on the Moon?

Lesson Overview: Students will research information about the Moon in order to identify potential challenges/hazards that astronauts might face there, each small group choosing (or being assigned) one on which to focus.

Then, in those small groups, students will design and build a prototype for an astronaut base that provides a solution to their problem.

After building their prototypes, each group will design and execute an experiment to test the effectiveness of their prototype solution.

Finally, students will write a report analyzing the following: their solutions to the challenges identified, their representation of the solution by the prototype, the design of their experiment to test the prototype, and the degree of success of their prototype when tested.

TEACHER PREPARATION

Subject Matter Overview: Links

1. **Abstract of Paper on Lunar Dust Hazards**
2. **Abstract of Paper on Lunar Hazards**
3. **NASA Article - Don't Breathe the Moondust**
4. **NASA GSFC Liftoff - The Moon**
5. **NASA GSFC Lunar and Planetary Science - The Moon**
6. **Popular Mechanics Article: NASA Moon Base**
7. **The Nine Planets - The Moon**

Materials: RESEARCH:
Internet Access

DESIGN AND CONSTRUCTION:
Various craft supplies/simple materials, such as -
• paper - various kinds and colors
• popsicle sticks
• modeling clay
• aluminum foil

- plastic wrap
- garbage bags
- glue
- glue gun
- scissors
- string, etc.

EXPERIMENTATION:

- blacklight(s)
- uv light detector, like laundry detergent or uv beads
- baby powder or other moon-like dust
- oven
- freezer
- thermometer
- small air compressor or pump
- tinsel strands
- incense (optional)
- smoke detector (optional)
- ball bearings or bb's

Preparation: Collect and organize all materials so that they are available to students, and prepare computers for internet research using sites given above.

Differentiated Instruction: For lower-level classes, do not leave the experiment design up to the students. Instead have the experiment already set up for the students and guide the students through their experiments as a class. That is, the whole class watches while one group tests their prototype.

For upper-level students, require them to address more than one hazard in their design, even if they do not test more than one aspect of the prototype.

TEACHING THE LESSON

Lesson Management: DAY 1 - THE PROBLEM/RESEARCH

Large Group: Inform students that NASA will be sending astronauts to the Moon by 2020 to build a lunar astronaut base and that, right now, NASA is working to plan and design this astronaut base so that it can withstand the lunar environment. Since the Moon is very different from Earth, this requires a lot more planning than just building a house on Earth. Ask students to brainstorm a list of extra challenges/hazards/problems that must be faced to build a lunar astronaut base. Write student ideas on the board. Ask each student to explain the challenges/hazards that he/she identifies. This will give an idea of the background knowledge of the students.

Pairs or Small Groups: Provide students with the Lunar Hazard Research Form. Have students work in pairs to conduct on-line research in order to list and explain as many potential hazards as possible. Collect Research Forms at the end of class.

DAY 2 - THE TASK

Large Group: List the following hazard titles on the board - Ultraviolet Radiation, Lunar Regolith (Dust), Extreme Temperatures, Vacuum (Depressurization), Micrometeoroid Impacts. Hopefully, the students will have discovered many of these in their research from Day 1. Explain that there are many more hazards than just these, but that these are the ones on which you will be focusing. Ask students to explain why each of the things on the board could be a hazard to astronauts and equipment on the Moon. If there are any that the students did not think of or find, give a brief explanation of why each might be a hazard. Then, either assign or somehow have students (in their small groups) choose one of the topics given. Tell the students that their task is to build a prototype of an astronaut base that will provide protection and/or solve their assigned problems. Remind them that the astronauts have to be able to live and work in this astronaut base as well as be able to leave the base to explore.

Small Groups: Working in small groups, students should begin using the materials that you provide to build their astronaut bases. (It is up to you to provide any size restrictions or materials restrictions for the group. It is also up to you whether or not they can bring in additional supplementary materials.) It is probably a good idea to have a couple of computers with Internet access available, as well, in case students would like to do any research to get started in their design.

It is up to you as the instructor whether the students should take their designs and/or materials home to work on as homework.

DAY 3: THE TASK (CONTINUED)

Small Groups: Students should continue to build their prototypes. Near the end of class, gather students into a large group.

Large Group: Inform/remind students that they will only have a little bit of time to put finishing touches on their prototypes during Day 4. Then, tell the students that their designs and prototypes are worthless unless we know whether or not they work, whether or not they solve the problem that they were suppose to solve . . . which means that they must be put to the test. Inform the class that for most of Day 4, they will be designing an experiment that will test how well their prototype addressed the hazard that they were assigned. Then, on Day 5, they will actually be conducting the test to determine the success of the prototype. Show/Explain some of the equipment that is available for the experiments. Inform students that if they need further equipment, they can ask you whether or not it is available. Or, if they have something at home that they think will be helpful, they can bring it in to be approved by you. Give the students the assignment to begin thinking creatively about how they might be able to put their design to the test.

DAY 4: THE TEST

Small Groups: Give students a few minutes to finish building their prototypes.

Large Group: Remind students that they will now be designing a scientific experiment that will test the prototype that they built. (This might be a good time to ask them what some characteristics of good experiments are and to give a few examples of what makes an experiment bad. Examples of factors that discredit an experiment are: too many variables, relying on human observation or constancy, etc.)

Small Groups: Have students work in small groups to plan, design, and set up their experiment as well as design any data sheets that they will need to collect the data from their experiment. To save time, for now, these data sheets can just be hand-made. Walk around from group to group guiding them and asking them questions about their experiment.

DAY 5: THE TEST (CONTINUED)

[You can either have each group test their prototype one at a time with the whole class watching (presentation style), or you can have all groups conduct their experiments at the same time in different areas of the room.]

The groups should collect/record the data from their test as they perform them. Once all groups are finished testing their prototypes, give students the "Lunar Base Analysis Worksheet". This will be their homework to answer all of the questions on the worksheet as a lab report/reflection on the week's activities.

Teaching Tips: Depending upon your students, you may need to give them more time to build the prototypes and design the experiments for testing the prototypes.

Throughout the time that the students are designing their experiments, conducting their tests, and writing their analyses, remind students often of the following:
- The point of the test is not to prove that the prototype is a success. The point of the test is to accurately identify the strengths and weaknesses of the prototype.
- Their grades do not depend solely upon the success of their prototype. Rather, the most significant factors in determining their grades will be: (1)their explanation of how they designed their prototypes and why; (2)the design of their experiment to test their prototype; and (3)their explanation/analysis of the test results.

Student Worksheets:

1. **Lunar Base Analysis Worksheet**
2. **Lunar Hazard Research Form**

ASSESSMENT AND EXTENSIONS

Rubrics: **Build an Astronaut Base Rubric***

Extension Activities: After students test their own prototypes, they could make any necessary modifications to the design/prototype. Then, have groups trade prototypes in order to conduct a 2nd experiment. That way, each group has to design a 2nd experiment, but to test a different factor than the 1st experiment that they designed. Also, for the 2nd experiment, they will be testing a different group's prototype.

STANDARDS:

USA- National Science Education Standards

- **Chapter Chapter 6:** Science Content Standards
  - **Grade Level :** 5-8
    - **Content Standard D:** Earth and Space Science: As a result of their activities in grades 5-8, all students should develop an understanding of
      - **Ability/ Concept :** Structure of the earth system
        - **Detail :** The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.
        - **Detail :** Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and in rocks underground.
        - **Detail :** Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.
      - **Ability/ Concept :** Earth in the solar system
        - **Detail :** The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system
        - **Detail :** The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.
    - **Content Standard A:** Science as Inquiry: As a result of activities in grades 5-8, all students should develop
      - **Ability/ Concept :** Abilities necessary to do scientific inquiry
        - **Detail :** USE APPROPRIATE TOOLS AND TECHNIQUES TO GATHER, ANALYZE, AND

INTERPRET DATA. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes.

■ **Detail :** DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

■ **Detail :** THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment. Students should begin to state some explanations in terms of the relationship between two or more variables.

■ **Detail :** RECOGNIZE AND ANALYZE ALTERNATIVE EXPLANATIONS AND PREDICTIONS. Students should develop the ability to listen to and respect the explanations proposed by other students. They should remain open to and acknowledge different ideas and explanations, be able to accept the skepticism of others, and consider alternative explanations.

■ **Detail :** COMMUNICATE SCIENTIFIC PROCEDURES AND EXPLANATIONS. With practice, students should become competent at communicating experimental methods, following instructions, describing observations, summarizing the results of other groups, and telling other students about investigations and explanations

- **Detail :** USE MATHEMATICS IN ALL ASPECTS OF SCIENTIFIC INQUIRY. Mathematics is essential to asking and answering questions about the natural world. Mathematics can be used to ask questions; to gather, organize, and present data; and to structure convincing explanations.
- **Detail :** IDENTIFY QUESTIONS THAT CAN BE ANSWERED THROUGH SCIENTIFIC INVESTIGATIONS. Students should develop the ability to refine and refocus broad and ill-defined questions. An important aspect of this ability consists of students' ability to clarify questions and inquiries and direct them toward objects and phenomena that can be described, explained, or predicted by scientific investigations. Students should develop the ability to identify their questions with scientific ideas, concepts, and quantitative relationships that guide investigation.
- **Detail :** DESIGN AND CONDUCT A SCIENTIFIC INVESTIGATION. Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables. They should also develop the ability to clarify their ideas that are influencing and guiding the inquiry, and to understand how those ideas compare with current scientific knowledge. Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

• **Ability/ Concept :** Understandings about scientific inquiry

- **Detail :** Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.

■ **Detail :** Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding

■ **Detail :** Mathematics is important in all aspects of scientific inquiry.

■ **Detail :** Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.

■ **Detail :** Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

■ **Detail :** Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

■ **Detail :** Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

- **Content Standard B:** Physical Science: As a result of their activities in grades 5-8, all students should develop an understanding of
  - **Ability/ Concept :** Transfer of energy

■ **Detail :** The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation

- **Detail :** Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

• **Content Standard C:** Life Science: As a result of their activities in grades 5-8, all students should develop understanding of

- **Ability/ Concept :** Structure and function in living systems
  - **Detail :** Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms, and ecosystems
  - **Detail :** The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease. These systems interact with one another.
  - **Detail :** Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.
- **Ability/ Concept :** Regulation and behavior
  - **Detail :** All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.
  - **Detail :** Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.
- **Ability/ Concept :** Populations and ecosystems
  - **Detail :** For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.
  - **Detail :** The number of organisms an ecosystem can support depends on the resources available and

abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.