SCIENCE GIANTS
EARTH & SPACE

25 Activites Exploring the World's Greatest Scientific Discoveries

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GOOD YEAR BOOKS

Dedication

To the giants upon whose shoulders I have stood,
in memory of Mary and Tye and Freema, and to Milton,
who continues to inspire and guide me.

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GOOD YEAR BOOKS

Contents

Introduction for Teachers

Some ideas people believed in the past appear foolish to us. Other ideas seem to be inevitable but erroneous conclusions reached using limited resources and information. One may assume with reasonable certainty that some of today's prevailing knowledge will be overturned by new discoveries in the future. Science can describe reality to the limit of our tools and our ability to conceptualize that which we cannot measure or observe. New ideas constantly challenge old assumptions. Revolutions occur when an idea is discarded in favor of a better one.

The Structure of This Book

Science Giants: Earth and Space arranges important scientific discoveries in major disciplines into a historical context. Activities and simulations provide hands-on experiences for students using readily available classroom supplies. Activities are followed by student reading pages summarizing the history of scientific discovery and explaining the theories.

The book is divided into chapters based on major areas of science inquiry. Each chapter contains teacher instructions for active student investigations paired with student reading pages. You can use chapters individually, or you can follow the sequence of the book to provide an overview of the history of earth and space science.

Activities are designed for teams of students and follow a simple format—a list of materials needed per team (mostly common, inexpensive items), followed by instructions and teacher background information. Teamwork among students provides valuable rewards in the classroom. Working in teams:

- encourages dialogue among students, creating better thinking and more discovery.
- improves communication skills.
- increases motivation.
- promotes peer teaching and learning.
- builds social competency.

After doing an activity, hand out the student reading pages to enhance students' knowledge of the history behind each discovery. Student reading pages include vocabulary words, which are shown in bold type and defined at the end of each reading, and offer suggestions for further study. Time lines at the beginning of each chapter provide reference points and springboards for studying biography, an important and interesting aspect of the history of science. There's a bibliography for teachers at the end of the book.

The book focuses on ideas rather than personalities. Some famous legends are covered because scientific and historical literacy would be incomplete without them. The circumstances of discovery often illustrate the truth of Louis Pasteur's observation, ". . . chance favors the prepared mind." Using *Science Giants* should help prepare the minds of students for future discoveries.

Gender Equity

Why is there a predominance of men in the history of science? Margaret Cavendish appeared before the prestigious Royal Society in 1667; the first women were admitted as members in 1945. Examples of women scientists are necessary and important for students—and so is a discussion about why such a high percentage of great scientists mentioned in the history books are men.

As you and your students follow modern scientific developments in newspapers, magazines, and other media, note how both women and men contribute to the advances in all fields. Make it an assumption in your class: scientists come in all genders and colors and from all countries—in short, every variety of human being. Resources abound to help you if you choose to devote a section of study exclusively to women's contributions to science.

Generating Enthusiasm

Start each section with students' questions and ideas. What do they know? What do they want to know? Then go on and survey the history of each field you choose. The activities will emphasize science process skills and most will need little introduction—get the kids started and stay out of the way. Through the experimenting, students will be controlling variables, making predictions, recording and interpreting data, drawing conclusions, and *doing* science.

Connecting the main ideas in a historical and social context should enrich their overall understanding and make them eager to discover where science is heading today. Studying today's news should be a major goal for all of us who teach and especially those who teach science—helping students become scientifically literate and able to understand current issues and ideas.

As Isaac Newton once said, "If I have seen further, it is by standing on the shoulders of giants." A goal of writing and using this book is to excite the scientists of tomorrow about all there is to know now and all there is for them to discover in the future. There's a lot you can see from the shoulders of giants.

Introduction for Students

Science as Historical Process

What do we know and how do we know it? These two questions can lead you on a very rewarding journey. Thanks to thousands or even more years of questioning, observing, and experimenting, we know a mind-boggling amount about the world and universe around us. The average ten-year-old school child knows more science than anyone knew just a few hundred years ago. How did all that knowledge get here?

Isaac Newton (1642–1727) was born in the same year in which another famous scientist, Galileo Galilei (1564–1642), died. Responding to a question about how he could know so much, Newton is reported to have said, "If I have seen further, it is by standing on the shoulders of giants." Galileo was a giant pair of shoulders for Newton, and Newton grew giant shoulders for others. Every generation starts from the current knowledge and builds further.

Look outside your classroom window. The sun comes up on one side of the building, rises and travels across the sky, then heads down to set on another side. Throughout the year, the sun's path changes as it appears lower in the winter and higher in the summer. Doesn't it seem reasonable to describe the sun as traveling around the Earth?

In fact, not so long ago, most people thought the Earth was the center of the universe. Other ideas that have changed include the following:

- Scientists believe the Earth was formed about five billion years ago. In 1650, Bishop Ussher set the date at 4004 B.C.
- Things burn when they combine with *oxygen*, not because they contain a substance called *phlogiston*.
- Matter consists of tiny atoms that are themselves made of smaller substances. Earlier people believed all matter was made from four elements: earth, fire, water, and air.
- Plants make their own food mostly out of the carbon in the air, not from the soil or water.

Who knows what ideas of today will be changed in the future? Enjoy these activities and ideas that teach about how science has grown and changed, and maybe you will see something new on the shoulders of giants.

CHAPTER 1

The Universe

TIME LINE

Year	Notable Event
8000 B.C.	Central American civilizations built structures aligned with celestial objects.
4000 B.C.	Egyptians devised a calendar based on the sun and stars. Over time, they built pyramids aligned with sky objects.
2800 B.C.	Stonehenge was built in England.
2296 B.C.	Chinese observers tracked a comet.
A.D. 150	Claudius Ptolemy wrote an astronomy book that was accepted as a text for hundreds of years. The Earth was considered to be the center of the universe.
1543	Nicolaus Copernicus published his theory that the Earth and other planets orbit the sun.
1577	Tycho Brahe determined that a comet was farther from Earth than the moon.
1609	Galileo Galilei built a telescope and the next year published *The Starry Messenger,* which described his discoveries with his telescope.
1618	Johannes Kepler published his theories, one of which stated that planets travel in elliptical orbits.
1656	Christiaan Huygens observed the rings of Saturn.
1682	Edmond Halley observed a comet and predicted its return.
1687	Isaac Newton published the *Principia* containing theories of gravity and orbital motion.
1781	William Herschel observed Uranus.
1846	Johan Galle observed Neptune using calculations from Urbain Leverrier and John Couch Adams.
1912	Henrietta Leavitt studied Cepheid variable stars and devised a way to measure their distance from Earth.
1927	Georges Lemaitre theorized that the universe began with a large explosion, now popularly called the "Big Bang."
1929	Edwin Hubble confirmed that the universe is expanding.
1930	Clyde Tombaugh discovered Pluto.
1969	Neil Armstrong and Buzz Aldrin landed on the moon.

Materials per Team

- round balloons
- soft-tipped markers

The Big Bang

An Expanding Universe

This activity has two parts. The first illustrates the movement of matter away from the site of the so-called Big Bang, a primeval occurrence scientists theorize may have formed the universe. The second simulates how wavelength changes as objects move in relation to each other.

Activity 1

To illustrate the concept of an expanding universe, use balloons to simulate movement in all directions from a central beginning point. Have students make small dots on the surface of uninflated balloons. As they blow air into the balloons, ask them to observe how the dots move away from each other and from the center of the balloon. The dots may represent stars or galaxies of stars.