National Aeronautics and Space Administration

Teaching How Scientists Use Models with *What Makes Up Most of the Solar System?*

strategy guide

Common Core State Standards for English Language Arts Literacy in Science & Technical Subjects, Grades 6–8

KEY IDEAS AND DETAILS

RST.6–8.2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

INTEGRATION OF KNOWLEDGE AND IDEAS

RST.6–8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

RANGE OF READING AND LEVEL OF TEXT COMPLEXITY

RST.6–8.10. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.

Using Models

About this strategy. Developing, evaluating, and using models is a fundamental practice in science. Scientists use models to investigate objects or processes that happen too slowly, too quickly, or on too small of a scale to observe directly. They also use models to explore phenomena that are too vast, too complex, or too dangerous to study firsthand. Scientists use different types of models depending on the question they are investigating. For example, a physical model represents a smaller version of something that may be too large to manipulate (e.g., a globe is a model of Earth). Two-dimensional drawings or diagrams can represent a process or an object (e.g., a diagram of the Solar System). Finally, computer models, such as animations, can be used to make predictions about future events. The article *What Makes Up Most of the Solar System?* includes two diagrams that model the relative scale and emptiness of the Solar System.

What Makes Up Most of the Solar System?

About the article. *What Makes Up Most of the Solar System?* introduces students to the idea that most of the Solar System is made up of empty space. Building on students' prior knowledge about planets, moons, comets, and other objects, this article presents data about the relative size and distance of objects in the Solar System. The article also presents the surprising idea that if all these objects were combined, the total size still would be smaller than the Sun.

Flesch-Kincaid Grade Level Readability: 7.9; Lexile Framework for Reading: 930

Getting Ready

- ★ Make one copy of the Summarizing How Scientists Use Models copymaster for each student. Have examples of physical models of the Solar System on hand (optional).
- ★ Make one copy of the article *What Makes Up Most of the Solar System?* for each student.
- ★ Preview the URLs referenced in the teaching instructions.

Educational Product
Educators & Students | Grades 6–8

Disciplinary Literacy in Science

Literacy is an integral part of science. Practicing scientists use reading, writing, and oral communication to explain their findings, conduct research, connect to the work of other scientists, and communicate ideas to a variety of audiences. Situating literacy instruction in a content area, such as science, has several benefits. First, it helps students develop ways of thinking that are characteristic to the discipline. By building background knowledge, science also helps students access high-level content in text that often can be difficult to grasp. Finally, science provides an authentic reason for reading—to better understand the science ideas under study. Reading, like science, can be an act of inquiry when there are genuine questions to be investigated.

AAAS Benchmarks for Scientific Literacy

★ **11B/E4** Models are very useful for communicating ideas about objects, events, and processes. When using a model to communicate about something, it is important to keep in mind how it is different from the thing being modeled.

★ **11B/M3** Different models can be used to represent the same thing. What model to use depends on its purpose.

★ **11D/M2** As the complexity of any system increases, gaining an understanding of it depends increasingly on summaries, such as averages and ranges, and on descriptions of typical examples of that system.

★ **11D/M3** Natural phenomena often involve sizes, durations, and speeds that are extremely small or extremely large. These phenomena may be difficult to appreciate because they involve magnitudes far outside human experience.

★ **12D/M4** Understand oral, written, or visual presentations that incorporate circle charts, bar and line graphs, two-way data tables, diagrams, and symbols.

Teaching About Using Models with *What Makes Up Most of the Solar System?*

Activate and Build Background Knowledge

1. On the board, write the following guiding question: **"What makes up most of the Solar System?"**
2. Pose the guiding question and invite students to turn to a neighbor to talk about their ideas. Invite students to share with the class what they discussed with their partners.
3. Project and show the video: http://www.nasa.gov/mov/196757main_047_The_Planets.mov. Prompt students to share any new information they gathered from the video.

Set Purpose for Reading

1. Introduce the article *What Makes Up Most of the Solar System*? and tell students that it provides details about an idea they may not have thought of—the empty space in the Solar System.
2. Distribute the article and prompt students to read only the first two sentences.
3. Using a document camera, project a copy of the article and highlight or underline the following sentence: *Actually, the Solar System is mostly empty space.*
4. Model thinking aloud about this idea. For instance, you might point out that most people probably don't think about the empty space in the Solar System.
5. Read another few sentences aloud and annotate the projected copy of the article by writing a few notes in the margins. Explain that recording your thinking while reading can improve understanding.
6. Prompt students to examine the diagram on the first page and compare it to the text in the first paragraph.
7. Invite students to read the rest of the article and make notes in the margins about any questions or connections they have.

Integrate Text and Experience

1. After students finish reading, project the visualization The Scale of the Universe 2 found at http://htwins.net/scale2/.
2. Start the visualization and use the scroll bar to zoom out (to the right) until you reach the Sun and the Solar System. Discuss the relative sizes of different objects in the Universe.

Teaching About Using Models with *What Makes Up Most of the Solar System?* (continued)

3. Explain that scientists often use several different kinds of models to understand a single phenomenon, especially when the objects they study are too big or too far away to observe directly. Different types of models include physical models, two-dimensional models, or computer models.
4. Revisit the article to examine the diagram on the second page. Read the caption aloud and discuss what the diagram shows. Compare the diagram to The Scale of the Universe 2 visualization.
5. Conduct a physical modeling activity with students to explore the relative size or distance of objects in the Solar System. For examples of scale and size models, see http://solarsystem.nasa.gov/docs/modelingsolarsystem_20070112.pdf.

Apply New Ideas

1. Return to the guiding question **What makes up most of the Solar System?**
2. After reading about, visualizing, and demonstrating just how much empty space is in the Solar System, distribute the Summarizing How Scientists Use Models copymaster, while also projecting a blank copy.
3. In the appropriate box, write the main idea "Scientists use different types of models to show what makes up the Solar System." Instruct students to do the same on their copies. Then, instruct students to write supporting details from the diagrams, the visualization, and the physical model in the Supporting details boxes.
4. See below for additional and updated NASA resources.

Additional Support for Students with Dyslexia

- ★ **Modify reading materials.** The student articles and copymasters are available in the Dyslexie font, a typeface developed to help individuals with dyslexia read more fluently. For more information, see http://www.studiostudio.nl/.
- ★ **Provide explicit instruction.** This text contains several complex sentences and large numerical values that may tax the short-term memory of students with dyslexia. Work with students to identify the most important details and transfer these into note form to include in their written summaries.
- ★ **Make concrete connections.** Compare the scale of the Solar System to a common analogue of a football field: http://www.nasa.gov/audience/foreducators/5-8/features/F_Solar_System_Scale.html.
- ★ **Provide more experience.** Provide directions for how to create a bead-and-string size and scale model of the Solar System, which can be found at http://www.jpl.nasa.gov/education/index.cfm?page=100.
- ★ **Allow independent exploration.** Set up a computer with Internet access and provide time for students to virtually navigate the Solar System, using this online app: http://eyes.nasa.gov/index.html.

NASA Resources

Image Scale Math Educator Guide: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Image_Scale_Math.html

Cosmic Distance Scale Visualizations: http://heasarc.gsfc.nasa.gov/docs/cosmic/

Our Solar System Resource Page: http://solarsystem.nasa.gov/planets/profile.cfm?Object=SolarSys

What's Up in Our Solar System Podcast: http://www.nasa.gov/multimedia/podcasting/whatsup2012August.html

Name _____ Date _____

Summarizing How Scientists Use Models

Title of article: _____

Main idea:	
Supporting detail:	**Supporting detail:**
Supporting detail:	**Supporting detail:**

Using your notes above, write a summary paragraph that begins with the main idea and includes supporting details.

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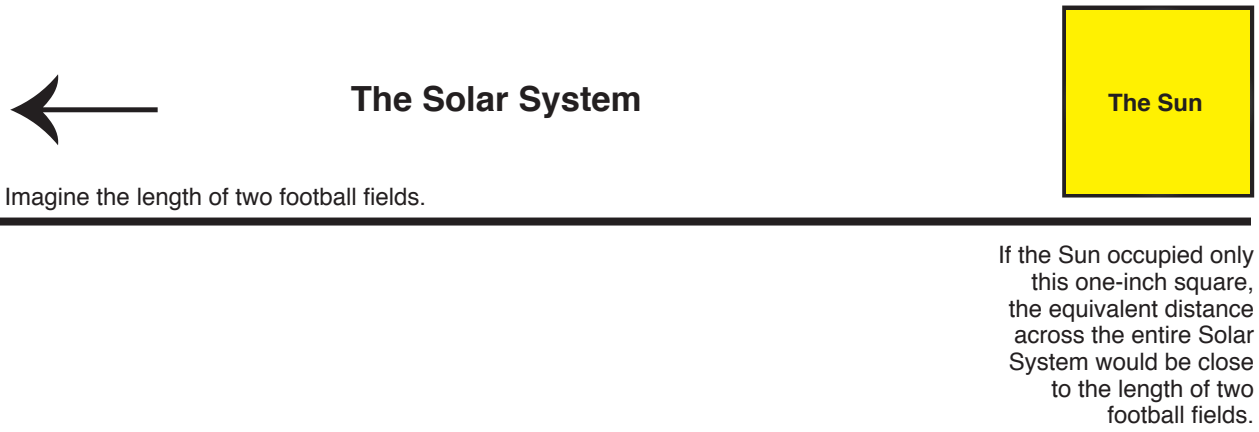
What Makes Up Most of the Solar System?

When people think of the Solar System, they think of the Sun, planets, moons, comets, and other objects. Actually, the Solar System is mostly empty space. The biggest object in the Solar System is the Sun. The diameter of the Sun is 1,400,000 (1.4 million) kilometers. In comparison, about 58,000,000 (58 million) kilometers of empty space separate the Sun from its closest planet, Mercury. The whole Solar System takes up a vast area of space; it's about 9,000,000,000 (9 billion) kilometers in diameter. That's over 6,000 times wider than the Sun! This evidence shows that even the Sun is tiny compared to the empty space in the Solar System.

This diagram shows the relative size of the Sun compared to the entire Solar System.



All the other objects in the Solar System fill up even less of this empty space. Imagine gathering all eight planets (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune) and all their moons, plus all the asteroids, comets, and other objects in the Solar System. All together they would add up to an object smaller than the Sun. Compared to all the empty space in the Solar System, the objects in it are very small. Empty space makes up most of the Solar System.

In the diagram below (drawn to scale), the Sun holds the seven largest planets. Mars is almost too small to see. Mercury and Earth's Moon are even smaller than Mars. While there are many, many objects in the Solar System, all together they are smaller than the Sun.