Sample Lesson-Moon Phases

Mark Emmet and Patrick Preisinger

Group: Mark Emmet and Patrick Preisinger

Group Norms: Established

Select a Goal for the Group

What aspirations do you have for your students? What qualities do you want your students to have by the time they leave your school? What kind of learning behaviors do you want them to exhibit?

- Students will take their own thinking seriously, and be "thoughtful about thinking".
- Students will see science as a set of intriguing puzzles and will discover that they have the skills to solve these puzzles.
- Students will enjoy learning science.
- Students will struggle with learning on their own, and will see that they can figure things out and learn to enjoy (or at least appreciate) the struggle.
- Students will learn the content in a way that is meaningful and memorable, allowing them some day to explain concepts they learned in this lesson to their grandchildren.
- We'd like to have students who feel comfortable struggling with understanding new ideas. Students should persevere and feel confident that they can think through and learn new ideas on their own.
- Students will not demand that the teacher just tell them 'the answer'. They will be interested in trying to figure things out for themselves.
- Students will be confident in their abilities to learn new things.
- When they leave high school, we'd like our students to be scientifically literate (as defined in *Science for All Americans*).

What gaps do you see between these aspirations and how children are actually developing at your school?

- Students by and large aren't independent learners. They have learned to lean on the teacher a lot and are used to and often prefer to be passive learners.
- The high achieving students are generally frustrated and intolerant with intellectual challenges. We believe this is true because they have been very successful with traditional teaching where memorization and regurgitation of facts is the norm. Middle achieving students seem to feel more comfortable with intellectual challenge perhaps because they have always struggled. Lower achieving students often tune out because the goals of education are so far removed from their daily lives. They also have not had success in

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academic settings and find little motivation for educational accomplishment. Additionally, their skills are so far behind what they are being asked to do that they find it difficult to achieve success.

- Students who do learn content generally have learned a body of disconnected facts. These facts often are not placed into a conceptual framework.

The gap we would like to focus on.

- Students struggle with independent learning. They require and demand excessive support and input from the teacher.
- Not all students "learn" science topics with deep conceptual understanding. The dynamics of group work can contribute to this problem: One or two students may dominate the group and do all or most of the work, while the others passively copy results.

Write a group goal that states the quality you would like to develop in your students. The goal must address the gap you selected above.

- We'd like to focus on assisting all students in the class to realize a higher level of comfort as they struggle independently with intellectual challenge and become less dependent on the teacher.
- We'd like all students in the class to develop a deep, abiding conceptual understanding of the content in our chosen lesson.
- Students in cooperative groups will ALL participate equally in activities and discussions.

Select a Research Lesson

Think about the curriculum that you currently use. Consider a major science topic within your curriculum. The topic you select should be one in which the group goal can be addressed and must be represented in Science Curriculum Topic Study (SCTS). Use the index in SCTS to find the page(s) (pp. 113-271) that address this curricular topic. List the topic and page number from SCTS.

Science Curriculum Topic Study p. 194; "The Earth, Moon, and Sun System";

Science Curriculum Topic Study p. 197 "The Motions of Planets, Moons, and Stars".

Identify the Curricular kit or unit that you will use to teach this topic.

Planetary Science – FOSS

Decide upon a lesson from the kit or unit that will be developed for Lesson Study. This will be the primary context for your research.

Investigation Nine, Lesson Two: *What Causes Moon Phases?*

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A. Background Information:

- *Why is this science content well suited to addressing the group goal of Lesson Study?*

  Phases of the Moon is recognized as a sub-topic of the "big idea" *Sun, Earth, and Moon System* as indicated in National Benchmarks. It is an excellent topic in that it allows students to make their own observations, analyze their data and draw conclusions. This type of activity is important in order for students to be critical thinkers and knowledgeable consumers of information. In addition, we believe that all people should be aware of the workings of the solar system, and phases of the moon is something that is a concrete, everyday phenomenon that all of us have seen all of our lives. There are misconceptions around phases of the moon and studying the topic teaches them to be skeptical and to ask questions. Many students have underdeveloped three-dimensional spatial skills. By studying this topic students will construct a three-dimensional mental model to explain these concepts and make predictions.

- *What do you hope to learn from this lesson that will inform your practice more generally?*

  We want to find out if the prompts we give students will allow them to present their thinking in such a way that their preconceptions will be visible to me. We want to learn what motivates and frustrates students in the context of an inquiry lesson. We want to see how students respond to questions which are designed to elicit their current conceptions and bridge the gap between where they are and where we want them to be. We want to see where students are intellectually engaged, where they flounder, and what teaching techniques triggered their responses. Finally, we want to see if the use of the painted ping-pong ball helps students understand the concept of "light reflection" or does it cause more confusion that it resolves.

- *What are the goals for your students' learning and intellectual development in this lesson?*

  We will assist students in the development of a robust, three-dimensional mental model that will account for all of their observations through building a physical model that represents the earth-moon-sun system. This lesson challenges students to confront preconceptions and encourages them to use evidence to develop conclusions and not simply rely on intuition. When students see the effect and strength of developing mental models they will be able to transfer this skill. Students will develop their own observational skills in order to answer fundamental questions about the cause of the phases of the moon.

- *What do observers need to know about your classroom?*

  My students have been exposed to this before, but they cannot answer fundamental questions about the topic. They are also used to having the teacher give them the answers, and not struggling to resolve inconsistencies between their conceptual framework and observations on their own.

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- *What learning or problem solving strategies are your students familiar or comfortable with up to this point?*

  Students frequently ask the teacher "What is the answer." Good grades or pleasing the teacher motivate them. Students who have been successful in traditional classroom settings rely on memorization, which they are skilled at, but do not necessarily build a deep conceptual framework of how facts are related to each other. There are a few in the class who are motivated by learning for the sake of learning.

- *What misconceptions do your students have coming into this lesson?*

  Student misconceptions include: moon phases are caused by the shadow of the earth or by clouds; only the part of the moon they can see that is lit is actually illuminated; people on different places on earth see different moon phases on the same night; the moon-earth and sun move in the same plane; the moon is never visible in the daytime; there is a "dark side" of the moon; lunar eclipses happen monthly (if we don't see eclipses, someone else does).

  Students often lack an understanding of the relative sizes and distance of the sun-earth-moon system. Students may not understand the difference between radiant and reflected light. They may not understand that the light they see on the moon is reflected light from the sun. Many students may not really understand what occurs when light interacts with a sphere; that is, half the sphere is in the light and half is in the dark.

- *What should students know at the end of this lesson?*

  Students should be able to create a perspective drawing of the earth-sun-moon system showing the directions of rotation of the earth on its axis and the rotation of the moon around the earth. Student should know all eight phases of the moon and the order of the phases as well as how to account for the presence of each of those phases. Students should be able to predict the phase on any given date if they know the phase on a given day. They should know the terms "waxing and waning, gibbous, crescent, first quarter, third quarter, half, full, etc." They should be able to show in two dimensional drawings and three dimensional models the relative positions of the sun, earth and moon that produce the distinct phases. Students should know the directions of the earth and moon rotations.

- *What else would you like them to gain from this lesson?*

  We would like students to learn that an intellectual struggle with a difficult concept creates robust and lasting understanding. The activities students encounter in this lesson should be significantly engaging that they will want to learn the material, (solve the puzzle). Students should gain confidence as learners and not depend on the teacher to give them the answers. All students in the group should be actively engaged in struggling with and understanding the material.

- *Are there any teaching techniques or approaches that are central to the design of this lesson?*

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There is a multi-sensory, minds-on approach to this lesson. Students will engage in the development of physical and mental models to account for their observations. Students will be given application questions and/or activities to challenge, test, and reinforce their understanding of the content.

- *What administrative support or involvement do you need to insure the success of this research lesson?*

  We would like to involve my principal in any and all phases of the Lesson Study process that she would like to be involved in. If nothing else, we would like to see her in the classroom during the teaching of the lesson and have her participate in the debriefing session after the lesson is taught. She has been very supportive of our efforts thus far, but we would like to give her the opportunity to witness the lesson and the discussions our group will have afterward.

  We would also like to see her begin to advocate and support this process with professional development time with other teachers in my building.

II. Unit Information

A. Unit Details

Title of Unit

Planetary Science

Unit References/Citations

FOSS

B. Background Information for this Unit

1. *Provide the page references from the SCTS for the Curriculum Topic Study Guides that address this unit.*

   Science Curriculum Topic Study p. 194; "The Earth, Moon, and Sun System";

   Science Curriculum Topic Study p. 197 "The Motions of Planets, Moons, and Stars"

2. *Summarize the adult content knowledge required for this unit. See section I of the appropriate Curriculum Topic Study Guide(s) (CTSG) for page numbers in the references* "Science for All Americans", "Benchmarks", *etc.*

   - Earth is a small planet, third from the sun of the nine planets in the solar system.
   - Of all the diverse planets in the solar system, only the earth seems capable of supporting life as we know it.
   - The distance of the earth from the sun ensures that the planet receives enough energy to sustain life.
   - The motion of the earth and its position with regard to the sun and the moon have noticeable effects; among them, night and day, seasons, and the phases of the moon.

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3. *Summarize the instructional implications for this unit. (See section II of your CTSG).*

- *Benchmarks* (Pp. 62 – 65) "In middle school, students should add more detail to their picture of the universe, paying more attention to matters of scale and backing up their understanding with a variety of astronomical tools. Developing models of relative sizes and distances of solar system objects is essential. Some experience with parallax can help students understand how distances to the sun and moon were calculated and why stars must be much further away (i.e. star positions don't change significantly when the earth is on different sides of the sun)."
- *Benchmarks* (Pp. 67 – 70) "Middle school students can get a firmer grasp of the geometry involved in explaining the seasons and phases of the moon. And in improving their ability to handle scale, and shifting their frame of reference away from the earth when needed. The cause of the seasons is a subtle combination of global and orbital geometry and of the effects of radiation at different angles. Students can learn part of the story at this grade level, but a complete picture cannot be expected until later."

C. Goals of the unit

1. *Identify and list the science content and process goals of this unit. See section III of your CTSG guide(s) for page numbers in the references* "Science for All Americans", "Benchmarks", *etc.*

Science Content

- Students will become familiar with maps and images presented in a variety of different scales, specifically of the earth in relation to the solar system.
- Students will be provided access to several kinds of historical evidence to induce them to understand that the earth is round.
- Students will understand the celestial geometry that results in the night-day cycle on earth.
- Students will become familiar with the moon as a dynamic celestial neighbor and with major processes that shape and change the moon's surface.
- Students will gain a better understanding of the earth and moon in relation to the sun that result in the phases of the moon we observe on earth.
- Students will become more familiar with the other planets in the solar system.

Science Process Skills

- Students will use appropriate tools and techniques to gather, analyze, and interpret data.
- Students will develop descriptions, explanations, predictions, and models using evidence.
- Students will think critically and logically to make connections between evidence and explanations.
- Students will communicate scientific procedures and explanations.
- Students will understand that scientific explanations emphasize evidence.

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2. *How does the selected content promote depth of understanding of key concepts?*

- This FOSS unit focuses on developing "…a sense of the planet earth as a base for inquiry into the solar system. Students review the evidence that led astronomers to conclude that the earth is round. Students explore the geometry of the sun, earth, and moon system that produces night and day and the phases of the moon." Students explore these concepts using physical models to demonstrate each aspect of this system. They are not just told about it. Additional questions have been embedded in the lesson to challenge students to apply their mental model to new situations.

3. *How does the content connect to the background, experience, and needs of the students?*

- Students will have made and recorded several weeks' worth of detailed observations of the moon. This lesson will give them the opportunity to take these observations and put them together to create a comprehensive conceptual understanding of the sun, earth, and moon system and the causes of the phases of the moon.
- Students will build on their prior knowledge and observations that the earth is one of several planets that orbit the sun and that the moon orbits around the earth and looks a little different each day, but looks the same about every four weeks.

4. *Examine and summarize the research on student learning for this topic. See section IV of your CTSG.*

- "Explanation of the day-night cycle, the phases of the moon…are very challenging for students. To understand these phenomena, students should first master the idea of a spherical earth, itself a challenging task. Similarly, students must understand the concept of 'light reflection' and how the moon gets it's light from the sun before they can understand the phases of the moon. Finally, students may not be able to understand explanations of any of these phenomena before they reasonably understand the relative size, motion and distance of the sun, moon and the earth." (Benchmarks, Pp. 335 – 336)
- "Studies of American fourteen year olds identify the variety of ideas held about the cause of day and night. Over half of the students had taken or were taking a one year course of which a quarter was astronomy. These students did not seem to have the correct view any more often than the other pupils, but they did use many more scientific terms in their explanations. Misconceptions they have about night and day include: the sun is animate and hides or sleeps at night; the sun is covered by clouds or the moon at night; the sun goes around the earth once a day; the earth goes around the sun once a day; and, the sun moves up and down. Ideas about the size, shape and the relationships of the sun, earth, and moon show no apparent trend toward a correct understanding among older children and far fewer girls than boys chose the correct model. Most students draw the sun, earth and moon the same size or between half or double each others' diameters. These misconceptions may be caused or compounded by models used in classrooms or diagrams in books which do not use the true scales for size and distance. For

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phases of the moon and eclipses, ideas such as phases of the moon are caused by the shadow of the earth are prevalent even among sixteen year olds. Other misconceptions include: the earth and the moon both orbit the sun independently; the moon is actually a crescent shape and stars can be seen behind it. A study showed that only 65% of university students had no knowledge of the phases of the moon and just 6% had a correct notion. Among eleven and twelve year olds these misconceptions are common: the shadow of the sun covers the moon; clouds cover part of the moon; and the shadow of a planet covers the moon." (Making Sense of Secondary Science Pp. 169 – 174).

D. How does content for this unit fit into the curriculum?

1. *What prior student knowledge is necessary to learn the content that this unit focuses on?*

- **K – 2:** The sun can only be seen in the daytime, but the moon can be seen sometimes during the day and sometimes at night. The sun, moon and stars all appear to move slowly across the sky. The moon looks a little different every day, but looks the same again every four weeks.
- **3 – 5**: The rotation of the earth on its axis every 24 hours produces the day and night cycle. The turning of the planet makes it seem that the sun, moon, planets and stars move around the earth once a day. The earth is one of several planets that orbit the sun and the moon orbits the earth.
- **6 – 8:** The moon's orbit around the earth once in about 28 days changes what part of the moon is lighted by the sun and how much of that part can be seen from the earth – the phases of the moon.
- **9 – 12:** Students can develop a more sophisticated understanding of the sun, earth, and moon system in these grades.

2. *What new student knowledge can be developed from the concepts that students will learn in this unit?*

   Students will gain an understanding of the causes of the phases of the moon. Students will develop physical and mental models to explain and predict phenomena. Students will become more self-reliant learners.

3. *Describe the relationship of EALRs to your topic. What GLEs are addressed in this lesson? How does this unit fit in with the district curriculum?*

   The Washington State Science Essential Academic Requirement 1.3, **Understand how interactions within and among systems cause changes in matter and energy,** benchmark 2, grade 7 state: "Describe how the regular and predictable motions of most objects in the solar system account for such phenomena as the day, year, phases of the moon, eclipses, seasons, and ocean tides."

   The Bellingham School District Science Curriculum Guide states, "The pattern of changes in systems and organisms is predictable;" and "Motion of the objects in

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the solar system explains phenomena such as the day, year, eclipses, and phases of the moon."

GLE 1.2.5: Understand the structure of the Solar System.

GLE 1.3.7: Understand the effects of the regular and predictable motions of planets and moons in the Solar System.

GLE 2.1.4: Analyze how models are used to investigate objects, events, systems, and processes.

GLE 2.2.1: Apply curiosity, honesty, skepticism, and openness when considering explanations and conducting investigations.

GLE 2.2.2: Understand that scientific theories explain facts using inferential logic.

GLE 3.2.2: Analyze scientific inquiry and scientific design and understand how science supports technological development and vice versa.

E. How the lesson study fits into the unit

1. *Outline the instructional sequence of the unit. Briefly identify the topics covered and the number of lessons spent covering each topic. Be sure to indicate where the research lesson falls in this sequence*

   Investigation One: My Place in the Universe - familiarization with maps and personal orientation with respect to maps and the Solar System. (3 lessons)

   Investigation Two: The Round Earth – night, day and time zones. (6 lessons)

   Investigation Three: The Moon as a Dynamic Celestial Neighbor - major processes that shape and change the surface of planets and satellites: major features on the moon; rocks and minerals on the moon; **phases of the moon.** (22 lessons)

   Investigation Four: Other Planets in the Solar System. (3 lessons)

2. *Will any of the concepts and/or skills in your planned lesson get addressed at other points in the unit?*

   The concept of the round earth, light reflecting on a sphere, causes of night and day, the relative size, motion and distances in the sun, earth, and moon system, and scale will all be addressed in this unit.

III. Lesson Information

A. Name of the study lesson

What Causes Moon Phases?

B. Background information for the study lesson

1. *Review and summarize the adult science content required for this lesson.*

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- The revolution of the moon around the earth and rotation of the earth on its axis account for the phases of the moon and the time of day or night when we see the moon (on the basis of the changing angle at which we see the sunlit side of the moon).
- There are two aspects of the earth-sun-moon system that should be kept in mind, the huge distances and the relative sizes of the bodies involved.
- The orbit of the earth around the sun and the orbit of the moon around the earth are not in the same plane.
- Eclipses are rare because of the large distances between the earth and the moon and because of the tilt of the moon's orbit with respect to the ecliptic.
- The moon is not a radiant object. It reflects light from the sun.
- The earth rotates west to east (counterclockwise as seen from above the North Pole). The moon orbits the earth in the same direction.
- The sun illuminates exactly half of both spheres of the earth and moon.
- There is no "dark side" of the moon. Each place on the moon experiences a lunar day and night in about 30 earth days.
- If you lived on the moon and the earth was in the sky above you, it would not change position but it would go through phases. The earth never appears to rise or set from a stationary position on the moon. The earth would turn as you watched it.
- Because the moon moves 1/30th of the distance around the earth each day and turns 1/30th of a revolution each day, one side of the moon always faces the earth.

2. What prior student knowledge and skills are required for this lesson?

- The moon looks a little different every day, but looks the same again every four weeks. The rotation of the earth on its axis every 24 hours produces the day and night cycle. The turning of the planet makes it seem that the sun, moon, planet and stars move around the earth once a day. The earth is one of several planets that orbit the sun and the moon orbits the earth.
- The earth is approximately spherical in shape. The turning of the planet makes it seem that the sun, moon, planets and stars move around the earth once a day.

C. Goals of the study lesson

1. What should students have learned by the end of this lesson?

Students should be able to draw a perspective drawing of the earth-sun-moon system showing the directions of rotation of the earth on its axis and the rotation of the moon around the earth. Student should know all eight phases of the moon and the order of the phases as well as how to account for the presence of each of those phases. Students should be able to predict the phase on any given date if you know the phase today. They should know the terms "waxing and waning, gibbous, crescent, first quarter, third quarter, half, full, etc." They should be able to show in two dimensional drawings and three dimensional physical models the

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relative positions of the sun, earth and moon that produce the distinct phases. Students should know the directions of the earth's and moon's rotations.

2. *How are you going to assess student understanding of the content and skills covered in this lesson? Discuss both formative and summative assessments.*

Formative assessment in this lesson will include the teacher checking student drawings for initial conceptual understanding. As students begin to grapple with the globe, tennis ball, and ping-pong balls the teacher will be able to see what difficulties students have in modeling the sun, earth, and moon system. The teacher should also be able to assess whether the painted ping-pong balls help students clarify the concept of light reflecting on a sphere.

Traditional summative assessment would consist of students being able to answer the following:

- Describe and name each of the eight phases as well as show the correct sequence of the eight phases.
- When prompted to show a three-dimensional model of the sun-earth-moon system (with their bodies or with spheres that represent the sun, moon and earth), they should be able to show the relative position of each for any given phase (e.g. show me the relative positions of the sun, earth and moon when the moon is a waxing gibbous).

An important part of the assessment will be "extension" and "challenge" questions that will stretch student understanding and allow the teacher to test how well developed the students' conceptual understanding and three-dimensional mental model of the sun-moon-earth system is. We will use questions such as

- Assuming that the sun rises at 6 and sets at 6, where would the new moon be at any given time during the day? Where would the full moon be at any given time of the day? Where would the first quarter moon be at any given time? Etc.
- What's in this picture does not fit with your current understanding?

Answer: Stars can't be seen behind the disk of the moon.

- Students should try to answer questions like this alone and then in pairs.

If you were an astronaut standing on the moon looking at the Earth, what phase would the moon be in (as viewed from the Earth) if you saw a ***full*** Earth?

a. new moon
b. full moon
c. half moon
d. You wouldn't see the Earth; it would rise and set with the sun.

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3. *Are there specific misconceptions that this lesson addresses?*

   - Phases are caused by the shadow of the earth or by clouds.
   - Only the lit part students can see is actually illuminated.
   - The moon is luminous.
   - The moon is never visible in the daytime.
   - There is a "dark side" of the moon.
   - Relative size and distance of the sun, earth, and moon system.
   - The moon is actually a crescent shape and stars can be seen behind it.

4. *What specific instructional strategies form the core of this lesson?*

   Students will engage in an inquiry model to develop physical and mental models to account for their observations. There is a multi-sensory, minds-on approach to this lesson. Questioning to elicit, challenge, and extend student understanding is a major instructional approach in this lesson.

D. How the study lesson is related to the group goal

1. *Describe how you expect the research lesson to address the group goal.*

   This lesson lends itself to finding enough simple and readily available materials for *all* students to participate actively in the lesson. Because students have carefully recorded six weeks of moon observations prior to this lesson, and because of the careful selection of instructional materials and sequence, students have all the tools they need to succeed. The structure of the lesson is such that all students will have the opportunity, and hopefully the motivation, to be actively engaged in constructing their own conceptual understanding of the topic.

2. *What features of the lesson make it well suited to addressing the group goal?*

   Through careful structuring of a series of discrepant events, inquiries and sequentially more sophisticated questions, students will be able to confront misconceptions and incomplete ideas they may have about the phases of the moon. The conceptual leaps in this activity are appropriately spaced so that students will struggle, but eventually succeed with their task and become more comfortable with independent learning and less reliant on "teacher telling". Because phases of the moon is a phenomena that they all have experienced, typically with incomplete understanding, they will likely be motivated to fully engage with the content.

E. Process of the study lesson

For the completed lesson plan, see Addendum (Moon Phases Sample Lesson 'A').
Note: Students, through previous carefully guided inquiry lessons, have developed a solid understanding:

- that the earth is approximately spherical in shape
- of the causes of night and day
- of the relative sizes and distances in the sun, earth, and moon system

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F. Lesson implementation logistics

Date: November 17, 2005

Grade: 8th

Period and Location: Period One, Fairhaven Middle School

Instructor: Mark Emmet

G. Evaluation

1. How will you determine if the students understood the concepts taught in this lesson?

Student evaluation in this lesson consists of a pre and post test, as well as opportunities for formative assessment throughout. Students should show a deeper conceptual understanding of the sun, earth, and moon system as they progress through the stages of this lesson. They should be able to explain the reasoning that led them to construct their model accurately, and in answering the post test questions.

2. How will you determine the extent that the group lesson study goal was met?

We will be looking for student behavior consistent with our goal to have students realize a higher level of comfort as they struggle with the intellectual challenge of the lesson. Specifically, we will look to see if students are showing their misconceptions in drawings and three dimensional models, if the cues (questions) from the instructor are clearly helping students make progress, if students are persistent in their attempts to understand the sun, earth, and moon system, and if students are confident that they can answer the challenging questions themselves.

We will determine if students understand the concepts taught in this lesson in several ways. We will look at the pre-test responses as students are making their first drawing to ascertain student pre-conceptions. We will monitor student responses to prompts to draw and model the three dimensional sun, earth, and moon system to account for the phases of the moon. We will check student understanding of the important prior knowledge that when lit, half the sphere is illuminated. Finally, we will ask questions that will extend the experience to a higher level where students will need to apply their understandings to new situations. Student success on these challenge questions will demonstrate complete conceptual understanding.

3. What information will you collect in the course of this lesson?

Observers will collect evidence of student conceptual understanding through several points of evaluation. These points include: *What evidence do you have that students are appropriately challenged by the teacher's questions? What evidence do you have that shows that the black and white ping-pong balls helped students develop an understanding of light reflection on a sphere? Are students who struggled early in the lesson showing more persistence toward the end of the lesson? Is everyone in*

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the group actively engaged? If so, what made this engagement occur? If not, what occurred when students lost interest?

4. What role will the observers play in gathering this information?

Observers will quietly listen and observe student behavior to answer the research questions in this lesson. Observers should not interact with students except to ask clarifying questions.

H. Appendix

Supporting materials:

Moon Phases Sample Lesson Plan 'A'

Moon Phases Pre and Post Test

Moon Phases LS Think Sheet

Materials available at:

www.ncosp.wwu.edu → Collaboration → NCOSP Additional Lesson Study Resources

I. Reference Materials

American Association for the Advancement of Science (AAAS). (1990). Science for all americans. New York: Oxford University Press.

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