Session 7.

Our Nearest Neighbor: The Moon

The Moon has been a source of curiosity throughout human history. It is Earth's closest companion in the Solar System, yet it appears to be very different from the Earth. There is a growing body of knowledge, however, that tells us that there are also important similarities between the Earth and its Moon. In this session, we "travel" to our nearest neighbor to collect clues that we can use to interpret the features of the Moon and the story of the Moon's origin.

The Video

The Moon's motions in the night sky are so familiar to us that we may take the Moon for granted. But what can we learn from studying the Moon? What means can we use to investigate it? Both Soviet and American astronauts collected rocks from the Moon's surface and returned them to Earth for study. What stories can these rocks tell us about the Moon's mysterious past and what can they reveal about the history of our home planet, Earth?

In the video, *our* journey to the Moon begins with a first-person perspective from Dr. Harrison Schmitt, an Apollo astronaut and geologist, and the only scientist to have ever set foot on another world. Then Dr. R. Hank Donnelly, Dr. John Wood, and Dr. Myron Lecar assist us in considering the current theories and supporting evidence for the Moon's origin. We end our journey by considering what the Moon can tell us about events early in Earth's history.

Throughout the video, we observe elementary school children being interviewed as they explore their ideas about the Moon and its origin. We also visit Kathy Price and her fifth graders at Naaba Ani Elementary School in Bloomfield, New Mexico as they think about the sizes of the Earth and the Moon, and the distance between them. Finally, we observe as the students apply knowledge of the angular size of the Earth and Moon in constructing a scale model of the Earth–Moon system.

Learning Goals

During this session, you will build understandings to help you:

- Describe, cite evidence for, and evaluate current theories of the Moon's origin
- Explain how the Moon's history informs our understanding of Earth's history
- Comprehend the scale of the Earth–Moon system

On-Site Activities

Getting Ready (60 minutes)

Activity One—Problem Set and Reading Discussion (20 minutes)

1. In small groups, review the questions from the problem set for Session 6.
2. With a partner, review and discuss each other's concept maps for landforms.
3. With your group, share the picture of the Moon that you brought to today's session with your group. As you look at these pictures, think about what you know about the surface features of the Moon. Discuss how surface features of the Moon compare to landforms on the Earth. How or where might the Moon connect to your concept map?
4. Session 6's homework asked you to identify several children's ideas in the article "Children's Understandings of Astronomy and Earth Sciences" that compare to your own or are prevalent among students that you have known, and to write a question about the related content and try to answer it. As a whole group, discuss the questions and answers you brought in.

Activity Two—When the Moon Hits Your Eye… (15 minutes)

1. To prepare for today's session, you were asked to brainstorm and list what you know about Earth's Moon and answer the following questions: Where did the Moon come from and how did it form? What can the Moon tell us about the Earth? Share your list and your ideas with your group.
2. How are the Earth and the Moon alike and different? With your partner, discuss the similarities and differences between our home planet and our nearest neighbor. Be sure to incorporate reflections on the topics of past sessions (for example, soil, rocks, Earth's interior, plate tectonics, landforms, forces that sculpt the surface) as you consider similarities and differences. Using newsprint, make a two-column chart to record your ideas. Label the first column "Earth" and the second "Moon."

Facilitators: Distribute the balloons you brought to the session.

Activity Three—Scale of the Earth–Moon System (25 minutes)

1. Work with a partner. Thinking about relative size, inflate two balloons, one to represent the Earth and the other to represent the Moon.
2. Once the spheres have been selected, measure and record the diameters of the model Earth and Moon. Calculate the ratio of the diameter of the Earth to the diameter of the Moon (Ratio A) as follows:

   $$\frac{\text{Diameter of Earth}}{\text{Diameter of Moon}} = \text{Ratio A}$$

   Using this ratio, draw a quick sketch of the sizes of the model Earth and Moon showing how many times larger one is than the other.
3. You and your partner should then choose to represent either the "Earth" or the "Moon." Facing each other, hold your models and position yourselves to represent what you think is the proper scale for the distance between the Earth and Moon. Use the diameters of your models as a basis for this estimate (i.e., how many Moon diameters is it to the Earth?). Measure and record this distance. Mark your positions with tape. You will return to these spots after the video.

4. Calculate the ratio of the distance between your model Earth and Moon to the diameter of the Earth (Ratio B) as follows:

   $$\frac{\text{Distance between Earth and Moon}}{\text{Diameter of Earth}} = \text{Ratio B}$$

   Record this value.

5. Return to your earlier sketch and label the distance you measured between you and your partner to represent the distance between the Earth and the Moon. On your sketch, write a few sentences about why you and your partner believe your scale model of the Earth–Moon system accurately represents the relative sizes of the Earth and Moon and the distance between them.

Viewing the Program (60 minutes)

As you watch the video, think about the following focus questions:

1. What can we learn about the Earth from investigating the Moon?
2. The children interviewed have a range of notions about where our Moon came from and how it formed. As you watch, keep track of their ideas and compare them to yours.
3. Watch the students in the featured classroom as they create their scale models of the Earth–Moon system. Use their strategies to inform the work you will do following the video. Listen for their values for Ratio A and Ratio B.

Going Further (60 minutes)

1. As a whole group, spend a few minutes discussing the video. Review the theories of the Moon's origin presented in the video and revisit your answer to the question discussed during Getting Ready: Activity Two. Talk about how your ideas about the origin of the Moon have changed.
2. Discuss the following question: What can we learn about the Earth from investigating the Moon? Compare your thinking now with the ideas you discussed as you considered what the Moon could tell us about the Earth during Getting Ready: Activity Two. Each group member should record the group's ideas for a later discussion in Session 8.
3. Present the chart you and your partner created comparing the Earth and the Moon to the whole group. Discuss the content of each chart. Amend your chart to reflect new learning.
4. Share the sketch you and your partner made of your model Earth–Moon system and the sentences you wrote about the accuracy of your model with your other group members. Compare the sketches and each other's calculations for the ratio of the Earth's diameter to the diameter of the Moon (Ratio A), and the ratio of the distance between the model Earth and Moon to the diameter of the Earth (Ratio B). Compare the value of these two ratios to the values given during the video. Evaluate the accuracy of each paper scale model and discuss discrepancies between the group's scale and the correct scale.

On-Site Activities, cont'd.

5. With your partner, return to your original Earth and Moon positions marked by tape on the floor with your spheres that represented the Earth and the Moon. Utilizing your new knowledge of the angular size of the Moon from Earth (1/2˚, or roughly one pinky fingernail width with your arm fully extended) and the angular size of the Earth from the Moon (2˚ or roughly 2 fingernail widths with your arm fully extended—don't use your pinky this time!), test the accuracy of your physical scale model. Create a correct physical scale model by choosing different spheres, adjusting to new positions, or both. Then check the accuracy of your new physical model (your sphere sizes, and distances between your model Earth and Moon) through calculation of Ratio A and Ratio B.

Note: See the *Earth and Space Science* Web site to learn more about how to determine the angular size of an object (A Closer Look: Angular Size) at www.learner.org/channel/courses/essential/earthspace/session7.

6. Return to your group and share your impressions and experiences as you and your partner reconstructed your physical scale model. Discuss how or if this activity has changed your thinking about the Earth–Moon system. Discuss your thoughts on the scale of our Solar System. Does today's activity change your impressions of the scale of our Solar System? If so, how?

Between Sessions

Homework (* = required)

* Reading Assignment

Bar, V., Sneider, C., and Martimbeau, N. "Is There Gravity in Space?" *Science and Children*, April (1997): 38–43.

Before reading the assigned article, answer the question asked in the title: Is there gravity in space? After reading the article, write an answer to the question: How do the moons of Jupiter stay in orbit?

* Problem Set

(Suggested answers are listed in the Appendix.)

1. What evidence suggests that the Moon formed with a molten surface?
2. What can the cratering on the Moon tell us about the Earth and events in Earth's early history?
3. How does the Earth's Moon compare with other moons in the Solar System? Research this beyond the information provided in this session's video. Create at least four statements of generalization that describe the nature of the moons in our Solar System, particularly in comparison to our Moon.

* Ongoing Concept Mapping

Develop a concept map around the concept of "the Moon." Reflect on the content of the video and the site investigation activities and identify major concepts that could be included in your map. Be sure to incorporate what you have learned about the surface features of the Moon and the Moon's probable origin story into your map.

Between Sessions, cont'd.

Guided Journal Entry

In this session's video, Dr. John Wood told us that rock samples collected during an Apollo mission from the mare at Tranquility Base, one of the dark patches on the lunar surface, were basaltic lava. This type of rock has been located at other landing sites as well. What are the implications of this find? What does this tell us about the similarities and differences between the Earth and the Moon? Write about your ideas in your journal entry for this session.

Guided Channel-Talk Posting

During this session you participated in an activity that addressed the scale of the Earth–Moon system. Having a sense of size, distance, and time scales relating to the study of the Earth and our Solar System can greatly inform our understanding of many Earth and space science concepts. Why is this so? How could you incorporate issues of scale into your science curriculum? Which scale issues do you consider appropriate to introduce at your grade level? Discuss this with your colleagues in your Channel-Talk posting for this session. Be sure to share any experiences you've had.

Suggestions for Textbook Reading

- Surface features of the Moon
- Impact cratering on the Moon
- History of the Moon
- Structure of the Moon's interior
- Apollo missions
- Moon rocks
- Lunar highlands and lowlands
- The lunar surface material
- Geology of the Moon
- Theories of the Moon's origin
- Findings of the Apollo program
- History of the scientific study of the Moon

* Preparing for the Next Session

For "Getting Ready"

A central question that organizes the content of the next session is "What is the nature of the Solar System?" This is a very complex question that encompasses a broad scope of science ideas. List the characteristics of the Solar System. What are your understandings of how it formed? Record your ideas.

Materials Needed for Next Time

Facilitator:

- Rulers (1 per pair)
- Broadsheet newsprint paper (18-in.x 24-in.) (2 per pair)

All participants:

- The group's list of responses to the question: What can the Moon tell us about the Earth?
- Your list of characteristics of the Solar System and understandings of how it formed from "Getting Ready"

Graduate Credit Activities

Continue your work on the annotated bibliography and action research project.

Notes