Utah Elementary Science Core Curriculum
Sixth Grade
Adopted by Utah State Board of Education
March 12, 2002

Introduction

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands–on, active experiences throughout the instruction of the science curriculum.

The Elementary Science Core describes what students should know and be able to do at the end of each of the K–6 grade levels. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science, the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

Organization of the Elementary Science Core

The Core is designed to help teachers organize and deliver instruction.

The Science Core Curriculum's organization:

- ✓ Each grade level begins with a brief course description.
- ✓ The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- ✓ The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.
- ✓ A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- ✓ An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- ✓ An INDICATOR is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

Eight Guidelines Were Used in Developing the Elementary Science Core

Reflects the Nature of Science: Science is a way of knowing, a process of gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students. Please see the Intended Learning Outcomes document for each grade level core.

As described in these ILOs, students will:

1. Use science process and thinking skills.
2. Manifest science interests and attitudes.
3. Understand important science concepts and principles.
4. Communicate effectively using science language and reasoning.
5. Demonstrate awareness of the social and historical aspects of science.
6. Understand the nature of science.

Coherent: The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

Developmentally Appropriate: The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to each grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom), because they repeated appropriate names and vocabulary (such as electron and neutron). The Core resists the temptation to tell about abstract concepts at inappropriate grade levels, but focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Good Teaching Practices: It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Elementary Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students' daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes. The vignettes listed on the "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science for each of the Core standards provide examples, based on actual practice, that demonstrate that excellent teaching of the Science Core is possible.

Comprehensive: The Elementary Science Core does not cover all topics that have traditionally been in the elementary science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Feasible: Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A Teacher Resource Book (TRB) is available for elementary grades and has sample lessons on each topic for each grade level. The TRB is a document that will grow as teachers add exemplary lessons aligned with the new Core. The middle grade levels have electronic textbooks available at the Utah State Office of Education's "Utah Science Home Page" at http://www.usoe.k12.ut.us/curr/science.

Useful and Relevant: This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

Encourages Good Assessment Practices: Student achievement of the standards and objectives in this Core are best assessed using a variety of assessment instruments. One's purpose should be clearly in mind as assessment is planned and implemented. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding of science.

The Most Important Goal

Elementary school reaches the greatest number of students for a longer period of time during the most formative years of the school experience. Effective elementary science instruction engages students actively in enjoyable learning experiences. Science instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or holding a toad. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science–related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of doing science.

Sixth Grade Science Core Curriculum

The theme for Sixth Grade Science is **Scale,** with **Relative Position** as an underlying concept. Sixth graders should begin to relate to the incredible size and distance of objects in the solar system, galaxy, and universe, as well as compare their world to the miniscule scale of microorganisms. Students will also understand how relative position affects such events as the appearance of the moon and the changing of the seasons. Students will experiment with heat, light, and sound, and begin to understand concepts of energy.

Students should begin to design and perform experiments and value inquiry as the fundamental scientific process. They should be encouraged to maintain an open and questioning mind as they plan and conduct experiments. They should be helped and encouraged to pose their own questions about objects, events, processes, and results. They should have the opportunity to plan and conduct their own experiments, and come to their own conclusions as they read, observe, compare, describe, infer, and draw conclusions. The results of their experiments need to be compared for reasonableness to multiple sources of information. It is important for students at this age to begin to formalize the processes of science and be able to identify the variables in a formal experiment.

Good science instruction requires hands–on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for all students to experience many things. Sixth graders should experience the excitement of locating the North Star and Little Dipper, and the wonders of gazing into the night sky. They should find the fascination of peering into the world of microorganisms, experimenting and watching them as they move and feed and reproduce. Students should come to enjoy science as a process of discovering the natural world.

Science Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing, and mathematics skills should be emphasized as integral to the instruction of science. Technology issues and the nature of science are significant components of this Core. Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.

This Core was designed using the American Association for the Advancement of Science's Project 2061: Benchmarks For Science Literacy and the National Academy of Science's National Science Education Standards as guides to determine appropriate content and skills.

The sixth grade Science Core has three online resources designed to help with classroom instruction; they include Teacher Resource Book –a set of lesson plans, assessment items and science information specific to sixth grade; Sci-ber Text –an electronic science textbook specific to the Utah Core; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the sixth grade Science Core. These resources are all available on the Utah Science Home Page at http://www.usoe.k12.ut.us/curr/science .

SAFETY PRECAUTIONS

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Proper handling and disposal of microorganisms is crucial for a safe classroom. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

Intended Learning Outcomes for Sixth Grade Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

By the end of sixth grade students will be able to:

1. **Use Science Process and Thinking Skills**
   a. Observe simple objects, patterns, and events, and report their observations.
   b. Sort and sequence data according to criteria given.
   c. Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
   d. Compare things, processes, and events.
   e. Use classification systems.
   f. Plan and conduct simple experiments.
   g. Formulate simple research questions.
   h. Predict results of investigations based on prior data.
   i. Use data to construct a reasonable conclusion.

2. **Manifest Scientific Attitudes and Interests**
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read and look at books and other materials about science.
   c. Pose science questions about objects, events, and processes.
   d. Maintain an open and questioning mind toward new ideas and alternative points of view.
   e. Seek and weigh evidence before drawing conclusions.
   f. Accept and use scientific evidence to help resolve ecological problems.

3. **Understand Science Concepts and Principles**
   a. Know and explain science information specified for the grade level.
   b. Distinguish between examples and non-examples of concepts that have been taught.
   c. Solve problems appropriate to grade level by applying science principles and procedures.

4. **Communicate Effectively Using Science Language and Reasoning**
   a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
   b. Describe or explain observations carefully and report with pictures, sentences, and models.
   c. Use scientific language in oral and written communication.
   d. Use reference sources to obtain information and cite the source.
   e. Use mathematical reasoning to communicate information.

5. **Demonstrate Awareness of Social and Historical Aspects of Science**
   a. Cite examples of how science affects life.
   b. Understand the cumulative nature of science knowledge.

6. **Understand the Nature of Science**
   a. Science is a way of knowing that is used by many people not just scientists.
   b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
   c. Science findings are based upon evidence.

Science Benchmark

The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the sun. Earth turns on an axis that is tilted relative to the plane of Earth's yearly orbit. The tilt causes sunlight to fall more intensely on different parts of the Earth during various parts of the year. The differences in heating of Earth's surface and length of daylight hours produce the seasons.

STANDARD I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.
b. Identify the pattern of change in the moon's appearance.
c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.
c. Model the movement and relative positions of Earth, the moon, and the sun.

STANDARD II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1: Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

a. Describe the yearly revolution (orbit) of Earth around the sun.
b. Explain that Earth's axis is tilted relative to its yearly orbit around the sun.
c. Investigate the relationship between the amount of heat absorbed and the angle to the light source.

Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

a. Compare Earth's position in relationship to the sun during each season.
b. Compare the hours of daylight and illustrate the angle that the sun's rays strikes the surface of Earth during summer, fall, winter, and spring in the Northern Hemisphere.
c. Use collected data to compare patterns relating to seasonal daylight changes.
d. Use a drawing and/or model to explain that changes in the angle at which light from the sun strikes Earth, and the length of daylight, determine seasonal differences in the amount of energy received.
e. Use a model to explain why the seasons are reversed in the Northern and Southern Hemispheres.

Science language students should use:	Earth's tilt, seasons, axis of rotation, orbits, phases of the moon, revolution, reflection

Science Benchmark

The solar system consists of planets, moons, and other smaller objects including asteroids and comets that orbit the sun. Planets in the solar system differ in terms of their distance from the sun, number of moons, size, composition, and ability to sustain life. Every object exerts gravitational force on every other object depending on the mass of the objects and the distance between them. The sun's gravitational pull holds Earth and other planets in orbit. Earth's gravitational force holds the moon in orbit. The sun is one of billions of stars in the Milky Way galaxy, that is one of billions of galaxies in the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

STANDARD III: Students will understand the relationship and attributes of objects in the solar system.

Objective 1: Describe and compare the components of the solar system.

a. Identify the planets in the solar system by name and relative location from the sun.
b. Using references, compare the physical properties of the planets (e.g., size, solid or gaseous).
c. Use models and graphs that accurately depict scale to compare the size and distance between objects in the solar system.
d. Describe the characteristics of comets, asteroids, and meteors.
e. Research and report on the use of manmade satellites orbiting Earth and various planets.

Objective 2: Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

a. Describe the use of instruments to observe and explore the moon and planets.
b. Describe the role of computers in understanding the solar system (e.g., collecting and interpreting data from observations, predicting motion of objects, operating space probes).
c. Relate science's understanding of the solar system to the technology used to investigate it.
d. Find and report on ways technology has been and is being used to investigate the solar system.

Objective 3: Describe the forces that keep objects in orbit in the solar system.

a. Describe the forces holding Earth in orbit around the sun, and the moon in orbit around Earth.
b. Relate a celestial object's mass to its gravitational force on other objects.
c. Identify the role gravity plays in the structure of the solar system.

STANDARD IV: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

a. Use the speed of light as a measuring standard to describe the relative distances to objects in the universe (e.g., 4.4 light years to star Alpha Centauri; 0.00002 light years to the sun).
b. Compare distances between objects in the solar system.
c. Compare the size of the Solar System to the size of the Milky Way galaxy.
d. Compare the size of the Milky Way galaxy to the size of the known universe.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

a. Locate and identify stars that are grouped in patterns in the night sky.
b. Identify ways people have historically grouped stars in the night sky.
c. Recognize that stars in a constellation are not all the same distance from Earth.
d. Relate the seasonal change in the appearance of the night sky to Earth's position.
e. Describe ways that familiar groups of stars may be used for navigation and calendars.

Science language students should use:	asteroids, celestial object, comets, galaxy, planets, satellites, star**,** distance, force, gravity, gravitational force, mass, scale, solar system, constellation, Milky Way galaxy, speed of light, telescope, universe, sun, light years

Science Benchmark

Microorganisms are those living things that are visible as individual organisms only with the aid of magnification. Microorganisms are components of every ecosystem on Earth. Microorganisms range in complexity from single to multicellular organisms. Most microorganisms do not cause disease and many are beneficial. Microorganisms require food, water, air, ways to dispose of waste, and an environment in which they can live. Investigation of microorganisms is accomplished by observing organisms using direct observation with the aid of magnification, observation of colonies of these organisms and their waste, and observation of microorganisms' effects on an environment and other organisms.

STANDARD V: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 1: Observe and summarize information about microorganisms.

a. Examine and illustrate size, shape, and structure of organisms found in an environment such as pond water.
b. Compare characteristics common in observed organisms (e.g., color, movement, appendages, shape) and infer their function (e.g., green color found in organisms that are producers, appendages help movement).
c. Research and report on a microorganism's requirements (i.e., food, water, air, waste disposal, temperature of environment, reproduction).

Objective 2: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

a. Formulate a question about microorganisms that can be answered with a student experiment.
b. Develop a hypothesis for a question about microorganisms based on observations and prior knowledge.
c. Plan and carry out an investigation on microorganisms. {Note: Teacher must examine plans and procedures to assure the safety of students; for additional information, you may wish to read microbe safety information on Utah Science Home Page.}
d. Display results in an appropriate format (e.g., graphs, tables, diagrams).
e. Prepare a written summary or conclusion to describe the results in terms of the hypothesis for the investigation on microorganisms.

Objective 3: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.
b. Identify how microorganisms are used as food or in the production of food (e.g., yeast helps bread rise, fungi flavor cheese, algae are used in ice cream, bacteria are used to make cheese and yogurt).
c. Identify helpful uses of microorganisms (e.g., clean up oil spills, purify water, digest food in digestive tract, antibiotics) and the role of science in the development of understanding that led to positive uses (i.e., Pasteur established the existence, growth, and control of bacteria; Fleming isolated and developed penicillin).
d. Relate several diseases caused by microorganisms to the organism causing the disease (e.g., athlete's foot -fungi, streptococcus throat -bacteria, giardia -protozoa).
e. Observe and report on microorganisms' harmful effects on food (e.g., causes fruits and vegetables to rot, destroys food bearing plants, makes milk sour).

Science language students should use:	algae, fungi, microorganism, decomposer, single–celled, organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Science Benchmark

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

STANDARD VI: Students will understand properties and behavior of heat, light, and sound.

Objective 1: Investigate the movement of heat between objects by conduction, convection, and radiation.

a. Compare materials that conduct heat to materials that insulate the transfer of heat energy.
b. Describe the movement of heat from warmer objects to cooler objects by conduction and convection.
c. Describe the movement of heat across space from the sun to Earth by radiation.
d. Observe and describe, with the use of models, heat energy being transferred through a fluid medium (liquid and/or gas) by convection currents.
e. Design and conduct an investigation on the movement of heat energy.

Objective 2: Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

a. Compare light from various sources (e.g., intensity, direction, color).
b. Compare the reflection of light from various surfaces (e.g., loss of light, angle of reflection, reflected color).
c. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).
d. Predict and test the behavior of light interacting with various fluids (e.g., light transmission through fluids, refraction of light).
e. Predict and test the appearance of various materials when light of different colors is shone on the material.

Objective 3: Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

a. Describe how sound is made from vibration and moves in all directions from the source in waves.
b. Explain the relationship of the size and shape of a vibrating object to the pitch of the sound produced.
c. Relate the volume of a sound to the amount of energy used to create the vibration of the object producing the sound.
d. Make a musical instrument and report on how it produces sound.

Science language students should use:	angle of incidence, angle of reflection, absorption, conduction, conductor, convection, medium, pitch, prism, radiation, reflection, refraction, spectrum, vibration