Great Explorations in Math and Science (GEMS)

Lawrence Hall of Science,
University of California, Berkeley

SPACE SCIENCE SEQUENCE FOR GRADES 3–5

Teacher's Guide

The Space Science Sequence is a collaboration between the
Great Explorations in Math and Science (GEMS) Program
of the Lawrence Hall of Science,
University of California at Berkeley and the
NASA Sun–Earth Connection Education Forum
NASA Kepler Mission Education and Public Outreach
NASA Origins Education Forum/Hubble Space Telescope
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NASA IBEX Mission Education and Public Outreach
Special advisors: Cary Sneider and Timothy Slater
Foreword by Andrew Fraknoi

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Lawrence Hall of Science
University of California
Berkeley, CA 94720-5200
Director: Elizabeth K. Stage

Project Coordinator: Carolyn Willard
Lead Developers: Kevin Beals, Carolyn Willard
Development Team: Jacqueline Barber, Lauren Brodsky, John Erickson, Alan Gould, Greg Schultz
Principal Editor: Lincoln Bergman
Production Manager: Steven Dunphy
Student Readings: Kevin Beals, Ashley Chase
Assessment Development: Kristin Nagy Catz
Evaluation: Kristin Nagy Catz, Ann Barter
Technology Development: Alana Chan, Nicole Medina, Glenn Motowidlak, Darrell Porcello, Roger Vang

Cover Design: Sherry McAdams, Carolina Biological Supply Co.
Internal Design: Lisa Klofkorn, Carol Bevilaqua, Sarah Kessler
Illustrations: Lisa Haderlie Baker
Copy Editor: Kathy Kaiser

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FOREWORD

BY ANDREW FRAKNOI

When I visit classrooms or talk with teachers, the first thing they are eager to tell me is that kids think astronomy and space are "cool!" Space is right up there with dinosaurs among the topics children (and grownups) like to hear and talk about. The astronomy in the sequence you are now holding is especially cool, because it deals with just those astronomy questions that kids experience in their own lives. Unless we give them a chance to investigate these questions when they are young, their endless curiosity about cosmic questions could soon be lost in the teenage world of instant messaging, endless malls, and garish video games.

While this is not the first astronomy curriculum sequence put together for the early grades, it is very likely the one most effectively based on what we know about how students learn. As veteran astronomy educator Dennis Schatz has often written, the essence of good science education is to put children in the position of acting like scientists. When scientists investigate a new problem, they don't know the answer in advance. They don't have a lab book that tells them what steps to follow to find that answer. And when they think they've found it, they must rely on each other to point out when they have made a mistake. If we take the time in our classrooms to show students these same steps in figuring out science answers for themselves, we give them a skill they will value for the rest of their lives.

It's certainly true that the more we teach students about HOW science works and the more we give them a chance to practice the steps, the less time they will have to memorize science "factoids." But astronomy, like all real science, is more than just a group of disconnected numbers or facts—it's a way of seeing the large-scale world as refracted by the lens of hands-on experiments. Once you know the technique, the facts are easier to assemble.

For me, depth of understanding (that the activities in this book make possible) beats breadth of knowledge hands-down. Reading a little bit about every part of astronomy when you are in 5th grade often means knowing nothing at all for long. But if you can explain to a member of your family what one basic concept in astronomy is all about and *how* you know it's true—you're likely to remember it for the rest of your life. After they do the activities in this sequence, students should be able to explain concepts like phases of the Moon, eclipses of the Sun, or "weightlessness" in space to their grandparents or cousins with enthusiasm.

Students in the United States are among the most gullible in the world. They learn early to be cynical, but often never learn to be skeptical—to sift evidence to decide among competing ideas. Whatever economic race the U.S. is winning these days, we are surely losing one of the most important races of all—the race to produce students capable of clear thinking.

A key part of what we can teach our students in a good science class is "talking things through." This is something many employers now really want in the people they hire, but also something many schools still actively discourage. I think it's a terrific life lesson to teach—before we make a decision, let's talk it through… let's get lots of different perspectives … let's make sure our decision really fits with all the facts. Students and teachers who use this sequence of activities will find many opportunities for fruitful discussion and even heated argument as they discuss scientific issues in "evidence circles." This is just what scientists do, when they e-mail each other, circulate pre-prints of their papers to colleagues in the same field, and go to conferences and argue over coffee and dinner.

When students do the activities in this book, they will feel that—like the views of scientific colleagues—their opinions and observations MATTER. They will feel invited to the table to DO science, not merely to witness it from afar.

Some teachers worry that argument and differing views might disrupt the hard-earned order of their classrooms. But doubting, arguing, and convincing (working from the facts, and only the facts) is one of the great gifts you can bestow on your students. I think that's worth a little disorder during science periods.

Surveys of American adults show woeful ignorance about the ideas of space science—about the reasons for the seasons, about the age of the Universe, and why the Moon's shape changes. Most of these adults were lectured at and told to read on their own. They grew up knowing far more about the stars on television than the stars in the sky. They never got to hold the Moon in their hands and look at it from Mount Nose. Let's make sure the next generation actually gets to do science (and not just read about and listen to science).

I might note that we all owe a great debt of thanks to NASA's Space Mission Directorate (formerly known as the Office of Space Science) for the resources that they have been putting into science education in this country. This curriculum is just one of many in-depth approaches to space science education that this Office has funded in the last decade and a half. (I, for one, fervently hope that their great insight from this time—moving education away from supporting specific NASA missions and toward looking to research to reveal where the real educational needs are—will not be lost in the changes that are happening at NASA.)

Just in the last few years, astronomers have discovered "dwarf planets" beyond Pluto, giant black holes that swallowed billions of stars, and evidence that the expanding Universe may be (contrary to all predictions) speeding up. None of these discoveries is necessarily appropriate for fourth grade. But unless your students understand the basic ideas in the sequence you hold in your hands, they'll never be able to appreciate the latest cosmic discoveries when they are ready for them.

So have fun helping them take their first steps in comprehending the Universe!

Andrew Fraknoi is the Chair of the Astronomy Program at Foothill College near San Francisco, and the former Director of Project ASTRO at the Astronomical Society of the Pacific, which pairs volunteer astronomers with classroom teachers. He is the co-author of a leading college textbook in astronomy, and is writing "The Wonderful World of Space" *for Disney Publishing. He appears regularly on local and national radio explaining astronomical ideas in everyday language. To pay tribute to his work in helping the public understand science, the International Astronomical Union has named Asteroid 4859 Asteroid Fraknoi.*

Acknowledgments

The *Space Science Sequence* was developed through a collaboration of the Great Explorations in Math and Science (GEMS) Program of the Lawrence Hall of Science, University of California at Berkeley and the partners and their institutions listed below. We are grateful to each of these partners for their invaluable help. We appreciate their scientific and pedagogical expertise and their deep commitment to science education.

- **Isabel Hawkins** and **Greg Schultz** of the NASA Sun-Earth Connection Education Forum;
- **Ian Griffin, Jim Manning, Denise Smith, Bonnie Eisenhamer,** and **Matt Bobrowsky** of the NASA Origins Education Forum/Hubble Space Telescope, Space Telescope Science Institute;
- **Lindsay Marie Bartolone** and **Paul Knappenberger** of NASA's Interstellar Boundary Explorer (IBEX) Mission, Education and Public Outreach;
- **Alan Gould** of NASA's Kepler Mission, Education and Public Outreach;
- **Leslie Lowes** of the NASA Solar System Education Forum.

Special Advisors:

- **Cary I. Sneider,** Museum of Science, Boston, Massachusetts
- **Timothy F. Slater,** University of Arizona, Steward Observatory, Tucson, Arizona

All of these partners and advisors reviewed drafts, joined us regularly around the table during development, and provided their expert guidance. Bonnie Eisenhamer, Denise Smith, and the team at Space Telescope Science Institute provided a final, scientific review of the draft, as did Alan Gould and Greg Schultz. Development of the CD-ROM was supported by funding from the Education and Public Outreach component of NASA's Kepler Mission.

The development team for this sequence is listed on page ii. However, in one way or another, every member of the Lawrence Hall of Science GEMS staff assisted in some aspect of the development, field testing, and completion of this sequence. The GEMS staff is listed at the back of the binder.

Special thanks to all classroom teachers who field tested the sequence, gave us their feedback, and shared their student work. Their names and schools are listed on page viii.

Session 3.2: Mount Nose

Overview: This activity introduces students to the current scientific model, now accepted as fact, that explains the Sun's apparent movement in the sky. In this model, a light bulb at the center of the room represents the Sun, and each student's head represents the Earth. Each student's nose represents a mountain on Earth. Each student slowly turns to simulate the spinning of the Earth. As the Earth spins, the student notes the position of the Sun in the sky and the time of day for a person standing on Mount Nose. They notice that although the Sun appears to be moving around them, much as it does in the sky, it's actually the Earth itself that is spinning. The model is also used to illustrate why it is daytime on one side of the Earth while it is night on the other side.

Students are then challenged to apply their knowledge by describing the model to someone who thinks that the Sun goes around the Earth. In small groups called *evidence circles*, students discuss ways to explain that the Earth's spinning motion causes the apparent motion of the Sun, as well as night and day. Finally, each student writes their explanations on a student sheet, which can be used as an assessment before moving on to Session 3.3.

3.2 Mount Nose	Estimated Time
The scientific model: Mount Nose and discussion	25 minutes
Evidence circles: Discussion and writing	35 minutes
TOTAL	**60 minutes**

What You Need for Session 3.2

For the class
- ❑ 1 light bulb base or lamp with no shade
- ❑ 1 40-watt (or greater) light bulb
- ❑ 1 extension cord
- ❑ duct tape or masking tape to tape down cord
- ❑ wide–tip felt pen
- ❑ sentence strips for four key concepts

For each student
- ❑ *Evidence Circles: How Does the Earth Move?* student sheet, from the student sheet packet

Unit Goals

The Earth moves with regular and predictable motion.

The Earth spins (rotates) and orbits the Sun (revolves).

The spinning of the Earth causes the apparent daily movement of the Sun and stars.

Light from the Sun shining on the spinning Earth causes day and night.

The Sun, Earth and Moon form a system.

TEACHER CONSIDERATIONS

We recommend you review the last page of this document before starting this sample lesson. You'll want to be familiar with the Left/Right page orientation.

SCIENCE NOTES

If the Earth is spinning, why can't we feel the motion? A question that students often ask is, "Why can't we feel the spin of the Earth?" We don't feel this spin because the atmosphere and everything else on the ground is rotating with us, and because the spinning motion is extremely smooth. Think of sitting in a car and reading a book or playing a game. If the car were moving very smoothly, with no stops or bumps, if you didn't look out the window, and if the windows were closed, then you really wouldn't know that you were moving. In a similar way, we don't feel or hear any "whoosh" related to our approximately 1,000 miles per hour spinning motion in space because our atmosphere is moving right along with us. And we don't get "thrown off" the Earth by this spinning motion because the Earth's gravity holds us down on the surface.

How fast is the Earth spinning? Students may also ask how fast the Earth is spinning. At the equator, the Earth's spin speed is about 1,670 kilometers per hour, or about 1,040 miles per hour. Away from the equator, the speed is slower because the radius of the spin circle (the distance from Earth's surface to its rotation axis) is less, thus so is the circumference of the rotation circle. As you move close to either the North Pole or South Pole, in fact, the speed of rotation approaches zero. The speed quoted above is derived from the Earth's circumference around the equator divided by the number of hours in one rotation (24 hours = one day).

Key Vocabulary

Science and Inquiry Vocabulary

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Scientific Explanation
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Scale Model
Prediction
Scientist
Three–Dimensional (3-D)
Two–Dimensional (2-D)

Space Science Vocabulary

Force
Mass
Gravity
Satellite
Orbit
Diameter
Sphere
System
Rotate
Revolve

Getting Ready for Session 3.2

1. Decide where you will gather your students in a circle around the light bulb for the Mount Nose activity. You may want to have students move some desks aside temporarily during the session. Or you can plan to have students form a circle around some or all of the desks. It is not necessary to darken the room for this activity, but it is desirable.

2. Use the extension cord to plug in the lamp and set it up in the middle of the area where students will form the circle. It's best if the light bulb is at roughly eye level for most students. Tape the cord down to the floor for safety.

3. Make a copy for each student of the *Evidence Circles: How Does the Earth Move?* student sheet.

4. Prepare sentence strips for the following four space science concepts introduced during this session. Have them ready to post during the session under the *What We Have Learned About Space Science* side of the concept wall:

The Earth spins.
The spinning of the Earth makes it look as though the Sun and stars are moving.
It takes the Earth 24 hours to spin once.
The Earth spinning in sunlight causes day and night.

Mount Nose: A Scientific Model to Explain the Apparent Movement of the Sun

Note: With the Mount Nose model, you begin by giving students a chance to witness the Sun rising and setting from a viewpoint on Earth. Once students understand that it is the spinning Earth that causes the apparent movement of the Sun, you use the model to explain global night and day.

TEACHING NOTES

Why wait to introduce the terms *rotation* and *revolution?* Many adults have trouble remembering the difference between *rotation* and *revolution,* as used to describe the Earth's movements. This is probably because these words are used almost interchangeably in familiar usage and in other contexts. In astronomy, however, the terminology is very specific. Rotation is used to describe a body's spin. (The Earth rotates on its axis.) Revolution is used to describe a body's orbit around something else. (The Earth revolves around the Sun.)

We have chosen to use the word *spin* in this activity, rather than *rotation*, and *orbit* in Session 3.4, rather than *revolution*. We have found it easier initially for students to grasp the concepts using these more readily distinguished terms. We have also chosen to use these terms on the questionnaires, to prevent students who understand the concept from becoming confused by the terms and marking the questionnaires inaccurately. Although it is important for students to learn the terms rotation and revolution, especially if those words are used in your state standards, we recommend beginning with spin and orbit, then changing to rotation and revolution when you think it is appropriate for your students.

What Some Teachers Said

"My students loved Mount Nose. I could really see an impact on the students' understanding after we finished these activities. They were all eager to demonstrate and describe what they learned in this lesson. Most of my students like to share, but this is the first time this year that I had all my students excited about learning more."

" Such a simple way to explain a difficult concept. I'm sure my students will remember this lesson and therefore the concept."

1. Scientific model to explain why the Sun rises and sets. Let students know that they will now see a scientific model for what causes us to see the Sun rise, move, and set. This model has been around for a long time, and because it has so much evidence supporting it and no evidence that does not support it, it is the model accepted by scientists today.

2. Students form a circle. Have the class stand in a circle around the light bulb. Turn on the light bulb and turn off the classroom lights. Explain that in this model, each of their heads represents the Earth. The light in the center represents the Sun.

3. Inaccuracies in the model. Ask, "What is inaccurate about this model?" [The Sun is actually much bigger than the Earth, and the Sun and Earth are much farther apart than in this model.] Say that even though this model's scale is not accurate, it is useful to explain why the Sun rises and sets.

4. Introduce Mount Nose. Ask students to imagine that each of their noses is a mountain called *Mount Nose,* and that a person lives on the tip. Point out that this is another inaccuracy of scale in the model, because there is no mountain that big on Earth.

5. What time is it on Mount Nose? With the students facing the light bulb, ask, "For the person standing on your Mount Nose, where in the sky is the Sun?" [High in the sky, overhead.] Ask, "What time of day do you think it is for the person on Mount Nose?" [Around noon.]

6. The Earth spins. Have everyone turn to their left, and stop when their right ears are facing the Sun. Ask, "For the person on Mount Nose, where in the sky does the Sun seem to be?" [Near the horizon, low in the sky.] Ask, "What time of day is it for the person?" [Sunset.] Ask them to watch as the Sun appears to "set" the next time they turn.

7. Backs to the light. Have the students make another quarter turn, stopping when their backs are to the light bulb. Ask, "What time is it now for the person on Mount Nose?" [Around midnight.]

8. Left ears toward the Sun. Have the students make another quarter turn, so that their left ears face the Sun. Ask, "Where is the Sun for the person on Mount Nose?" [Low in the sky, just "coming up."] "What time is it on Mount Nose?" [Sunrise.]

9. Do one or two more spins. Have students slowly do a few more complete turns on their own, watching as the Sun appears to rise, move across the sky, and set again.

Unit Goals

The Earth moves with regular and predictable motion.

The Earth spins (rotates) and orbits the Sun (revolves).

The spinning of the Earth causes the apparent daily movement of the Sun and stars.

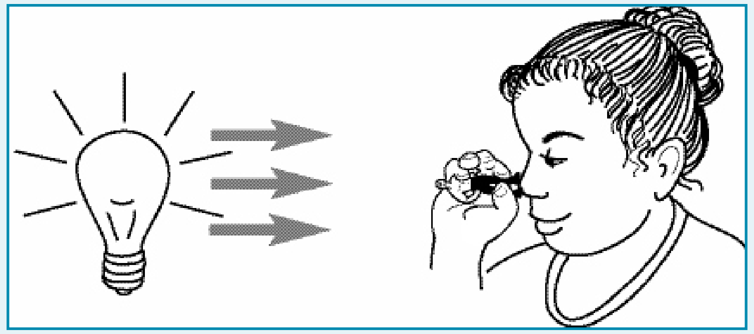
Light from the Sun shining on the spinning Earth causes day and night.

The Sun, Earth and Moon form a system.

TEACHER CONSIDERATIONS

PROVIDING MORE EXPERIENCE

A tiny figure standing on the summit of Mount Nose: To help students with spatial reasoning during the Mount Nose activity, one teacher gave each of her students a tiny plastic human figure. Each student held a tiny human figure in a standing position on the tip of his or her nose while doing the Mount Nose activity. This helped students understand where the Sun would be in the sky in relation to the person (for example, that the Sun would be overhead at noon). The teacher was careful to point out to students that the scale of the tiny plastic figure was even more inaccurate than the scale of Mount Nose itself.



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10. The Sun was stationary. Ask, "Why did the Sun look as though it were moving to the person on Mount Nose?" [Because the Earth was spinning.] Ask, "Did the Sun really move?" Emphasize that the Sun did not move. Scientists today use a model like the one they have just made to explain why the Sun seems to move in the sky.

How the Mount Nose Model Explains Night and Day

1. One spin is 24 hours. Keep students standing around the light bulb, and tell them that this model can also explain night and day. Ask if anyone knows how long it takes the real Earth to spin one time around. [24 hours.]

2. Where is it night? While they are facing the light, say, "Point to a part of your head where it is dark." [The back of the head.] Tell them that this is where it is night. Make sure that everyone notices that while it is daytime on Mount Nose, it is nighttime on the other side of the Earth.

3. Where is it day? Have them turn to the left until their backs are to the light, and say, "Point to the part of your head where it is daytime now." [The back of the head, because it is now facing the Sun.] "What time is it on Mount Nose?" [Midnight.]

4. Watch night and day on one student. Have the class watch as one student spins slowly, observing how the shadow darkens different parts of the head as it moves. Have everyone watch the student's Mount Nose and call out "day" and "night" as the student spins.

5. The stars seem to move when the Earth spins. Mention that at night, as the Earth spins, the stars seem to move across the sky, just as the Sun does during the day. Emphasize that the stars only *seem* to move. Turn on the classroom lights, turn off the light bulb, and have the class return to their seats.

TEACHER CONSIDERATIONS

SCIENCE NOTES

The Sun spins, too: Although the light bulb "Sun" in this model is completely stationary, the real Sun is not. The Sun spins, too. Galileo was able to observe sunspots move across the surface of the Sun, and figured out how fast the Sun spins by keeping track of how sunspots move. It takes 27 Earth days for the Sun to spin around one time at the Sun's equator. But because the Sun is not solid, but gas, the North and South poles of the Sun take longer to spin around. They take almost 35 Earth days.

QUESTIONNAIRE CONNECTION

The Mount Nose activity relates to most of the questions on the *Pre–Unit 3 Questionnaire*. You might want to revisit several questions (#1, #2, and #4 especially, and perhaps #5) either now, or after Session 3.3.

TEACHING NOTES

More on Shadows: Many students think of a shadow as the "Peter Pan" shadow that is cast onto other surfaces by an object that is blocking the light. They may have difficulty understanding that night on Earth is caused by the Earth's own shadow on itself. In Unit 4, Session 4.1, a *Shadow Play* activity addresses common student misconceptions about the Earth's shadow.

It's Following Us: A teacher told us that a few of her students remained convinced that the Sun is moving "because it follows us when we are in the car." This is an interesting ***optical illusion*** that is also experienced for the Moon. If some of your students suggest this, and you have not done Unit 1 of this sequence (on scale, including distance, size, and apparent size), you might want to consider presenting sessions from it.

What One Teacher Said

"The Mount Nose experiment was the highlight of the unit. In addition, the discussion about explaining to someone who thinks the Sun goes around the Earth was very effective. It helped clear any misconceptions my students had."

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Revolve

6. **Post key concepts.** Read and review each of the following key concepts as you add them to the concept wall:

The Earth spins.
The spinning of the Earth makes it look as though the Sun and stars are moving.
It takes the Earth 24 hours to spin once.
The Earth spinning in sunlight causes day and night.

Evidence Circles: Explaining the Scientific Model

1. **A dialogue with a person from ancient times.** Ask the class to pretend that they could go back in time 3,000 years and talk to a person in ancient times. Pretend that the person says, "Each day, I see the Sun rise, go across the sky, and set. I think that this is because the Sun goes around the Earth every day."

2. **It's easy to see why ancient people might have thought this.** Acknowledge that it is understandable that someone would think that the Sun goes around the Earth, but that this is not the scientific model. We know now that the Sun does not go around the Earth.

3. **Evidence circles.** Say that they will be working in small teams called *evidence circles* to explain to the imaginary person from the past why the Sun seems to move the way it does. They will use their experience with the Mount Nose model to explain why the Sun seems to rise, move, and set each day.

4. **Divide the class into teams of about four students.** Put the students in groups of four, and have students in each team number off from one to four.

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TEACHER CONSIDERATIONS

ASSESSMENT OPPORTUNITY

Embedded Assessment: The main goal of the evidence circle discussion and writing assignment is to deepen students' understanding of the scientific model for Earth's movement, presented in the Mount Nose activity. (Students will gather more evidence about how the Earth moves in Sessions 3.3 and 3.4.)

As in other units of the *Space Science Sequence,* evidence circles are one way that students act as scientists. Students' written responses to the questions provide an opportunity to evaluate each individual students' ability to write a coherent and compelling argument based on evidence from key concepts presented in Sessions 3.1 and 3.2. An "understanding science concepts" rubric specifically created for this assessment is included on page 311. The assessment can also be scored using the rubrics on page 466.

EVIDENCE CIRCLES: HOW DOES THE EARTH MOVE?

Session 3.2 Student Sheet Name ____________
Evidence Circles: How Does the Earth Move?

A person 3,000 years ago might have said, "Each day, I see the Sun rise, go across the sky, and set. I think that this is because the Sun goes around the Earth every day."

Pretend that you can talk with a person from 3,000 years ago who thinks that the Sun goes around the Earth. Try to help the person understand the scientific model. Write the answers to the questions below.

1. Why does the Sun seem to move across the sky? ____________

2. What causes sunrise? ____________

3. What causes sunset? ____________

4. What causes night and day? ____________

OPTIONAL PROMPT FOR WRITING

You may want to have students use the prompt below in their science journals at the end of this session or as homework:
Pretend that you are looking down from the ceiling on the Mount Nose model. Draw the model, including one person's head, the light bulb, and a person standing on Mount Nose. Draw the model showing one of these times for the person on Mount Nose: sunset, sunrise, or midnight.

5. **Procedure for discussion and writing.** Pass out the *Evidence Circles: How Does the Earth Move?* student sheet to each student. Explain the procedure for evidence circles:

a. **The first student in an evidence circle reads and answers question #1.** Student #1 will read the first question and try to answer it out loud, as if they were talking to someone who doesn't understand how the Earth moves.

b. **Each person has a turn to speak.** Next, everyone in their team will have a turn to add anything helpful. The team should discuss all the evidence and arguments they can think of to help the person from 3,000 years ago understand how the Earth moves.

c. **Everyone writes.** After everyone in an evidence circle has had a chance to talk, each person will write down on the student sheet their best explanation for question #1.

d. **Same procedure for the other three questions.** Explain that students #2, 3, and 4 will each read their questions, the team will discuss them the same way, and everyone will write down their best explanations.

6. **Use the evidence from the Mount Nose model.** Tell students to use their experience with the Mount Nose model as they try to help the person from ancient times understand why the Sun seems to move. Mention that they can also refer to the key concepts (on the concept wall) about how the Earth moves. Have them begin.

7. **Circulate during discussions.** As students work, circulate to teams and make sure that everyone has a turn to speak. Remind students to think about the Mount Nose model as they put their explanations into words.

8. **Class discussion.** When students have finished, ask one or two volunteers to read aloud their responses to question #1, and ask if others have anything to add. Do this for each statement. If students seem to have trouble addressing any of the questions, spend a little time discussing them as a class.

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TEACHER CONSIDERATIONS

RUBRIC FOR EMBEDDED ASSESSMENT:

Evidence Circles: How Does the Earth Move?
Student progress and understanding can be assessed with the specific *Understanding Science Concepts* rubric below or with the general rubrics provided on page 466.

Understanding Science Concepts The key science concepts for this assessment are the following: 1. The Earth spins (rotates). 2. The spinning of the Earth causes the apparent daily movement of the Sun. 3. Light from the Sun shining on the spinning Earth causes day and night.	
4	The student demonstrates a complete understanding of all of the key science concepts and uses scientific evidence to support the written explanation. The student needs to mention that the spinning of the Earth causes the apparent movement of the Sun across the sky each day, sunrise, sunset, or day and night. Evidence from the Mount Nose activity should be used to support their argument.
3	The student demonstrates a partial understanding of the key science concepts. Although understanding is demonstrated, the student does not tie all of these concepts together in the explanation and does not support the explanation with evidence from the Mount Nose class activity. The "evidence" may be more generally experiential or rely on statements of presumed fact, rather than being drawn directly from classroom science experiences.
2	The student demonstrates an insufficient understanding of the science concepts. The student demonstrates an understanding of one of the key concepts, but does not demonstrate an understanding of all of the concepts and does not use evidence from class to support the explanation.
1	The information is inaccurate. Some possible inaccuracies are a. The Sun appears to move across the sky, rise, set, or day and night occur because the Sun orbits around the Earth. b. The Sun appears to move across the sky, rise, set, or day and night occur because Earth orbits around the Sun. c. The Sun appears to move across the sky, rise, set, or day and night occur because the sky is a round dome and the Sun is on the other side of the Earth at night. d. The Sun appears to move across the sky, rise, set, or day and night occur because the Sun is driven across the sky by the Sun god in his chariot.
0	The response is irrelevant or off topic.
n/a	The student has no opportunity to respond and has left the question blank.

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System
Rotate
Revolve

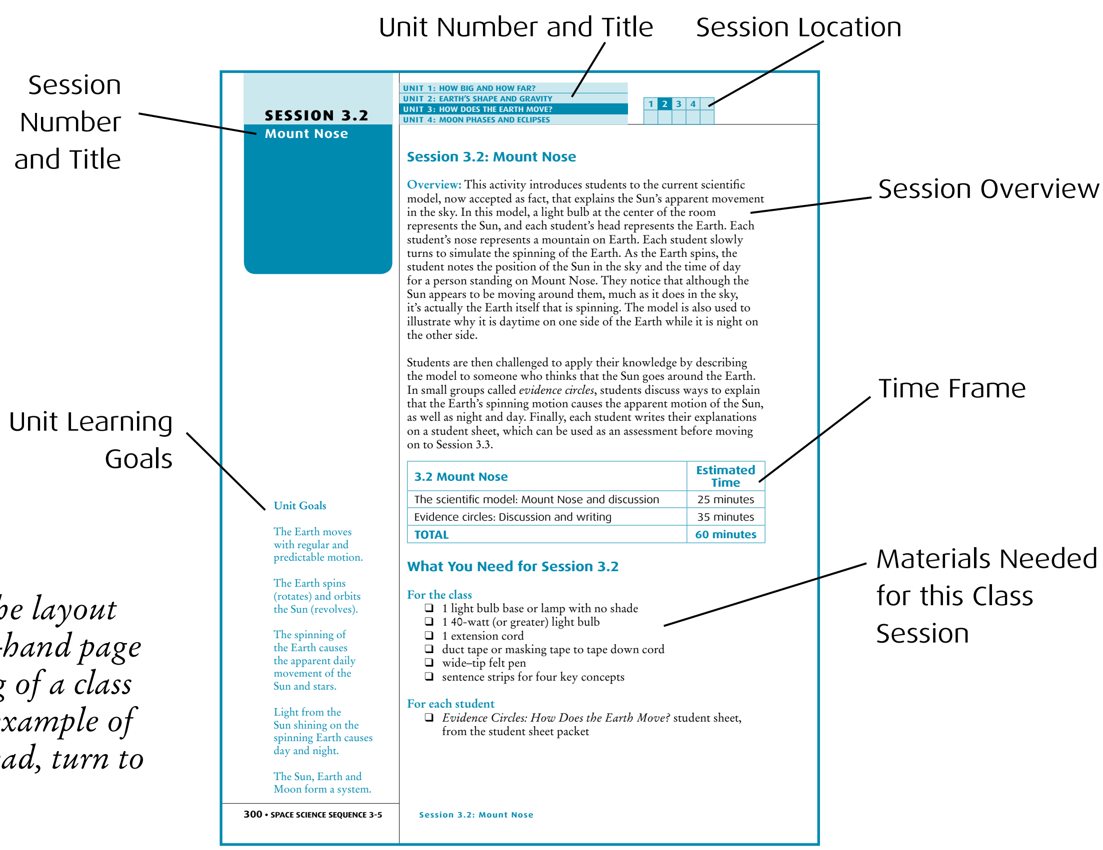
How to Navigate This Teacher's Guide

There are three main sections in this Teacher's Guide:

Introductory Section. This section gives the overall picture: What are the key features of this sequence? What do students learn in each unit? What is the assessment system? How do the key concepts presented relate to national and state standards?

Background and Resources Sections. In the back of the guide is a background section with more in-depth science and pedagogical information for the teacher, resources, and scoring guides for the pre and post unit questionnaires. In a separate packet are black-line masters for all overhead transparencies and student sheets, arranged by unit.

The Main Body of the Teacher's Guide—Guiding Students through the Four Units in the Sequence. The main body of the Teacher's Guide contains a separate section for each of the four units. These four sections have an innovative page layout, designed to be practical for teachers to refer to as they teach, while offering more information than a typical teacher's guide. When you open the binder to this section, you will see a two-page spread with *a different focus for the left-hand and right-hand pages.* The left pages contain the step-by-step *presentation guide* for teaching the activities. The right pages provide additional *teacher considerations* for the session. Teacher considerations include short summaries of relevant background, presentation options, assessments, and ideas for providing additional experiences for students to deepen learning and/or help students who are having difficulty.



Shown here is the layout of a typical left–hand page at the beginning of a class session. For an example of a two–page spread, turn to pages 6 and 7.