Exploring Origins

The Origins of the Solar System

TEACHER GUIDE

BACKGROUND INFORMATION

In this activity, students will become familiar with current scientific thought on the origins of the solar system and the path that scientists have followed to come to that current understanding. Students will then develop research questions that they will investigate in order to advance scientific knowledge in this field.

The Student Text *Theories in the Making* explains the unique features of the scientific way of thinking. Hypotheses are working models of explanations of natural phenomena. As they become generally accepted, these explanations are called theories. Theories cannot be proven, as a fact can. It is important to the functioning of science that a theory can be disproved. Cultural- and belief-based explanations, such as those presented in the stories in *Exploring Stories of Origins,* are recognized as useful and relevant in personal and social realms. However, without the skeptical approach of the scientist and without the possibility of being disproved by a single negative instance, these stories are not theories. Other types of folk stories, such as ones relating animal behavior to future weather, are theories, as they can be tested and the possibility of disproving them exists.

As stated in the 9-12 Content Standards for the History and Nature of Science:

> Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public. Explanations on how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific.

STANDARDS ADDRESSED

Grades K-4

Science
History and Nature of Science
Science as a Human Endeavor
Language Arts
Writing Standards
Speaking and Listening Standards
Technology
Life Skills Standards
Thinking and Reasoning
Working With Others

Grades 5-8

Science-
Earth and Space Science
Earth in the Solar System

History and Nature of Science
- Science as a Human Endeavor
- Nature of Science and Scientific Knowledge
- History of Science/ Historical Perspectives

Language Arts
Writing Standards
Speaking and Listening Standards
Technology

Life Skills Standards
Thinking and Reasoning
Working With Others

Grades 9-12

Science
Earth and Space Science
- The Origin and Evolution of the Earth System
- The Origin and Evolution of the Solar System

History and Nature of Science
- Science as a Human Endeavor
- Nature of Science and Scientific Knowledge
- History of Science/ Historical Perspectives

Language Arts
Writing Standards
Speaking and Listening Standards
Technology

Life Skills Standards
Thinking and Reasoning
Working with Others

MATERIALS

Videos on Solar System Origin
For each student:
- Completed Student Activity Sheets from *Exploring Stories of Origins*
- Student Text
  - The Origins of the Solar System
  - Theories in the Making
- One sheet of newsprint
- Marker

PROCEDURE

1. Remind the class about the commonalties and differences they discovered in the cultural solar system origin stories. Tell them that scientists from many of these cultures have addressed the question of the origin of the solar system from a scientific perspective and that the class is now going to explore those ideas.

2. Show a video segment that outlines the scientific theory on the origin of the solar system. Widely available video resources include Carl Sagan's *Cosmos* series, PBS's *Mysteries of Deep Space,* and The Learning Channel's *Solar Empire*.

3. Hand out the Student Text *The Origins of the Solar System* for the students to read about the historical development of the scientific theory of the origin of the solar system. Comment on similarities and differences between information in the student texts and in the video.

4. Ask students to return to the groups in which they had been previously worked. Provide a large, blank classroom timeline to which student groups can add information. Assign groups to search the Internet and other library resources for basic information about the persons named in the video and student text. This timeline can be added to throughout this unit, as more information becomes available.

5. Ask the students to fill out the blank row on their Analysis Criteria question charts for the scientific theory. Ask them to consider in their groups if different analysis criteria questions need to be added for this explanation. Remind them that scientists are observing and explaining the same world that the storytellers charted previously.

6. In a whole-class discussion, compare and contrast the different aspects of the cultural stories and of the scientific theory. Ask the students to consider what characteristics of scientific thought make a theoretical explanation different than the other stories they studied. Such characteristics include:

   - The necessity of experimental or observational evidence to support claims.
   - The utility of the theory for making accurate predictions.
   - The opportunity for revision over time based on new evidence.
   - The collaborative nature of the processes of science.
   - The need for testable hypotheses.
   - The way that new scientific knowledge is built upon old ideas.

   Look at these aspects of the nature of scientific thought from the perspective of the history of scientific understanding about the origin of the solar system. Point out on the classroom timeline where each of these aspects is exemplified.

   Ask students to read the Student Text *Theories in the Making*, and discuss as a class the types of thinking that forms the foundation for the development of scientific theories.

From Another Angle

Stay in context with the module while utilizing writing skills and multiple learning strategies by using any of the following procedures in addition to the approach taken in step #6.

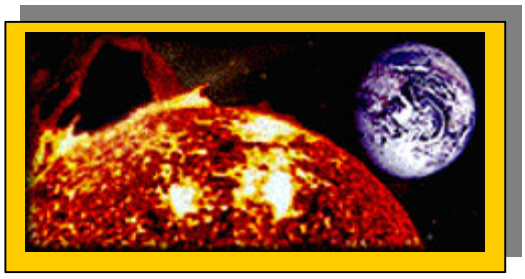
Develop students' technical writing skills:
Write a short essay comparing and contrasting the purposes and foundation of mythology and science in explaining the origin of the solar system. A helpful reference might be "Origin Myths" by Robert Carneiro (American Museum of Natural History).

Use multiple intelligences:
1. Compare how two different art forms express the dynamic nature of the creation of the solar system.
2. When should an explanation be considered a theory? Are cultural stories such as those that tell how animal behavior predicts weather theories? Why or why not?

7. Have the students write three research questions that could be addressed scientifically. One example might be "What is the origin of the solar system? Students could then gather some type of data that would further the understanding of the origins of the solar system. After they develop the individual questions, have them share their questions with a partner and decide which two questions they would most like to address. Have each student write a question on a large sheet of newsprint and post all of the questions on the walls of the room.

8. *Share the following with your class:*

   NASA is also trying to find out more information about the formation of the solar system. The specific question they are asking is: 'What is the chemical composition of the solar wind (particles being blown out from the outer layers of the sun)?' Scientists believe that the chemical composition of the solar wind is the same as the chemical composition of the gas cloud that formed into the solar system. In order to collect this data, they are launching a mission named Genesis that will collect solar wind particles for analysis.



   Add this question to those posted around the room by the students. Add the launch date of the Genesis mission (January 2001) to the classroom timeline.

Teacher Resources

Middle School and Above:

Butler, S. T., & Raymond, R. (1975). *The family of the sun.* NY: Anchor Books.

Chisholm, J. (1993). *The first guide to the universe.* London: Usborne Publishing, Ltd.

Cowper, H., & Henbest, N. A. (1994). *Reader's Digest how the universe works.* Pleasantville, NY: The Reader's Digest Association, Inc.

Hansen, R., & Bell, R. A. (1985). *My first book of space.* NY: Simon and Schuster Books for Young Readers.

Mitton, J. (1991). *Discovering the planets.* No location: Troll Associates.

Roop, P., & Roop, C. (1988). *The solar system: Opposing viewpoints.* St. Paul, MN: Greenhaven Press, Inc.

High School and Above:

Hartmann, W. K. (1983). *Moons and planets.* Belmont, CA: Wadsworth Publishing Co.

Kaufmann, W. J., III. (1979). *Planets and moons.* San Francisco: W. H. Freeman and Co.

Sagan, C. (1980). *Cosmos.* New York: Random House.

Smoluchowski, R. (1983). *The solar system.* New York: Scientific American Books, Inc.

Taylor, S. R., (1992). *Solar system evolution: A new perspective*. NY: Cambridge University Press.

Videos

The following videos are available online through several retail outlets. They also may be found in your library's video section.

Cosmos, produced by the Public Broadcasting System.
This is narrated by Carl Sagan and is a multi-volume set based on Sagan's book, *Cosmos* (see above).

Mysteries of Deep Space, produced by the Public Broadcasting System.
This is a three-volume set and is three hours in length. The titles are: "To the Edge of the Universe," "Exploding Stars and Black Holes," and "The Search for Alien Worlds."

Solar Empire, produced by The Learning Channel.
This is a three-volume set and is 300 minutes long. It is narrated by Star Trek's Michael Dorn and contains brilliant photos from the Hubble space telescope.