NIAC Caves of Mars Project
Related Education Standards

From National Science Education Standards,
Benchmarks for Science Literacy,
National Geography Standards
and
NASA Space Science Curriculum Standards "Quilt"
(Education Standards Matrix from NASA JPL)

for NASA Institute for Advanced Concepts (NIAC) Research Grant
Extraterrestrial Caves: Science, Habitat, and Resources
Caves of Mars Project

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Space Data Resources & Information

From National Science Education Standards and NASA Space Science Curriculum Standards "Quilt"

Life Sciences

Life Is –

Origins, Organisms, Detection:

-- Organisms cause changes in the environment where they live. (K-4)

-- Organisms require a constant input of energy to maintain chemical and physical organizations. (9-12)

Life Needs –

Energy, Environment, Nutrition:

-- Organisms have basic needs (air, water, food, light, plants). (K-4)

-- Organisms die if needs are not met. (K-4)

-- All animals depend on plants. (K-4)

-- All organisms must be able to obtain and use resources. (5-8)

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Life Grouping –

Structure, Function, Diversity:

-- Different environments support life of different types of organisms (K-4)

-- Functions sustain life such as growth, nutrition and repair. (5-8)

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Geology

Planetary Objects –

Composition and Structure:

-- Planetary materials are solid rock, soil and ice (K-4)

-- Solid materials have different physical and chemical properties (K-4)

-- Soils have color and texture (K-4)

-- Planetary objects have layers (5-8)

-- Landforms result from constructive and destructive forces (5-8)

-- Solid material is changed and recycled by compacting, heating and recrystalizing (5-8)

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Atmospheres

the Sky –

Atmospheric Processes:

-- Atmospheres are mixtures of gases and vapor (5-8)

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Communication (Inside Caves)

Energy –

Forms, Nature, Properties:

-- Waves can transfer energy such as sound, seismic and light (9-12)

-- Electromagnetic waves result when a charged object is accelerated. Examples are radio waves, microwaves, infrared, ultraviolet, visible (9-12)

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Other Relevant Standards
From National Science Education Standards

Science As Inquiry

-- Abilities necessary to do scientific inquiry

-- Understanding about scientific inquiry

Physical Science

-- Properties of objects and materials

-- Structure and properties of matter

-- Properties and changes of properties in matter

Earth and Space Science

-- Earth (and Mars) in the solar system

-- Structure of the Earth (and Mars) system

Science and Technology

-- Abilities of technological design

-- Understandings about science and technology

Science In Personal and Social Perspectives

-- Environmental quality

-- Natural and human-induced hazards

-- Science and technology in local, national and global challenges

-- Science and technology in society

History and Nature of Science

-- Science as a human endeavor

-- Nature of scientific knowledge

Unifying Concepts and Processes

-- Evidence, models and explanations

-- Form and function

Science Process Skills

-- Observing

-- Communication

-- Measuring

-- Collecting Data

-- Predicting

-- Making Graphics

-- Investigating

-- Interpreting Data

-- Inferring

-- Controlling Variables

-- Making Models

Mathematics Standards

-- Problem Solving

-- Communication

-- Reasoning

-- Measurement

-- Verifying and Interpreting Results

-- Graphs

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NIAC Caves of Mars Project
Related Standards

From Benchmarks for Science Literacy
(American Association for the Advancement of Science - AAAS)

Benchmarks Linked To -- Life Sciences

5. the Living Environment

A. Diversity of Life
(Life Sciences-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Plants and animals have features that help them live in different environments.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- All organisms, including the human species, are part of and depend on two main interconnected global food webs. One includes microscopic ocean plants, the animals that feed on them, and finally the animals that feed on those animals. the other web includes land plants, the animals that feed on them, and so forth. the cycles continue indefinitely because organisms decompose after death to return food material to the environment.

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5. the Living Environment

C. Cells
(Life Sciences-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Most living things need water, food, and air.

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Grades 3 - 5

By the end of the 5th grade, students should know that:

-- Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in.

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5. the Living Environment

D. Interdependence of Life
(Life Sciences-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Animals eat plants or other animals for food and may also use plants (or even other animals) for shelter and nesting.

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Grades 3 – 5

By the end of the 5th grade, students should know that:

-- for any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

-- Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.

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5. the Living Environment

E. Flow of Matter and Energy
(Life Sciences-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- the amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials.

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Benchmarks Linked To -- Geology

4. the Physical Setting

C. Processes That Shape the Earth
(Geology-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Chunks of rocks come in many sizes and shapes, from boulders to grains of sand and even smaller.

-- Change is something that happens to many things.

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Grades 3 - 5

By the end of the 5th grade, students should know that:

-- Rock is composed of different combinations of minerals. Smaller rocks come from the breakage and weathering of bedrock and larger rocks. Soil is made partly from weathered rock, partly from plant remains--and also contains many living organisms.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Sediments of sand and smaller particles (sometimes containing the remains of organisms) are gradually buried and are cemented together by dissolved minerals to form solid rock again.

-- Sedimentary rock buried deep enough may be reformed by pressure and heat, perhaps melting and recrystallizing into different kinds of rock. These re-formed rock layers may be forced up again to become land surface and even mountains. Subsequently, this new rock too will erode. Rock bears evidence of the minerals, temperatures, and forces that created it.

-- Thousands of layers of sedimentary rock confirm the long history of the changing surface of the Earth and the changing life forms whose remains are found in successive layers. the youngest layers are not always found on top, because of folding, breaking, and uplift of layers.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- the formation, weathering, sedimentation, and reformation of rock constitute a continuing "rock cycle" in which the total amount of material stays the same as its forms change.

-- the slow movement of material within the Earth results from heat flowing out from the deep interior and the action of gravitational forces on regions of different density.

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Benchmarks Linked To
-- Atmospheres

4. the Physical Setting

B. the Earth (Atmosphere-Related Benchmarks)

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Water can be a liquid or a solid and can go back and forth from one form to the other.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- the Earth is mostly rock. Three-fourths of its surface is covered by a relatively thin layer of water (some of it frozen), and the entire planet is surrounded by a relatively thin blanket of air. It is the only body in the solar system that appears able to support life. the other planets have compositions and conditions very different from the Earth's.

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Benchmarks Linked To
-- **Atmospheres**

4. the Physical Setting

C. Processes That Shape the Earth

Grade 3 - 5

By the end of the 5th grade, students should know that:

-- Waves, wind, water, and ice shape and reshape the Earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- the interior of the Earth is hot. Heat flow and movement of material within the Earth cause earthquakes and volcanic eruptions and create mountains and ocean basins.

-- Some changes in the Earth's surface are abrupt (such as earthquakes and volcanic eruptions) while other changes happen very slowly (such as uplift and wearing down of mountains). the Earth's surface is shaped in part by the motion of water and wind over very long times, which act to level mountain ranges.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Plants alter the Earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.

-- Earthquakes often occur along the boundaries between colliding plates, and molten rock from below creates pressure that is released by volcanic eruptions, helping to build up mountains.

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NIAC Caves of Mars Project-Related Benchmarks
-- General (In Addition To Atmospheres and Geology)

4. the Physical Setting

A. the Universe

Grades 3 - 5

By the end of the 5th grade, students should know that:

-- the Earth is one of several planets that orbit the Sun, and the Moon orbits around the earth.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Nine planets of very different size, composition, and surface features move around the Sun in nearly circular orbits. Some planets have a great variety of moons and even flat rings of rock and ice particles orbiting around them. Some of these planets and moons show evidence of geologic activity. the Earth is orbited by one moon, many artificial satellites and debris.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Increasingly sophisticated technology is used to learn about the universe. Visual, radio, and x-ray telescopes collect information from across the entire spectrum of electromagnetic waves; computers handle an avalanche of data and increasingly complicated computations to interpret them; space probes send back data and materials from the remote parts of the solar system.

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E. Energy Transformations

Grades K - 2

By the end of the 2nd grade, students should know that:

-- the Sun warms the land, air and water.

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Note:
The science Content Benchmarks in “The Physical Setting” (# 4) are listed above since they are more relevant to the NIAC Caves of Mars Project. Below, the other related Benchmarks are in numerical order.

1. the Nature of Science

A. the Scientific World View

Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.

B. Scientific Inquiry

Grades K - 2

By the end of the 2nd grade, students should know that:

-- People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.

-- Tools such as thermometers, magnifiers, rulers, or balances often give more information about things than can be obtained by just observing things without their help.

Grades 3 - 5

By the end of the 5th grade, students should know that:

-- Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. Investigations can focus on physical, biological and social questions.

-- Results of scientific investigations are seldom exactly the same, but if the differences are large, it is important to try to figure out why. One reason for following directions carefully and for keeping records of one's work is to provide information on what might have caused the differences.

-- Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think. Sometimes scientists have different explanations for the same set of observations. That usually leads to their making more observations to resolve the differences.

Grades 6 - 8

By the end of the 8th grade, students should know that:

-- New ideas in science sometimes spring from unexpected findings, and they usually lead to new investigations.

Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.

-- New ideas in science are limited by the context in which they are conceived; are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly, through contributions from many investigators.

C. THE Scientific Enterprise

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Everybody can do science and invent things and ideas.

-- In doing science, it is often helpful to work with a team and to share findings with others. All team members should reach their own individual conclusions, however, about what the findings mean.

Grades 3 - 5

By the end of the 5th grade, students should know that:

-- Science is an adventure that people everywhere can take part in, as they have for many centuries.

-- Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.

-- Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.

Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

-- Until recently, women and racial minorities, because of restrictions on their education and employment opportunities, were essentially left out of much of the formal work of the science

establishment; the remarkable few who overcame those obstacles were even then likely to have their work disregarded by the science establishment.

-- No matter who does science and mathematics or invents things, or when or where they do it, the knowledge and technology that result can eventually become available to everyone in the world.

-- Scientists are employed by colleges and universities, business and industry, hospitals, and many government agencies. Their places of work include offices, classrooms, laboratories, farms, factories, and natural field settings ranging from space to the ocean floor.

-- Computers have become invaluable in science because they speed up and extend people's ability to collect, store, compile, and analyze data, prepare research reports, and share data and ideas with investigators all over the world.

-- Accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Science disciplines differ from one another in what is studied, techniques used, and outcomes sought, but they share a common purpose and philosophy, and all are part of the same scientific enterprise.

-- Funding influences the direction of science by virtue of the decisions that are made on which research to support. Research funding comes from various federal government agencies, industry, and private foundations.

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2. the Nature of Mathematics

B. Mathematics, Science, and Technology

Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Mathematics and science as enterprises share many values and features: belief in order, ideals of honesty and openness, the importance of criticism by colleagues, and the essential role played by imagination.

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3. the Nature of Technology

A. Technology and Science

Grades K - 2

By the end of the 2nd grade, students should know that:

-- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure, and make things.

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Grades 3 - 5

By the end of the 5th grade, students should know that:

-- Technology enables scientists and others to observe things that are too small or too far away to be seen without them and to study the motion of objects that are moving very rapidly or are hardly moving at all.

-- Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.

-- Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds. the changes may be for survival needs such as food, shelter, and defense, for communication and transportation, or to gain knowledge and express ideas.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- Technological problems often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. the very availability of new technology itself often sparks scientific advances.

-- Technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs). In contrast, science affects society mainly by stimulating and satisfying people's curiosity and occasionally by enlarging or challenging their views of what the world is like.

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B. Design and Systems

Grades 3 - 5

By the end of the 5th grade, students should know that:

-- There is no perfect design. Designs that are best in one respect (safety or ease of use, for example) may be inferior in other ways (cost or appearance). Usually some features must be sacrificed to get others. How such trade-offs are received depends upon which features are emphasized and which are down-played.

-- Even a good design may fail. Sometimes steps can be taken ahead of time to reduce the likelihood of failure, but it cannot be entirely eliminated.

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Grades 6 - 8

By the end of the 8th grade, students should know that:

-- Design usually requires taking constraints into account. Some constraints, such as gravity or the properties of the materials to be used, are unavoidable. Other constraints, including economic, political, social, ethical, and aesthetic ones, limit choices.

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Grades 9 - 12

By the end of the 12th grade, students should know that:

-- To reduce the chance of system failure, performance testing is often conducted using small-scale models, computer simulations, analogous systems, or just the parts of the system thought to be least reliable.

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C. Issues In Technology

Grades 6 - 8

By the end of the 8th grade, students should know that:

-- the human ability to shape the future comes from a capacity for generating knowledge and developing new technologies--and for communicating ideas to others.

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12. Habits of Mind

C. Manipulation and Observation

Grades K - 2

By the end of the 2nd grade, students should be able to:

-- Make something out of paper, cardboard, wood, plastic, metal, or existing objects that can actually be used to perform a task.

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Grades 3 - 5

By the end of the 5th grade, students should be able to:

-- Choose appropriate common materials for making simple mechanical constructions and repairing things.

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Grades 6 - 8

By the end of the 8th grade, students should be able to:

-- Use computers to store and retrieve information in topical, alphabetical, numerical, and key-word files, and create simple files of their own devising.

-- Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, and temperature, and choose appropriate units for reporting various magnitudes.

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Grades 9 - 12

By the end of the 12th grade, students should be able to:

-- Use computers for producing tables and graphs and for making spreadsheet calculations.

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D. Communication Skills

Grades K - 2

By the end of the 2nd grade, students should be able to:

-- Describe and compare things in terms of number, shape, texture, size, weight, color, and motion.

-- Draw pictures that correctly portray at least some features of the thing being described.

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Grades 6 - 8

By the end of the 8th grade, students should be able to:

-- Read simple tables and graphs produced by others and describe in words what they show.

-- Locate information in reference books, back issues of newspapers and magazines, compact disks, and computer databases.

-- Find and describe locations on maps with rectangular and polar coordinates.

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Grades 9 - 12

By the end of the 12th grade, students should be able to:

-- Make and interpret scale drawings.

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E. Critical-Response Skills

Grades 3 - 5

By the end of the 5th grade, students should:

-- Buttress their statements with facts found in books, articles, and databases, and identify the sources used and expect others to do the same.

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Grades 6 - 8

By the end of the 8th grade, students should:

-- Be aware that there may be more than one good way to interpret a given set of findings.

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Geography Standards

From the National Geography Standards

Standard 1:
Use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

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Standard 7:
Understand the physical processes that shape the patterns of Earth's surface.

(For Caves of Mars -- the physical processes that shape the patterns of the surface of Mars.) Knowledge of these processes becomes a tool we can use to understand physical landscapes wherever we go.

Standard 17:
Apply geography to interpret the past. the geographic characteristics of Earth, its lands and peoples, can only be understood if we trace their evolution over time.

Standard 18:
Apply geography to interpret the present and plan for the future. Geographic concepts help us think clearly about alternative futures and make us wise decision-makers.

The National Geography Standards were developed by the National Council for Geographic Education (Indiana University of Pennsylvania) in conjunction with the American Geographical Society, the Association of American Geographers, and the National Geographic Society.