WHAT'S HAPPENING WITH THE MOON?

Performance Standard 12F/11A/13 B.D

Students will apply the processes of scientific inquiry to document the natural cycles and patterns in the solar system accordingly:

- *Knowledge*: Identify and describe lunar features and patterns of its revolution around the Earth.
- *Application*: Model the phases of the moon from an Earth (and possibly from the Sun's) perspective from collected data.
- *Communication*: Explain the Moon's revolution of the Earth.

Procedures

1. ***In order to know and apply concepts that explain the composition and structure of the universe and the Earth's place in it (12F) and the processes, concepts and principles of scientific inquiry (11A), and apply scientific technologies (13B),*** students should experience sufficient learning opportunities to develop the following:
   - Formulate inquiry questions associated with the Moon, and how we see it from Earth. Research sources of scientific information and technologies related to posed questions associated with lunar features, cycles, etc., as data for analysis. These two components may be reversed in order depending on classroom setting.
   - Propose and conduct inquiry investigation which finds answers to posed hypotheses/questions.
   - Collect findings from modeling of the Moon's revolution of the Earth and construct display media for data analysis.
   - Communicate the findings associated with adaptations related to the inferences from the analysis of modeling data.
   - Generate further questions for future investigations about the motion of the Moon.

   Note to teacher: This activity relates to knowledge associated with the standard 12F, while addressing the performance descriptors for stage D within standard 11A. A curricular unit may incorporate the performance descriptions from 13B which address how technology has enabled scientists to observe the Moon beyond the capabilities of the unaided eye.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. This resource provides a series of progressive constructivist activities that builds on students' current knowledge and possible misconceptions, prior to a group inquiry investigation. This could include sequencing the order of phases of the Moon's cycle from disordered pictures of the Moon. NASA resources at: *http://liftoff.msfc.nasa.gov/Academy/universe/moon.html* which provides a dated series of photographs of moon phases at selected dates. The photographs may be used for the disordered phases activity mentioned below, as well as resource information. It may be helpful to have a poster-sized photograph of the moon, to orient any of the photographs to the same direction. This activity could be followed by a month-long observation record of the lunar cycle. The format and directions for keeping a moon diary are offered (with permission from Marshall Space Flight Center, NASA); at http://magaxp1.msfc.nasa.gov/outreach/girlscouts/moon_phases.html . Students should record date, time, and moon description. A modified version is offered for younger students, if desired at that site.
4. Begin contextual inquiry investigation about the Earth's moon with questions about the moon and its phases, such as; Why does the appearance of the moon change? Can you see it in the day time? What does it mean for the moon to be new or full, etc.? A preliminary activity of ordering the moon phases in pictures with references to a large picture or poster of the moon. Guide students toward asking, recording and answering their questions and stating their understanding using appropriate scientific vocabulary terms and resources.
5. Introduce the investigation's premise: How can we best create a model which can show what we have learned about the cycle of the Moon? Another NASA activity (http://education.jpl.nasa.gov/educators/moonphase.html) provides a strategy for modeling the phases of the moon with the students directly. In this way, visual correlations to the moon's revolution of the Earth can be made. Follow these directions with small groups, preferably, or as a whole classroom. Each student will need a light colored ball (a 5 cm/2 inch Styrofoam ball is suggested). A lamp with a bright bulb or overhead projector is needed to be the Sun and the room needs to be darkened as much as possible. Discuss each of the variations for the moon phases as directed. Resolve questions with additional practice and explanation. Students should complete the worksheet and their lunar diary for assessment.
6. Encourage students to generate further questions which could follow from their initial research and presentations. Such questions could include: How does a solar or lunar eclipse happen? What about the tilt of the Earth? What about the night sky? (etc.)

7. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge*: The identification and descriptions of the moon phases were complete and correct.
   - *Application*: The lunar diary was complete and well-organized.
   - *Communication*: The explanations were complete and accurate.

Examples of Student Work not available

Time Requirements

- 1 class period for introduction to unit and lunar diary requirements; periodic review of status of diary 5-10 minutes; 1 class period for moon phase modeling and responses to work sheet

Resources

- Classroom set of Styrofoam balls, overhead projector or strong lamp; darkened classroom
- What's Happening on the Moon Reflection sheet
- Science Rubric

Useful Internet sites:

This site provides streaming 'photographic' display of the moon phases, as viewed from space and from earth. It requires installation of the free Shock Wave application. Students can move moon around earth
http://kids.msfc.nasa.gov/Sites/ExternSite.asp?url=http%3A%2F%2Fwww%2Espaceday%2Ecom%2Fen%2Fmission%2Fphaser%2Findex%2Ephp

This site provides animated views for eclipse models:
http://kids.msfc.nasa.gov/news/1999/news%2Dpostsolareclipse.asp

This site provides modeling moon phases instructions, which is copied in this activity:
http://learn.jpl.nasa.gov/educators/moonphase.html

This site is from the Exploratorium/NASA, at which students adjust the calendar to see moon phases; it can also be used as a source of sequential photographs of the moon phases throughout a full lunar cycle:
http://liftoff.msfc.nasa.gov/Academy/UNIVERSE/MOON.HTML

Copied with permission from: http://learnjpl.nasa.gov/educators/moonphase.html

Educator's Guide to Moon Phases

Easier Done Than Said

Phases of the Moon is at the top of the list of things that students seriously misunderstand. Most teachers run into problems in trying to explain the Moon's phases to youngsters and evidence suggests that many have a very difficult time with the concepts. The problem starts immediately when the teacher uses a light piece of chalk on a dark board. Is he or she making the drawing as a positive or a negative?

The supplies for this activity are rather modest. Each student will need a light colored sphere of some sort. Ideally it can be placed on the end of a pencil. Try 5 cm. (2") or greater white Styrofoam balls. Get a larger sphere (15 cm. or so) for your use as leader. You need a light source to serve as the Sun. A lamp with a bright bulb (400 watts) and the shade removed works fine. A dark room is also required.

With the lamp in the center of the room have each student place the ball at arm's length between the bulb and their eyes. They should hold the pencil in their left hand. The bulb is the Sun, the ball is the Moon and they are Earth. The view from their eyes is the same for both this exercise and for observations of the real sky.

At the start, the "Moon" is blocking the "Sun." (This is actually demonstrating a total solar eclipse which is very rare for any given location on Earth.) Usually the Moon passes above or below the Sun as viewed from Earth. Have the students move their moon up or down a bit so that they are looking into the Sun. As they look up (or down) at their moon they will see that all of the sunlight is shining on the far side, opposite the side that they are viewing. This phase is called "new moon" (like "no moon").

They should now move their hand towards the left, about 45 degrees (1/8) of the way around counterclockwise. Have them observe the sunlight on their Moon now. They should see the right hand edge illuminated as a crescent. The crescent will start out very thin and fatten up as the Moon moves farther away from the Sun. (Note: although the Moon is closer to the Sun during new and crescent phases, it is still 400 times closer to Earth; i.e., the Sun is VERY far away in reality.)

When their Moon is at 90 degrees to the left students will see the right half of the Moon illuminated. This phase is called "first quarter." Remember that fully one half of the sphere is illuminated at all times (except during lunar eclipses) but the illuminated portion that we observe changes as the Moon changes position. As they continue to move counter-clockwise past first quarter, the Moon goes into its "gibbous" phase (more than half, but less than fully illuminated) which grows as the Moon moves towards 180 degrees.

When the Moon reaches the position directly opposite the Sun, as viewed from Earth, the half viewed from Earth is fully illuminated (unless the student's head is causing a lunar eclipse). Of course only half of the Moon is illuminated. It has taken the Moon about two weeks to move from new to full. This growth in illumination is known as "waxing." The Moon chases the Sun across the (day and night) sky.

Students should now switch the pencil to their right hand and face in the general direction of the Sun. Starting with the Moon at full, students should continue the Moon's counterclockwise motion. They will observe the reverse of the Moon's phases seen so far with the left portion of the Moon illuminated.

After the gibbous phase diminishes, the Moon will reach the 270 degrees position, straight out to the right. This is "third" or "last quarter." It is followed by a thinning crescent and a return to new moon. From full to new the Moon has been "waning" and leading the Sun. The phase cycle takes 29.53 days. Be sure to observe the real Moon! Most newspapers give the Moon phases along with the weather data.

WHAT'S HAPPENING WITH THE MOON?

Sketch the moon in each of the four "quarter" phases of the moon, as seen from earth and explain why it looks this way at each stage.

FIRST

SECOND

THIRD

FOURTH

Why can we see the moon during the day?

Extension: How could a lunar eclipse be diagrammed? What about a solar eclipse?