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ABSTRACT

This document was created to establish competency goals and objectives for teaching and learning science in North Carolina for grades K-12. It contains the concepts and theories, strands, skills, and processes upon which all science instruction should be based. In addition, the curriculum defines and illustrates the connections between the National Science Education Standards, the Benchmarks for Science Literacy, and state standards. The 1999 revision further reflects the recommendations of the Third International Mathematics and Science Study (TIMSS) and the 1996 National Assessment of Educational Progress (NAEP) science framework and assessment. The approach to this curriculum follows four major strands across all grade levels. These strands--Nature of Science, Science as Inquiry, Science and Technology, and Science in Personal and Social Perspectives--provide unifying threads of understanding that are supported by competency goals. The Science Standard Course of Study does not include all science, but focuses on what all students should understand and be able to do as they move towards scientific literacy. The Basic Educational Program for North Carolina's Public Schools specifies that the North Carolina Standard Course of Study is the curriculum that should be provided in all schools throughout the state. (WRM)

SCIENCE

Standard Course of Study and Grade Level Competencies

K-12

Public Schools of North Carolina
Department of Public Instruction

State Board of Education

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TABLE OF CONTENTS

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We wish to express special thanks to:

- the Division of Instructional Services for providing the leadership and vision that guided the development of this document,
- the many local educators, parents, and business industry people who participated in the current revision process by serving on curriculum committees and reacting to draft documents,
- faculty from the institutions of higher education who advised the staff and assisted in the revision of the curriculum, and
- the Department of Public Instruction staff who carried the primary responsibility for revising and editing the curriculum.

The current revision process involved on some level the entire science educational community, and its end product is a North Carolina curriculum of which North Carolina can be proud. We will regularly revise and improve the curriculum in order to meet the needs of the students of North Carolina

PREFACE

Intent

In a 1786 letter to a friend, Thomas Jefferson called for "the diffusion of knowledge among the people. No other sure foundation can be devised for the preservation of freedom and happiness." Jefferson saw clearly what has since become evident: that nations' fortunes rest on their citizens' ability to understand and use information about their world.

Given his life-long fascination with the natural world, Jefferson would have agreed that an understanding of science is critical to the knowledge we all need to understand and successfully live in our world. The ability to use science in turn rests on the core education that people receive from kindergarten through high school.

The *North Carolina Science Standard Course of Study* was created to ensure such an education by establishing competency goals and objectives for teaching and learning science in all grades. It contains the concepts and theories, strands, skills, and processes on which all science instruction should be based. In addition, the curriculum defines and illustrates the connections between the *National Science Education Standards*, the *Benchmarks for Scientific Literacy*, and the state standards. The *North Carolina Science Standard Course of Study* is a guide to stronger, more relevant science education for every student.

The approach to this curriculum revision follows four major strands across all grade levels. These strands, Nature of Science, Science as Inquiry, Science and Technology, and Science in Personal and Social Perspectives, provide unifying threads of understanding that are supported by competency goals. These goals permeate the curriculum and reflect a *science as inquiry* approach to understanding and <u>doing</u> science. Objectives under these goals become more complex as students progress from kindergarten through grade 12.

Revisions

The *North Carolina Science Standard Course of Study* was last revised in 1994. The 1999 revision has been written to better reflect the development of National Science Education Standards. The 1999 revision further reflects the recommendations of the Third International Mathematics and Science Study (TIMSS) and the 1996 National Assessment of Educational Progress (NAEP) science framework and assessment. The *North Carolina Science Standard Course of Study* has been written to expand the intent of previous documents and represents an evolutionary process of curriculum refinement.

Connections

At all levels, science should be taught with an awareness of its connection to other subjects and to society's needs. As author James Burke wrote, "This interdependence is typical of almost every aspect of life in the modern world. We live surrounded by objects and systems that we take for granted, but which profoundly affect the way we behave, think, work, play and in, general, conduct our lives and those of our children." The *North Carolina Science Standard Course of Study* embodies this sense of connections, as each level draws on those that precede it and contributes to those that follow.

Scope

An enormous amount of scientific content has accumulated at an increasing rate, causing curricula to thicken as material is added but rarely deleted. *The Science Standard Course of Study*, therefore, does not include all science, but instead focuses on what all students should understand and be able to do as they move towards scientific literacy. Although the revisions suggest less coverage of numerous topics, they place more emphasis on teaching for understanding and the ability to apply that understanding to real life.

The Basic Educational Program for North Carolina's Public Schools specifies that *The North Carolina Standard Course of Study* is the curriculum that should be provided in all schools throughout the state. Local schools are in compliance with the *Basic Educational Plan* by providing the courses in the *Science Standard Course of Study.*

Underlying these standards is the principle that neither gender, economic status, nor cultural background limits a student's ability to understand scientific principles and develop science-related skills.

PHILOSOPHY

The science component of the *North Carolina Standard Course of Study* is designed to assist educators in planning, implementing, and assessing a science program that allows "students to develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture." (National Science Education Standards, 1996, p.21) It is based on the belief that:

- Science is a human activity that can be characterized by participants' processes.
- All students can learn and succeed in science.
- Learning science is something students do, not something that is done to them.
- Everyone can describe, explain, and predict natural phenomena.
- Science technology and society are interrelated.
- Attitudes toward science established in childhood shape adult scientific literacy.

The goal of the *North Carolina Standard Course of Study* is scientific literacy. The National Science Education Standards define scientific literacy as "the knowledge and understanding of scientific concepts and processes required for scientific decision making, participation in civic and cultural affairs, and economic productivity." The tenets of scientific literacy include the ability to:

- Find or determine answers to questions derived from everyday experiences.
- Describe, explain, and predict natural phenomena.
- Understand articles about science.
- Engage in non-technical conservation about the validity of conclusions.
- Identify scientific issues underlying national and local decisions.
- Pose explanations based on evidence derived from one's work.

This philosophy is based on research, state and federal documents, and ideas of professional societies. Though research shows that all students can learn and succeed in science, all students will not become scientists nor achieve the same level of understanding. Rather, the goal is to create the scientifically literate society crucial to our increasingly complex and technological world. The decisions of future policy makers will, in large measure, be based on attitudes developed in today's classrooms

Research in cognitive science and science education supports the need for concept development through science and technology instruction. All students, in all grades, deserve on-going and meaningful science instruction.

PURPOSE

The *North Carolina Science Standard Course of Study* is designed to ensure that our state produces scientifically literate students. Scientific literacy implies an understanding of the scientific concepts and processes needed for personal decision-making, participation in civic affairs, and economic productivity. The scientifically literate person has a substantial understanding of scientific concepts and inquiry skills, which enable one to continue to learn and think logically. This person understands and appreciates the limits of science and technology. North Carolina students can achieve scientific literacy through an instructional program based on the goals and objectives in the science component of the *Standard Course of Study*.

Elementary Education

The *Elementary Standard Course of Study* has four strands that provide the context for teaching the goals and objectives. The strands include:

- Nature of Science.
- Science as Inquiry.
- Science and Technology.
- Science in Social and Personal Perspectives.

By the end of fifth grade, all students should have constructed an understanding of the following:

- Characteristics of organisms.
- Similarities and differences in organisms.
- Life cycles of organisms.
- Organisms and environments.
- Ecosystems.
- Properties of earth materials.
- Weather concepts.
- Objects in the sky.
- Changes in earth and sky.
- Properties of objects and materials.
- Position and motion of objects.
- Light, heat, electricity, magnetism and sound.

Middle School Education

The *Middle Level Standard Course of Study* includes four strands that provide the context for teaching the goals and objectives. The strands encompass:

- Nature of Science.
- Science as Inquiry.
- Science and Technology.
- Science in Social and Personal Perspectives.

By the end of eighth grade, all students should have constructed understanding of the following concepts, theories, and universal laws:

- Cell theory.
- Human body systems.
- Heredity and genetics.
- Population dynamics.
- Diversity and adaptations of organisms.
- Change over time of life and landforms.
- Structure of the earth system.
- Earth in the universe.
- Transfer of energy.
- Motion and forces.
- Properties of matter.
- Flow of matter and energy.

High School Education

The *High School Standard Course of Study* includes four strands that provide the context for teaching the goals and objectives. They are
- Nature of Science.
- Science as Inquiry.
- Science and Technology.
- Science in Social and Personal Perspectives.

By the end of twelfth grade, all students should have constructed an understanding of the following concepts, theories, and universal laws. This understanding should result from required courses including Biology, an earth/environmental science, and a physical science (either Chemistry, Physics or Physical Science).
- The cell.
- Molecular basis of heredity.
- Biological evolution.
- Interdependence of organisms.
- Energy in the earth systems.
- Geochemical cycles.
- Origin and evolution of the earth system.
- Origin and evolution of the universe.
- Structure of atoms.
- Structure and properties of matter.
- Chemical reactions.
- Motions and forces.
- Conservation of energy and increase in disorder.
- Interaction of energy and matter.

The science graduation requirements may be satisfied in a variety of ways.

Satisfaction of the biology requirement may be locally designed to encourage the study of local and biological topics. Specific examples of courses that may satisfy this requirement include *Standard Course of Study Biology*, *AP Biology*, or *IB Biology*. Any locally designed course that satisfies this requirement must meet the five competency goals designated in the Biology Course in the *Science Standard Course of Study.*

Satisfaction of the earth/environmental science requirement (entering high school freshmen in school year 2000) may be locally designed to encourage the study of local earth/environmental issues. Specific examples of courses that may satisfy this requirement include, *Environmental Science, AP Environmental Science*, or *IB Environmental Systems.* Any locally designed course that satisfies this requirement must meet the seven competency goals designated in the Earth/Environmental Science course in the *Science Standard Course of Study.*

Satisfaction of the physical science requirement may be locally designed to encourage the study of local interest in the physical sciences. Specific examples of courses that may satisfy this requirement include Standard Course of Study Physical Science, Chemistry or Physics, AP Chemistry or Physics, IB Chemistry or Physics. Any locally designed course that satisfies this requirement must meet the competency goals designated in the Physical Science, Chemistry, or Physics course in the Science Standard Course of Study. In addition, Principles of Technology I or principles of Technology II can count as the

undesignated third science credit required for graduation under these conditions:
PT I may count as a science elective,

Principles of Technology I or Principles of Technology II can count as the undesignated third science credit required for graduation under these conditions:

- PT I may count as a science elective, a physical science credit, or as the course, Physical Science. When PT I is counted as the course Physical Science, students in this course are subject to the End of Course Test in Physical Science.
- PT II (with PT I as a prerequisite) may count as a science elective, a physical science credit, or as the course Physics. When PT I and II are counted as the course, Physics, students in this course are subject to the End of Course Test in Physics.

PT I and PT II may count as the elective laboratory science credit required for admission to the University of North Carolina System Institutions.

12

DESCRIPTION OF PROGRAM STRANDS

Nature of Science

The Nature of Science strand allows us to see science as a human endeavor. Women and men of various backgrounds, with diverse interests and motives, are involved in science, engineering, and related fields. While science encompasses many disciplines, such as physics, chemistry, biology, and the geosciences, these disciplines often take different approaches to the study of reality.

There also are different ways to define science. A lay person might see it as a body of information, a scientist might define it as set of procedures by which hypotheses are tested, and a philosopher might regard it as a way to question the truth of what we know. Each of these views is a valid, but only partial, definition of science. Collectively, however, these concepts begin to define the comprehensive nature of science, which is why a comprehensive science program should include inquiry, as well as the skill building investigations that demonstrate universal laws of science. (Chiappetta, 1998)

Science is a way of knowing about the world. In science, explanations are limited to those that can be inferred from confirmable data - the results obtained through observations and experiments that can be substantiated by other scientists. (NAS Evolution, 1998) When observations of a phenomenon have been confirmed or can be repeated, they are regarded as fact. Any scientific confirmation is, however, tentative, because it is always possible that the results occurred by chance.

A scientific theory is a body of continually refined observation, inference, and testable hypotheses. Because science is never irrevocably committed to any theory, no matter how firmly it appears to be established, science is not dogma. Any theory is always subject to change in the light of new and confirmed observations. Students should be taught that uncertainty is not a weakness, but a strength that leads to self-correction.

History provides yet another way to understand how science works. Students should learn that much of the progress in science and technology is the result of a gradual accumulation and application of knowledge over many centuries. (Benchmarks, 1993)

Engaging Science

Above all, the pursuit of science should be fun and exciting. Educators can capitalize on children's natural curiosity and the joy they experience "doing" science. Put the "wow" into science education, and students' attention is almost guaranteed.

> It was a strange sight: a man, standing before a fountain, watching the falling water and tilting his head from side to side. Drawing closer, I saw he was rapidly moving the fingers of his right hand up and down in front of his face.
>
> I was in the seventh grade, visiting Princeton University with my science class, and the man at the fountain was Albert Einstein.
>
> For several minutes, he continued silently flicking his fingers. Then he turned and asked, "Can you do it? Can you see the individual drops?"
>
> Copying him, I spread my fingers and moved them up and down before my eyes. Suddenly, the fountain's stream seemed to freeze into individual droplets. For some time, the two of us stood there perfecting our strobe technique. Then, as the professor turned to leave; he looked me in the eye and said, "Never forget that science is just that kind of exploring and fun."

Mary Budd Rowe, "Teach Your Child To Wonder," Reader's Digest, May 1995, p. 177

Science As Inquiry

Students cannot just read and/or be told about science -- they must do science. All students should experience the excitement of science as they try to understand the natural world. Science experiences should also connect students to everyday life and the science- and technology-related social issues with which local communities, nations, and all humanity struggle (Cheek, 1992; Aikenhead and Solomon, 1994).

The revised *North Carolina Standard Course of Study* takes students beyond science as merely a body of knowledge to science as inquiry. It requires students to combine science and scientific knowledge with scientific reasoning and critical thinking.

14

Engaging students in scientific inquiry helps them develop:

- An understanding of scientific concepts.
- An appreciation of how we know what we know in science.
- An understanding of the nature of science, along with the skills to become independent discoverers of the natural world.
- The disposition to use the skills and attitudes associated with science.

Science as inquiry is key to organizing and guiding students' activities. Students in all grades and in every scientific discipline should have the opportunity ask questions, plan and conduct investigations, use appropriate tools and techniques to gather data, think critically and logically about relationships between evidence and explanations, and communicate arguments.

With increasing emphasis on experiential learning, we also must teach appropriate safety practices when engaging in any science activity. Teachers must be aware of safety recommendations, regulations, and laws relating to such topics as eye safety, use of chemicals, and field trip behavior. When students and teachers know how to do science safely, such concerns should not deter meaningful learning activities. An effective science program provides ample opportunities for students to:

- Apply safe laboratory/manipulative procedures.
- Choose, construct, and/or assemble appropriate equipment.
- Manipulate materials, scientific equipment and technologies.
- Properly handle and care for living organisms, materials, and equipment.

If students are to understand the scientific process, they must make decisions themselves. Time must be allowed for revision and repetition of experiments, presentation of results, and even for response to criticism.

Inquiry-based programs lead to integrated studies because students seldom take divisions among disciplines very seriously. Students who learn to question, debate, or explore acquire a deeper understanding of the world. By discovering principles, rather than just memorizing them, students learn not just what we know, but how we know it, and why it is important.

"Science is a way to teach how something gets to be known, to what extent things are known (for nothing is known absolutely), how to handle doubt and uncertainty, what the rules of evidence are, how to think about things so that judgements can be made, how to distinguish truth from fraud and from show."
(Richard Fyneman)

Teaching Inquiry

Different scientific disciplines use various methods and theories to advance knowledge. Investigations may involve discovering, observing and describing objects, organisms or events. They also may involve experiments, a search for more information, or model making. To help focus investigations, students should frame questions, such as "What do we want to find out?" "How can we make the most accurate observations?" and "If we do this, what do we expect will happen?" Scientific inquiry should involve students in establishing and refining the methods, materials, and data to collect. As students investigate and observe, they should consider questions such as "What data will answer the question?" and "What are the best measurements to make?"

New knowledge and methods emerge from these investigations and from interaction. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections among natural phenomena, investigations, and scientific knowledge. In addition, the methods and procedures used to obtain evidence must be clearly reported to encourage further investigation.

Science advances through legitimate skepticism. To evaluate explanations proposed by others, scientists examine and compare evidence, identify faulty reasoning and statements that go beyond the evidence, and suggest alternative explanations. Scientific explanations must be logically consistent, based on historical and current scientific knowledge, and open to question and modification. Students, therefore, should be encouraged to present the results of their inquiries in oral or written reports. Student discussions should center on questions, such as "How should we organize the data to present the clearest answer to our question?" Out of the discussions about the ideas, the background, and the data, learners will gain experience in the practice of science and scientific thought.

Science and Technology

A single problem often has both scientific and technological aspects. For example, investigating the salinity of the water in North Carolina's sounds is science, while creating a way to make this salt water drinkable is technology. In other words, while science tries to understand the natural world, technology tries to solve practical problems. Technology expands our capacity to understand and control the natural and human-made environment.

"Technology" has many definitions. It may, for example, denote a way of doing things, and or a specific object. Stephen Kiln, Professor of Mechanical Engineering at Stanford University has four definitions of technology (Kiln, 1985):

- Artifact or hardware (e.g., an aspirin, chair, or video tape).
- Methodology or technique (e.g., painting, using a microscope).
- System of production (e.g., the automobile assembly line, a process for manufacturing a product or an entire industry).
- Social-technical system (an airplane, for example, suggests a plethora of interrelated devices, human resources, and artifacts such as airports, passengers and pilots, fuel, regulations and ticketing).

Science and Technology In Society

"Achieving the goal of scientific and technological literacy requires more than understanding major concepts and processes of science and technology. Indeed, there is a need for citizens to understand science and technology as an integral part of our society. Science and technology are enterprises that shape and are shaped by human thought and social actions." (Rodger W. Bybee and George E. DeBoer, "Research on Goals for the Science Curriculum," Handbook of Research on Science Teaching and Learning. Ed. Dorothy Gabel. MacMillan, NY 1994, p. 384)

Technology has always played a role in the growth of scientific knowledge. The techniques for shaping, producing or manufacturing tools, for example, are the primary evidence of the beginning of human culture.

Science and technology also reflect a culture's values. Consider, for example, how the acceptance of new ideas can be constrained by the environment in which they are conceived. Galileo's efforts to change perceptions of Earth's place in the solar system, Newton's demonstrations of the laws of motion, and Pasteur's identification of infection with microscopic organisms were rejected by the scientific establishment of their times. Only because of contributions from later investigators did they slowly achieve acceptance.

The development of technology also has been crucial to economic growth. For example, in an effort to make the 1890 U.S. Census faster and more efficient, Herman Hollerith drew upon early "counting machines" to develop a prototype of the computer, which in turn has created today's high-tech industries. In the words of C. Purcell ("The Machine in America: A Social History of Technology." 1995, p.xii), "Since individual technologies and their networks enhance or undermine the people we want to be and the society in which we want to live, we as citizens must try to understand this mighty force and see it not only for what it is but also for what it might be."

While properly applied technology will continue to benefit humanity, we must be aware that its misuse can harm the environment and jeopardize human well-being. Responsibility and stewardship are basic to teaching and learning science and technology. Students must understand that scientific and technological discoveries may have complex -- and perhaps unanticipated -- repercussions that must be addressed.

Technology As Design

Technology as design is analogous to science as inquiry.
All students should engage in problem-solving by designing, building, and testing solutions to real-world problems. By applying critical thinking skills and knowledge of materials, learners can compare and assess technological devices for costs, benefits, applications, practicality, environmental impact, safety, and convenience.

The goals and objectives for technological design call for students to accumulate the skills necessary to:

- Identify and state a problem, need, or product
- Design a solution including cost and risk/benefit analysis
- Implement and evaluate the solution
- accurately record and communicate observations.

Today's technology provides nearly instant access to a storehouse of information. Students must learn to use technology as a tool to help understand science and increase creativity in scientific investigations.

Science in Personal and Social Perspectives

An essential component of balanced science education is the use of scientific conceptual understandings and processes in personal and public decision-making. Science education gives students a means to understand and act on such issues. In addition, we are so dependent on science and technology that progress is almost universally identified with them. Students must therefore develop a basic understanding of science and technology in order to become responsible citizens capable of making decisions on social, technological, environmental and other problems faced by their communities and throughout the world.

The ability to understand the nature of science and technology, to apply the concepts of and theories about the earth and life, and to use inquiry and technological design in making personal and societal decisions should be the culmination of a K-12 science education. Our job as science educators is to prepare students to be informed, scientifically and technologically literate decision-makers and problem solvers.

Strands – Grades K-5

The *Standard Course of Study* for Grades K-5 provides unifying threads of understanding that span the content areas of elementary science. The strands include the following goals:

Nature of Science

As a result of activities in grades K-5, all students should develop an understanding of:

- Science as a human endeavor.

Science as Inquiry

As a result of activities in grades K-5, all students develop:

- Abilities necessary to do scientific inquiry.
- Understanding about scientific inquiry.
- Abilities necessary to use the process skills of science.
  - observe
  - classify
  - use numbers
  - communicate
  - measure
  - infer
  - predict
  - interpret
  - experiment
  - use space-time relations
  - control variables
  - formulate hypotheses
  - formulate models
  - define operationally

Science and Technology

As a result of activities in grades K-5, all students should develop:

- Abilities of technological design.
- Understanding about technology and design.
- Abilities to distinguish between natural and objects made by humans.

Science in Personal and Social Perspectives

As a result of activities in grades K-5, all students should develop understanding of:

- Personal health.
- Characteristics and changes in populations.
- Changes in environments.
- Science and technology in local challenges.

KINDERGARTEN

Goal

As students in kindergarten begin their science studies by using the five senses to **observe** plants, animals, earth materials, weather and other objects, the class setting should provide a stimulating atmosphere in which students are intellectually challenged to discover the physical world around them. Young students' natural curiosity leads them to **explore** the world by observing and manipulating common objects and materials in their environment. They **interpret** their observations through the senses; and **investigate** by using taste, smell, touch, hearing and sight. The following explanations are meant to introduce the strands. Strategy books to assist teachers are available through the Department of Public Instruction's Publications Section.

Nature of Science

The Nature of Science strand is designed to help students develop an understanding of the human dimensions of science, the nature of scientific thought, and the enterprise of science in society. Science education in kindergarten serves as the earliest foundation for students to experience science in a form that engages them in active construction of ideas and explanations. Young students have always had questions about themselves and their world. Science is one way of **communicating** their questions and enabling them to make sense of the natural world. Teaching science as inquiry enhances their opportunity to develop the abilities to do science.

The class setting should provide a stimulating atmosphere in which students are intellectually challenged. Young students' natural curiosity leads them to **explore** the world by observing and manipulating common objects and materials in their environment. They make observations directly through the senses; investigate by using taste, smell, touch, hearing, and sight.

Science as Inquiry

Research shows that young students work well in small groups or pairs to construct and share ideas The kindergarten classroom must employ simple equipment and tools to gather data and extend the senses. Students develop simple skills such as how to **observe**, **measure**(non-standard), **use numbers**, **sort** (using own rules) cut, connect, switch, turn on and off, pour, hold, tie, and hook. They begin to ask questions that they can answer with scientific knowledge, combined with their own observations and simple **predictions** In the earliest years, investigations are largely based on systematic observations. Through the observation and manipulation of common objects, students reflect on their likeness and differences. This leads to initial sketches and single word descriptions which in turn lead to increasingly more detailed drawings, richer verbal descriptions, and connections to writing.

Science and Technology

Young students' abilities in technological problem-solving can be developed by first hand experiences in doing tasks with a technological purpose. They can study technological products and systems in their world, such as zippers, coat hooks, can openers, tricycles and other tools. Students can engage in projects that are appropriately challenging for their development level, ones in which they must design a way to fasten, move, or **communicate**.

Personal and Social Perspectives

Students in kindergarten should have a variety of experiences that provide initial understandings for personal care and enable them to take responsibility for their own health. Students understandings should include following safety rules for all their school experiences as well as home, preventing abuse and neglect, avoiding injury, and when and how to say no.

His/Her World

The focus for kindergarten will center on students using all the five senses to make observations of events in both indoor and outdoor settings that make up their world. The strands provide a context for teaching the content throughout all goals. Students will be actively involved in:

- Exploring a variety of materials.
- Utilizing observed data to make predictions.
- Generating attributes and uses of common objects and organisms.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of similarities and differences in plants and animals.

Objectives

1.01 Identify the similarities and differences in plants:
- Appearance.
- Growth.
- Change.
- Uses.

1.02 Identify the similarities and differences in animals:
- Appearance.
- Growth.
- Change.
- Purpose.

1.03 Observe the different ways animals move from place to place, and how plants move in different ways.

1.04 Observe the similarities of humans to other animals and their basic needs. Observe how humans grow and change.

COMPETENCY GOAL 2: The learner will build an understanding of weather concepts.

Objectives

2.01 Observe daily weather changes throughout the year:

2.02 Identify types of precipitation, variations in wind, sky conditions and day and night changes.

2.03 Observe the seasonal and daily changes in weather: similarities and differences, temperature changes.

COMPETENCY GOAL 3: The learner will build an understanding of the properties/movement of common objects and organisms.

Objectives

3.01 Describe objects in terms of the materials they are made of (clay, metal, cloth, paper, etc.) their physical properties (color, size, shape, weight, texture, flexibility), and how they are used.

3.02 Describe how objects look, feel, smell, taste, and sound using all the senses.

3.03 Describe motion when an object, a person, an animal, or anything goes from one place to another.

COMPETENCY GOAL 4: The learner will increase his/her understanding of how the world works by using tools.

Objectives

4.01 Describe the functions of tools.

4.02 Determine the usefulness of tools to help people: scissors, pencils, crayons, paper clips, hammers, etc.

4.03 Apply nonstandard units of measure.

4.04 Conclude that tools extend human capabilities.

GRADE ONE

Goal

Science education in first grade extends the foundation that began in kindergarten. Teachers build on students' natural inclinations to ask questions and investigate common objects in the natural world. Students engage in active construction of ideas and explanations as they **observe**, collect data, and **classify** living and nonliving objects. The following explanations are meant to introduce the strands. Strategy books to assist teachers are available through the Department of Public Instruction's Publications Section.

Nature of Science

The Nature of Science strand is designed to help students develop an understanding of the human dimensions of science, the nature of scientific thought, and the enterprise of science in society. Through **communication** skills students are introduced to examples of women and men who have made contributions to science. Teachers can introduce young students to how scientists work and the contributions of diverse people to science and technology.

Science as Inquiry

The first grade classroom employs simple equipment and tools to gather data and extend the senses. Students develop simple skills such as how to **observe**, **measure**, connect, record and report data, and **classify** objects using their own rules. Using their own **observations**, they begin to ask questions and **make predictions**. Students' investigations are largely based on systematic **observations** and simple **classifications** using their own rules. As students develop concepts and vocabulary from such experiences, they develop the ability to ask questions, investigate aspects of the world around them, and use their observations to construct reasonable explanations for the questions posed.

Science and Technology

Students develop abilities to work individually and collaboratively and to use suitable tools and measurements when appropriate. Students' abilities in technological problem-solving are developed by first hand experiences in doing task with a technological purpose. They study technological products and systems as they investigate living and nonliving objects. Students develop the ability to explain a problem in their own words and identify a specific task and solution related to the problem.

Personal and Social Perspectives

First grade students should have a variety of experiences that provide initial understandings for personal safety and enable them to take responsibility for their own personal care. They should identify and follow simple safety rules while in school and at home. Students understand that resources are found in the living and nonliving environment.

26

Living and Nonliving Objects

The focus for first grade is on students using their senses to make observations based on their own rules for classification, and on experimenting to discover the properties of living and nonliving objects. The strands provide a context for teaching the content goals . Students will actively be involved in:

- Exploring a variety of materials.
- Using observed data to classify objects.
- Identifying properties of common objects.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of the needs of living organisms.

Objectives

1.01 Determine the needs of plants:
- Air.
- Water.
- Nutrients.
- Light.

1.02 Determine the needs of animals:
- Air.
- Water.
- Food.
- Shelter.

1.03 Identify environments that support various types of living organisms.

1.04 Identify local environments that support the needs of North Carolina plants and animals.

COMPETENCY GOAL 2: The learner will build an understanding of solid earth materials.

Objectives

2.01 Distinguish the size and shape of rocks, boulders, grains of sand and smaller materials.

2.02 Classify rocks and other earth materials according to their properties:
- Size.
- Shape.
- Color.
- Texture.
- Magnetism.
- The ability to float or sink.

2.03 Determine the properties of soil:
- Composition.
- Capacity to retain water.
- Color.
- Texture.
- Ability to support life.

COMPETENCY GOAL 3: The learner will build an understanding of the properties and relationship of objects.

Objectives

3.01 Determine the many ways in which objects can be grouped or classified.

3.02 Classify solids according to their properties:
- Color.
- Texture.
- Shape (ability to roll or stack).
- Weight (float or sink).

3.03 Determine the properties of liquids:
- Color.
- Ability to float or sink in water (buoyancy).

COMPETENCY GOAL 4: The learner will build an understanding of the actions of objects.

Objectives

4.01 Observe the ways in which things move:
- Straight.
- Zigzag.
- Round and round.
- Back and forth.
- Fast and slow.

4.02 Describe motion of objects by tracing and measuring movement over time.

4.03 Observe that movement can be affected by pushing or pulling.

4.04 Observe that objects can move steadily or change direction.

GRADE TWO

Goal

Science education in the second grade builds on the foundation that began in kindergarten and first grade. Second grade students will **observe** changes in animal and plant life cycles, systems of weather, properties of materials, and sound. Changes in rate, scale, and pattern will be the focus of their investigations. The following explanations are meant to introduce the strands. Strategy books to assist teachers are available through the Department of Public Instruction's Publications Section..

Nature of Science

The Nature of Science strand is designed to help students develop an understanding of the human dimensions of science, the nature of scientific thought, and the enterprise of science in society. Teachers should emphasize the experiences of investigating and thinking about explanations. Students using a cooperative learning approach can conduct investigations and present their findings to their classmates. Although people have learned much about phenomena in nature, much more remains to be understood. Science is constantly changing and will never be finished.

Science as Inquiry

Teaching science as inquiry provides teachers with the opportunity to develop students' abilities and to enrich student understanding of how things change. As students focus on the study of life cycles, changes in weather, changes in properties, and changing sounds, they develop the ability to ask scientific questions, **investigate** aspects of the world around them, and use their findings to construct reasonable explanations for the concepts posed. Inquiry involves asking a simple question, completing an investigation, recording and **communicating**, answering the question, and presenting the results to others. By engaging in these kinds of activities, students begin to develop the physical and intellectual abilities of scientific inquiry.

Science and Technology

Students develop the ability to explain a problem in their own words, identify a specific task and solve the related problem. Students develop abilities to work individually and collaboratively to use suitable tools and **measurements** when appropriate. Tools help students make better **observations** and **measurements** providing helpful equipment for **investigations**. They help students see, **measure**, and do things that they could not otherwise **observe**, **measure**, and do. Student abilities include oral, written, and pictorial

communication of design process and product. The science/technology connection is one way of answering questions and explaining changes in the natural world.

Personal and Social Perspectives

Second grade students have a variety of experiences that provide initial understandings for personal safety and enable them to take responsibility for their own personal care. They identify and follow simple safety rules while in school and at home. Students' understandings should include the idea that some environmental changes occur slowly, and others occur rapidly. Students should understand the different consequences of changing environments in small increments over long periods as compared with changing environments in large increments over short periods.

30

Change

The focus for second grade centers on students analyzing collected data over a period of time to make predictions and understand change. Students are to look at heat as a way of changing properties of objects and motion as being related to position and time. The strands provide a context for teaching the content goals. Students will actively be involved in:

- Conducting long term investigations to define changes.
- Using tools to collect data.
- Looking at change in properties.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of plant and animal life cycles.

Objectives

1.01 Analyze the life cycle of plants:
- Reproducing.
- Developing into an adult.
- Eventually dying.

1.02 Compare and contrast life cycles of different plants.

1.03 Analyze the life cycle of animals
- Being born.
- Developing into an adult.
- Reproducing.
- Eventually dying.

1.04 Compare and contrast life cycles of different animals.

COMPETENCY GOAL 2: The learner will build an understanding of the changes in weather.

Objectives

2.01 Describe weather by measurable quantities:
- Temperature.
- Wind direction.
- Wind speed.
- Precipitation.

2.02 Assess weather changes from day to day and over the seasons.

COMPETENCY GOAL 3: The learner will build an understanding of changes in properties.

Objectives

3.01 Determine three states of matter:
- Solid.
- Liquid.
- Gas.

3.02 Observe changes in state due to heating and cooling in common materials.

3.03 Determine what can be done to materials to change some of their properties. (buoyancy-float and sink)

3.04 Observe the change in position and motion of objects relative to the strength of the push or pull (force).

COMPETENCY GOAL 4: The learner will build an understanding of the concepts of sound.

Objectives

4.01 Discover how sounds are made by using a variety of instruments and "sound makers".

4.02 Discover that sound is produced by vibrating objects.

4.03 Determine the pitch of the sound by changing the rate of the vibration (how fast).

4.04 Analyze the pitch produced by changing the size and shape of a variety of instruments.

GRADE THREE

Goal

Third grade continues the concepts taught in grades K-2. The natural and designed world is complex; it is too large and complicated for students to investigate and comprehend all at once. The third grade program allows students to define small content portions for in-depth investigation. Each investigation unit addresses a system -- an organized group of related objects or components that form a whole. Plants, soils, earth/moon/sun, and heat/light are investigated as systems. The following explanations are meant to introduce the strands. To assist teachers, strategy books are available from the Department of Public Instruction's Publication Section.

Nature of Science

The Nature of Science strand helps students understand the human dimensions of science, the nature of scientific thought, and science's role in society. Students develop an understanding of regularities in systems, which in later grades allows them to understand basic laws and theories that explain the world. Teachers build on students' natural inclination to ask questions and investigate their world. Cooperative groups of students conduct investigations that begin with a question and progress toward **communicating** an answer. Stories, films, videos, and multimedia introduce women and men who have contributed to science. These examples highlight how scientists work, showing how they pose and answer the questions, the procedures they use, and their contributions to science, technology, and society.

Science as Inquiry

Students experience science in a way that engages them in active building of ideas and explanations, and gives them more opportunities to develop the ability to do science. Teaching science as inquiry requires a learning environment that engages students in hands-on activities and **investigations**. For example, if students ask each other how plants can survive in a particular environment, they might want to identify and compare the various environments where plants naturally occur. To develop the ability to do scientific inquiry, students plan and conduct a simple **investigation**, use simple equipment and tools to gather data, use data to construct reasonable explanations, and **communicate** explanations/evidence to others.

Science and Technology

Students become interested in technology as they design projects, use tools well, **measure** things carefully, make reasonable estimations, calculate accurately, and **communicate** clearly. They become competent designing, analyzing, and explaining their products. Does it work? Can I make it work better? Would it have worked better if I used different materials? The more experience students have with design, the less direct guidance they need. They should begin to enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with a new proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to other problems. Introduce the balance between constraints and social impact.

Personal and Social Perspectives

A variety of experiences give students an initial understanding of various science-related personal and societal challenges. "Central ideas related to health, populations, resources, and environments provide the foundations for students' eventual understandings and actions as citizens."(NSES) Resources are the things that we get from the living and nonliving environment to meet people's needs and wants. As students **investigate** making soil through composting, they learn that resources can be extended through recycling and wise use.

Patterns and Systems

The focus for third grade is on students understanding regularities in systems and that a system is made up of an organized group of related objects or components. Such systems can consist of plants, soils, mineral particles, and the earth/moon/sun. The strands provide a context for teaching the content goals. Students will be actively involved in:

- Exploring the properties of soil through plant investigations.
- Observing and recording data to understand the sun's changes in position.
- Generating data to support the period of time called a month.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of plant growth and adaptations.

Objectives

1.01 Determine that the quantities and qualities of nutrients, light, and water in the environment affect plant growth.

1.02 Observe how environmental conditions can determine how well plants grow and survive in a particular environment.

1.03 Analyze plant structures for specific functions:
- Growth.
- Survival.
- Reproduction.

1.04 Determine that new plants can be generated from:
- Seeds.
- Tubers.
- Bulbs.
- Cuttings.

1.05 Determine that the number of seeds a plant can produce depends on variables such as light, water, nutrients, and degree of pollination.

COMPETENCY GOAL 2: The learner will build an understanding of soil concepts.

Objectives

2.01 Differentiate the properties of soil such as color, texture, and capacity to retain water.

2.02 Analyze the ability of soil to support the growth of many plants, including those in our food supply.

2.03 Identify various types of soil:
- Sand.
- Clay.
- Humus.

2.04 Evaluate composting to show how plant and animal material can be broken down to form soil.

COMPETENCY GOAL 3: The learner will build an understanding of the earth/moon/sun system.

Objectives

3.01 Using shadows, observe the movement of the sun in the sky during the day.
3.02 Observe the angular position of the sun at noon over several months and relate to seasons.
3.03 Observe the change in shape of the moon from day to day over several months to determine a pattern.
3.04 Observe that stars in the night sky appear as tiny points of light.

COMPETENCY GOAL 4: The learner will build an understanding of light and heat concepts.

Objectives

4.01 Analyze the reflection of light.
4.02 Determine the nature of light through the use of shadows.
4.03 Analyze conduction (the movement of heat from one object to another).
4.04 Evaluate the ability of different materials to conduct heat.
4.05 Determine that heat is produced from decaying plants in a compost pile.

GRADE FOUR

Goal

The goal for the fourth grade is for students to think and analyze nature in terms of systems (A system is an organization of related objects that form a whole). Systems can consist of organisms, machines, fundamental particles, ideas, and numbers. Systems have boundaries, components, resources flow and feedback. The following explanations are meant to introduce the strands. To assist teachers, strategy books are available through the Department of Public Instruction's Publication Section.

Nature of Science

The Nature of Science strand helps students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Science assumes that nature is the same everywhere, and that it is understandable and predictable. Students can develop an understanding of the regularity of systems, which in turn leads to understanding of basic laws of nature, scientific theories, and models that explain the world. Students can read, **investigate**, and explore the theme that science is a human endeavor. Teachers should emphasize the diversity found in the science community. Students can begin to realize that doing science involves more than being a "scientist," and that many different occupations are a part of the scientific enterprise.

Science as Inquiry

Fourth grade students can master some skills of a good inquirer. Most students can make **measurements** using tools, rulers, thermometers, containers, and balances. But a student's most useful tools are the ability to make **predictions** based on **observations**, to take careful **measurements**, to record **observations** and **measurements**, and to **communicate** results in charts and simple graphs as well as prose. Good explanations are based on evidence from **investigations**.

By grade four, distinctions between the properties of objects and materials can be understood in specific context, such as a set of rocks or living materials. Through **experiments** with electricity and magnetism, students begin to understand that phenomena can be observed, measured and manipulated by **controlling variables**. Students begin developing the ability to **communicate**, **infer**, analyze and critique their work and that of other students. Results may be spoken, drawn, written or presented in multimedia.

Science and Technology

Students become interested in technology as they design projects, use tools well, **measure** things carefully, make reasonable **predictions**, calculate accurately, and **communicate** clearly. Students become confident designing and analyzing projects, and the more experience they have with design, the less direct guidance they need. They begin to enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with another proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this goal, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to others, and they become able to balance simple constraints in problem solving. Students should analyze and evaluate their own results or solutions, as well as those of other students, by considering how a product or design met the challenge to solve the problem.

Personal and Social Perspectives

Students **investigate** the progression of tool use over time. They understand that people continue to invent new ways of solving problems and getting things done. As they research inventions and technological advances, students begin to understand how new ideas and inventions affect other people. They analyze advantages and disadvantages of new ideas and inventions.

Analyzing Systems

The focus for fourth grade students is thinking and analyzing in terms of systems. This helps students keep track of objects, organisms, and events. The strands provide a context for teaching the content throughout all goals. Students will actively investigate concepts by:
- Predicting, observing, and recording results of simple experiments.
- Observing and examining structural characteristics and behavior of animals.
- Generating ideas to solve simple problems.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of animal growth and adaptation.

Objectives

1.01 Relate structural characteristics and behavior of a variety of animals to the environment in which they are typically found.

1.02 Determine animal behaviors and body structures that have specific growth and survival functions in a particular habitat.

1.03 Evaluate living and nonliving things that affect animal life:
- Other animals.
- Plants.
- Climate.
- Water.
- Air.
- Location.

COMPETENCY GOAL 2: The learner will build an understanding of the composition and uses of rocks and minerals.

Objectives

2.01 Describe the composition of a mineral. (Each mineral has a definite chemical composition and structure resulting in definite physical properties.)

2.02 Analyze the mineral composition of rocks.

2.03 Assess the uses of rocks and minerals.

2.04 Classify rocks using student-devised rules.

COMPETENCY GOAL 3: The learner will build an understanding of electricity and magnetism.

Objectives

3.01 Design an electric circuit as a complete pathway with an energy source, energy receiver, and energy conductor.

3.02 Determine the ability of electric circuits to produce light, heat, sound, and magnetic effects.
3.03 Analyze the parts of a light bulb.
3.04 Assess the pull of magnets on all materials made of iron and the pushes or pulls on other magnets.
3.05 Measure magnetic effects over distance or through substances such as glass and paper.

COMPETENCY GOAL 4: The learner will build an understanding of technological designs.

Objectives

4.01 Assess the invention of tools and techniques to solve problems.
4.02 Observe the many tools that are based on designs found in nature.
4.03 Determine how people use simple machines to solve problems.
4.04 Evaluate the attributes of simple machines that can be manipulated or combined to affect outcomes.
4.05 Assess the natural resources necessary to construct machines and tools.

GRADE FIVE

Goal

The goal for fifth grade is to **investigate** energy interactions. The understanding of energy builds on the K-4 experience with light, heat, sound, electricity, magnetism, and the motion of objects. Students connect those phenomena to understand that energy is an important property of substances, and that most change involves energy transfer. Students improve their understanding of energy by experiencing many kinds of energy transfer. The following explanations are meant to introduce the strands. To assist teachers, strategy books are available through the Department of Public Instruction's Publication Section.

Nature of Science

The Nature of Science strand helps students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Science **investigations** provide the background for developing and appreciating the nature of science. Science relies on human qualities, such as reasoning, insight, energy, skill and creativity. Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.

Science as Inquiry

Students must actively participate in science **investigations**, and use the cognitive and manipulative skills associated with the formation of scientific explanations. They examine the validity of an explanation based on evidence. Through **experiments** and **investigations** students conduct, shape, and modify their background knowledge. Students will explore ecosystems in their local environment focusing on the interactions between living and nonliving things. They will look at food webs within ecosystems and describe the relationships among producers, consumers, and decomposers while examining the energy flow from one organism to another. Students at this level should be able to formulate questions, design and carry out **investigations**, **interpret** and use data to generate explanations, and critique explanations and procedures. Students can construct understandings about the Earth's land forms and how those landforms change overtime because of interactions among soil, rocks, water, and wind. These investigations should lead students to conduct further investigations.

Science and Technology

Students can become interested in technology as they design projects, use tools well, **measure** things carefully, **make** reasonable **predictions**, calculate accurately, and **communicate** clearly. Students explore weather systems by **observing, measuring,** and recording local conditions. They use tools such as thermometers, rain gauges, and barometers to collect data to establish trends. Students become comfortable designing and analyzing their products. The more experience students have with design, the less direct guidance they need. They enjoy opportunities to clarify a problem, generate criteria for an acceptable solution, suggest possible solutions, try one out, and then make adjustments or start over with another proposed solution. It is important for students to find out that there is more than one way to design a product or solve a problem. To accomplish this, have several groups of students design and solve the same problem and then discuss the advantages and disadvantages of each solution. Students see that solving some problems may lead to other problems, and demonstrate the ability to balance simple constraints in problem solving. Students should analyze and evaluate their own results or solutions to problems, as well as those of other students, by considering how a product or design met the challenge to solve the problem.

Personal and Social Perspectives

Students **investigate** the progression of tool use and development over time. They understand that people continue inventing new ways of solving problems, and getting things done. As they research inventions and technological advances, they begin to understand how new ideas and inventions affect other people. They analyze the advantages and disadvantages of new ideas and inventions. As students study ecosystems they will become acquainted with what happens when the environment becomes overpopulated and the use of resources increases. Through the landforms investigation students will **observe** earth's external processes that cause natural changes and present challenges, including landslides, floods, and storms.

Science – Grade 5

Energy Interactions

The focus for fifth grade students is on energy as a property of substances, its function within the earth and its environment, and its effect on the earth's processes and atmospheric movement. The strands provide a context for the teaching the content throughout all goals. Students will be actively involved in:

- Exploring energy interactions.
- Creating and maintaining a model ecosystem.
- Recognizing the forms of energy.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives

COMPETENCY GOAL 1: The learner will build an understanding of the interdependence of plants and animals.

Objectives

1.01 Assess a variety of ecosystems (communities of organisms and their interaction with the environment).
1.02 Determine the function of organisms within the population of the ecosystem: producers, consumers, and decomposers.
1.03 Evaluate the variety of organisms an ecosystem can support.
1.04 Relate the role of light, range of temperatures, and soil composition to an ecosystem's capacity to support life.
1.05 Evaluate the major source of energy for ecosystems (sunlight) and how it is passed from organism to organism in food webs.
1.06 Assess the interaction of organisms within an ecosystem.

COMPETENCY GOAL 2: The learner will build an understanding of forms and sources of energy.

Objectives

2.01 Assess the sources and forms of energy (heat, light, electricity, mechanical motion, and sound).
2.02 Assess the needs, benefits, distribution, pollution, and cost associated with society's use of energy.
2.03 Analyze the interaction and transformation of the forms of energy.

COMPETENCY GOAL 3: The learner will build an understanding of landforms.

Objectives

3.01 Summarize changes to the earth caused by erosion, weathering, and mass wasting.
3.02 Compare and contrast the stages of stream erosion and the valleys they produce.
3.03 Compare and contrast the rock structure and relief of plains, plateaus, and mountains

COMPETENCY GOAL 4: The learner will build an understanding of weather and climate.

Objectives

4.01 Analyze the water cycle:
- Evaporation.
- Condensation.
- Precipitation.
- Ground water.

4.02 Analyze the formation of clouds and their relation to weather systems.
4.03 Relate global atmospheric movement patterns to local weather.
4.04 Compile weather data to establish climate trends.
4.05 Evaluate oceans' effect on weather and climate.

Strands – Grades 6 – 8

The *Standard Course of Study* for Middle School Science provides unifying threads of understanding to weave through the integrated science content goals and objectives for middle school. The strands include the following goals:

Nature of Science

As a result of activities in grades 6-8, all students should develop an understanding of:

- Science as a human endeavor.
- Nature of scientific knowledge.
- Historical perspectives.

Science as Inquiry

As a result of activities in grades 6-8, all students should develop an understanding of:

- Ability to do scientific inquiry.
- Understanding about scientific inquiry.
- Ability to perform safe and appropriate manipulation of materials, scientific equipment, and technology.
- Mastery of integrated process skills.
  - -acquiring, processing, and interpreting data
  - -identifying variables and their relationships
  - -designing investigations
  - -experimenting
  - -analyzing investigations
  - -constructing hypotheses
  - -formulating models

Science and Technology

As a result of activities in grades 6-8, all students should develop an understanding of:

- What technologies are.
- Ability to perform technological design.
- Understanding science and technology.

Science in Personal and Social Perspectives

As a result of activities in grades 6-8, all students should develop an understanding of:

- Personal and community health.
- Population growth.
- Environmental quality.
- Natural and human-induced hazards.
- Science and technology in local, national, and global challenges.
- Careers in science and technology.

46

GRADE SIX

Goal

Sixth grade science builds on the concepts and skills acquired in kindergarten through fifth grade. Instructional design should provide opportunities for understanding the conceptual goals, objectives, and strands. Connections to mathematics, technology, social science, and communication skills also should be considered for instructional design. To assist teachers with instruction, materials explaining the goals, objectives, and strands with specific recommendations for classroom, laboratory, and/or field experiences are available through the Department of Public Instruction.

It is important that the nature of the adolescent be at the core of all curricula. Middle school students are undergoing extensive psychological, physiological, and social changes, which make them curious, energetic, and egocentric. Middle school science provides opportunities to channel the interests and concerns of adolescents, provided it maximizes their exposure to high interest topics. Middle school learners need to see a direct relationship between science education and daily life. Investigations designed to help students learn about themselves (human biology/health issues) and their world (environmental quality/space exploration/technology) motivate them.

Designing technological solutions and pondering benefits and risks should underlie the middle school science experience. As students take the initiative to learn science, they will learn about themselves, their community and possible careers. The confidence to pursue such personal goals can be instilled through successful science experience.

Nature of Science

Science is a human endeavor that relies on reasoning, insight, skill, and creativity. A parallel reliance on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas is crucial to the advancement of science and technology. Science would be a stagnant body of knowledge, were it not for humans continually seeking to understand and explain the natural world and their role in it. Capitalizing on the continuous public review of science and technology, middle school students should understand that the very nature of science is for some ideas to be constant yet tentative, probabilistic, historic, and replicable. The natural world can be understood through systematic study of the rules, patterns, and cycles in nature.

Many of science's universal laws are very old ideas that still apply today. In addition, using history to trace the technology evolution that led us from an agricultural to an industrial to an information and communication-based society exemplifies the nature of science. Public acceptance of modified or new ideas exemplifies the struggle of scientists who attempt to advance scientific knowledge or make breakthroughs. The learner should appreciate the efforts of past scientists that have given rise to modern science and technology.

A solid conceptual base of scientific principles, as well as knowledge of science safety is necessary for inquiry. Students should be given a supportive learning environment based on how scientists and engineers work. Adherence to all science safety criteria and guidelines for classroom, field, and laboratory experiences is imperative.

Science as Inquiry

Traditional laboratory experiences provide opportunities to demonstrate how science is constant, historic, probabilistic, and replicable Although there are no fixed steps that all scientists follow, scientific investigations usually involve collections of relevant evidence, the use of logical reasoning, and the application of imagination to devise hypotheses and explanations to make sense of collected evidence. Student engagement in scientific investigation provides background for understanding the nature of scientific inquiry. In addition, the science process skills necessary for inquiry are acquired through active experience. The process skills support development of reasoning and problem-solving ability and are the core of scientific methodologies. Students should:

- Structure questions that can be answered through scientific investigations.
- Clarify ideas that guide and influence the inquiry.
- Design and conduct scientific investigations to test ideas.
- Apply safe and appropriate abilities to manipulate materials, equipment, and technologies.
- Control and manipulate variables.
- Use appropriate resources and tools to gather, analyze, interpret, and communicate data.
- Use mathematics to gather, organize, and present data
  Students should:
- Make inferences from data .
- Use evidence to offer descriptions, predictions and models.
- Think critically and logically to bridge the relationships between evidence and explanations.
- Recognize and evaluate alternative explanations.

- Review experimental procedures.
- Communicate scientific procedures, results, and explanations.
- Formulate questions leading to further investigations.

Science and Technology

Science is the foundation of technology and new technology is necessary for the advancement of science. This reciprocity of science and technology should be emphasized with middle school learners. Current media topics, emerging technologies, and research issues provide a real-world context for understanding and applying targeted grade-level skills and concepts.

A single problem often has both scientific and technological aspects. For example, investigating the salinity of the water in North Carolina's sounds is the pursuit of science, while creating a way to make this salt water drinkable is the pursuit of technology. In other words, while science tries to understand the natural world, technology tries to solve practical problems. Technology expands our capacity to understand the world and to control the natural and human-made environment. Technology asks questions like "How does this work?" and "How can it be improved?"

The word "technology" has many definitions. It may, for example, mean a particular way of doing things, and or it may denote a specific object. Stephen Kiln, Professor of Mechanical Engineering at Stanford University has four definitions of technology (Kiln, 1985):

- artifact or hardware. (e.g., an aspirin, chair, computer, or video tape)
- methodology or technique. (e.g., painting, using a microscope or calculator)
- system of production. (e.g., the automobile assembly line, a process for manufacturing a product or an entire industry)
- social-technical system. (an airplane, for example, suggests a plethora of interrelated devices, human resources, and artifacts such as airports, passengers and pilots, fuel, regulations and ticketing).

Technology provides tools for understanding natural phenomena and often sparks scientific advances. It has always played a role in the growth of scientific knowledge. The techniques for shaping, producing or manufacturing tools, for example, are seen as the primary evidence of the beginning of human culture. Applying scientific knowledge of materials and processes to the benefit of people has been a determining factor in shaping our culture.

While understanding the connection of science and technology is critical, the ability to distinguish between the work of engineers and scientists also should be explored. Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations. Technology design skills are parallel to inquiry skills in science.

It is critical that students understand that technology enables us to design adaptations to the natural world but not without both positive and negative consequences. The limits on science's ability to answer all questions, and on technology's ability to design solutions for all adaptive problems, also must be stressed. Design requires that technological solutions adhere to the universal laws of nature. Constraints such as gravity or the properties of the materials to be used are critical to the success of a technological solution. Other constraints, including cost, time, politics, society, ethics, and aesthetics, also define parameters and limit choices. Students should analyze benefits and costs of technological solutions. Fundamental abilities of technological design include the ability to:

- Identify problems appropriate for technological design.
- Develop criteria for evaluating the product or solution.
- Identify constraints that must be taken into consideration
- Design a product or solution.
- Apply safe and appropriate abilities to manipulate materials, equipment, and technologies.
- Implement a proposed design.
- Evaluate completed design or product.
- Analyze the risks and benefits of the solution.
- Communicate the process of technological design.
- Review the process of technological design.

Science in Personal and Social Perspectives

The ultimate goal for a scientifically literate person is the ability to use appropriate scientific principles and processes in making personal decisions. Therefore, making personal and societal connections to scientific challenges is imperative for middle school learners. Concepts, skills and theories for middle school science afford opportunities to develop scientific understanding for many aspects of personal and societal health. Opportunities that nurture students' abilities to think creatively and scientifically abound, as students connect science to personal decision making. Personal and societal connections can be made as sixth grade students conduct in-depth investigations which:

- analyze the role of humans in the natural world using issues that concern the lithosphere.
- interpret the interconnectedness of all organisms in an ecosystem and the effect of disturbing parts of a system.
- evaluate the spin-offs generated by space exploration technology.
- investigate the importance of soil quality.

Patterns and Cycles

Learners study the patterns of natural and technological systems. The strands provide a context for teaching content throughout all goals. In-depth studies include:

- Lithosphere.
- Matter and Energy Flow in an Ecosystem.
- Solar System.
- Energy Transfer.

Strands: The Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives.

COMPETENCY GOAL 1: The learner will build an understanding of the lithosphere.

Objectives

1.01 Determine how physical and biological agents and processes form soil and affect soil characteristics.

1.02 Analyze soil properties that can be observed and measured to predict soil quality:
- Horizon profile.
- Infiltration.
- Soil temperature.
- Structure.
- Consistency.
- Texture.
- Particle size.
- Soil pH.
- Fertility.
- Soil moisture.

1.03 Evaluate ways in which human activities have affected Earth's pedosphere and the measures taken to control the impact:
- Ground cover.
- Farming.
- Land use.
- Nutrient balance.

COMPETENCY GOAL2: The learner will investigate the characteristics of matter and energy flow through an ecosystem.

Objectives

2.01 Examine evidence that plants convert light energy into stored energy which the plant, in turn, uses to carry out its life processes.

2.02 Differentiate between the interconnected terrestrial and aquatic global food webs.

2.03 Describe ways in which organisms interact with each other and with non-living parts of the environment:
- Limiting factors.
- Coexistence/Cooperation/Competition.
- Symbiosis.

2.04 Evaluate the consequences of disrupting food webs.

COMPETENCY GOAL 3: The learner will build understanding of the Solar System.

Objectives

3.01 Interpret scientific theories concerning the components, patterns, and cycles of the solar system.

3.02 Compare and contrast the Earth to other planets in terms of:
- Size.
- Composition.
- Relative distance from the sun.
- Ability to support life.

3.03 Relate the influence of the sun and the moon's orbit to the gravitational effects produced on Earth.

3.04 Associate the revolution of Earth around the sun and the tilt of Earth's axis with the seasons.

3.05 Identify technologies used to explore space.

3.06 Analyze the spin-off benefits generated by space exploration technology.

COMPETENCY GOAL 4: The learner will investigate the characteristics of energy transfer.

Objectives

4.01 Determine how convection and radiation transfer energy.

4.02 Analyze heat flow through materials or across space from warm objects to cooler objects until both objects are at equilibrium.

4.03 Conclude that vibrating materials generate waves that transfer energy.

4.04 Evaluate data for qualitative and quantitative relationships associated with energy transfer and/or transformation.

4.05 Analyze the physical interactions of light and matter:
- Absorption.
- Scattering.
- Color perception.

4.06 Examine the law of conservation of energy.

GRADE SEVEN

Goal

Seventh grade science builds on the concepts and skills acquired in kindergarten through sixth grade. Instructional design should provide opportunities for understanding the conceptual goals, objectives, and strands. Connections to mathematics, technology, social science, and communication skills also should be considered for instructional design. To assist teachers with instruction, materials explaining the goals, objectives, and strands with specific recommendations for classroom, laboratory, and/or field experiences are available through the Department of Public Instruction's Publications Section.

It is important that the nature of the adolescent be at the core of all curricula. Middle school students are undergoing extensive psychological, physiological, and social changes, which make them curious, energetic, and egocentric. Middle school science provides opportunities to channel the interests and concerns of adolescents, provided it maximizes their exposure to high-interest topics. Middle school learners need to see a direct relationship between science education and daily life. Investigations designed to help students learn about themselves (human biology/health issues) and their world (environmental quality/space exploration/technology) motivate them.

Designing technological solutions and pondering benefits and risks should underlie the middle school science experience. As students take the initiative to learn science, they will learn about themselves, their community and possible careers. The confidence to pursue such personal goals can be instilled through successful science experience.

Nature of Science

Science is a human endeavor that relies on reasoning, insight, skill, and creativity. A parallel reliance on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas is crucial to the advancement of science and technology. Science would be a stagnant body of knowledge, were it not for humans continually seeking to understand and explain the natural world and their role in it. Capitalizing on the continuous public review of science and technology, middle school students should understand that the very nature of science is for some ideas to be constant yet tentative, probabilistic, historic, and replicable. The natural world can be understood through systematic study of the rules, patterns, and cycles in nature.

Many of science's universal laws are very old ideas that still apply. In addition, using history to trace the technology evolution that led us from an agricultural to an industrial to an information and communication-based society illustrates the nature of science. Public acceptance of modified or new ideas exemplifies the struggle of scientists who attempt to advance scientific knowledge or make breakthroughs. The learner should appreciate the efforts of past scientists that have given rise to modern science and technology.

A solid conceptual base of scientific principles, as well as knowledge of science safety is necessary for inquiry. Students should be given a supportive learning environment based on how scientists and engineers work. Adherence to all science safety criteria and guidelines for classroom, field, and laboratory experiences is imperative.

Science as Inquiry

Traditional laboratory experiences provide opportunities to demonstrate how science is constant, historic, probabilistic, and replicable Although there are no fixed steps that all scientists follow, scientific investigations usually involve collections of relevant evidence, the use of logical reasoning, and the application of imagination to devise hypotheses and explanations to make sense of collected evidence. Student engagement in scientific investigation provides background for understanding the nature of scientific inquiry. In addition, the science process skills necessary for inquiry are acquired through active experience. The process skills support development of reasoning and problem-solving ability and are the core of scientific methodologies. Students should:

- Structure questions that can be answered through scientific investigations.
- Clarify ideas that guide and influence the inquiry.
- Design and conduct scientific investigations to test ideas.
- Apply safe and appropriate abilities to manipulate materials, equipment, and technologies.
- Control and manipulate variables.
- Use appropriate resources and tools to gather, analyze, interpret, and communicate data.
- Use mathematics to gather, organize, and present data.
- Make inferences from data.
- Use evidence to offer descriptions, predictions and models.

Students should:

- Think critically and logically to bridge the relationships between evidence and explanations.
- Recognize and evaluate alternative explanations.
- Review experimental procedures.
- Communicate scientific procedures, results, and explanations.
- Formulate questions leading to further investigations.

Science and Technology

Science is the foundation of technology and new technology is necessary for the advancement of science. This reciprocity of science and technology should be emphasized with middle school learners. Current media topics, emerging technologies, and research issues provide a real-world context for understanding and applying targeted grade-level skills and concepts.

A single problem often has both scientific and technological aspects. For example, investigating the salinity of the water in North Carolina's sounds is the pursuit of science, while creating a way to make this salt water drinkable is the pursuit of technology. In other words, while science tries to understand the natural world, technology tries to solve practical problems. Technology expands our capacity to understand the world and to control the natural and human-made environment. Technology asks questions like "How does this work?" and "How can it be improved?"

The word "technology" has many definitions. It may, for example, mean a particular way of doing things, and or it may denote a specific object. Stephen Kiln, Professor of Mechanical Engineering at Stanford University has four definitions of technology (Kiln, 1985):

- Artifact or hardware. (e.g., an aspirin, chair, computer, or video tape)
- Methodology or technique. (e.g., painting, using a microscope or calculator)
- System of production. (e.g., the automobile assembly line, a process for manufacturing a product or an entire industry)
- Social-technical system. (an airplane, for example, suggests a plethora of interrelated devices, human resources, and artifacts such as airports, passengers and pilots, fuel, regulations and ticketing)

Technology provides tools for understanding natural phenomena and often sparks scientific advances. It has always played a role in the growth of scientific knowledge. The techniques for shaping, producing or manufacturing tools, for example, are seen as the primary evidence of the beginning of human culture. Applying scientific knowledge of materials and processes to the benefit of people has been a determining factor in shaping our culture.

While understanding the connection of science and technology is critical, the ability to distinguish between the work of engineers and scientists also should be explored. Scientists propose explanations for questions about the natural world, while engineers propose solutions relating to human problems, needs, and aspirations. Technology design skills are parallel to inquiry skills in science.

It is critical that students understand that technology enables us to design adaptations to the natural world but not without both positive and negative consequences. The limits on science's ability to answer all questions, and on technology's ability to design solutions for all adaptive problems, also must be stressed. Design requires that technological solutions adhere to the universal laws of nature. Constraints such as gravity or the properties of the materials to be used are critical to the success of a technological solution. Other constraints, including cost, time, politics, society, ethics, and aesthetics, also define parameters and limit choices. Students should analyze benefits and costs of technological solutions. Fundamental understandings necessary for technological design include the abilities to:

- Identify problems appropriate for technological design.
- Develop criteria for evaluating the product or solution.
- Identify constraints that must be taken into consideration.
- Design a product or solution.
- Apply safe and appropriate abilities to manipulate materials, equipment, and technologies.
- Implement a proposed design.
- Evaluate completed design or product.
- Analyze the risks and benefits of the solution.
- Communicate the process of technological design.
- Review the process of technological design.

Science in Personal and Social Perspectives

The ultimate goal for a scientifically literate person is the ability to use appropriate scientific principles and processes in making personal decisions. Therefore, making personal and societal connections to scientific challenges is imperative for middle school learners. Concepts, skills and theories for middle school science afford opportunities to develop scientific understanding for many aspects of personal and societal health. Opportunities that nurture students' abilities to think creatively and scientifically abound, as students connect science to personal decision making. Personal and societal connections can be made as seventh grade students conduct in-depth investigations which:

- Conceptualize the form and function of interacting systems within an organism
- Evaluate the economic, social, and ethical issues raised by selective breeding and biomedical research
- Analyze the use of technology in predicting, monitoring, and recording atmospheric data
- Evaluate the importance of air quality
- Determine the suitability of materials for technological design.

Interactions and Limits

Learners study the interactions and limiting factors of natural and technological systems. The strands provide a context for teaching content throughout all goals. In-depth studies include:

- Atmosphere.
- Cell Theory.
- Genetics/Heredity.
- Matter.

Strands: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives.

COMPETENCY GOAL 1: The learner will build an understanding of the atmosphere.

Objectives

1.01 Explain the composition, properties, and structure of the atmosphere.

1.02 Analyze the properties that can be observed and measured to predict air quality:
- Particulate matter.
- Ozone.
- Pollen.
- Temperature inversions.

1.03 Examine evidence that atmospheric properties can be studied to predict atmospheric conditions and weather hazards:
- Humidity.
- Temperature.
- Wind speed and direction.
- Air pressure.
- Precipitation (pH).

1.04 Evaluate human impact on the atmosphere.

1.05 Assess the use of technology in predicting, monitoring, and recording atmospheric phenomena.

COMPETENCY GOAL 2: The learner will build an understanding of cell theory.

Objectives

2.01 Analyze structures, functions, and processes within plant and animal cells:
- Capture and release energy.
- Feedback information.
- Dispose of wastes.
- Reproduction.
- Enable movement.
- Specialized.

2.02 Compare life functions of protists.

2.03 Analyze human body systems:
- Form to function.
- Interrelationships.

2.04 Relate disease to biological hazards:
- Pollen.
- Viruses.
- Bacteria.
- Parasites.

COMPETENCY GOAL 3: The learner will build an understanding of heredity and genetics.

Objectives

3.01 Explain the significance of chromosomes, genes, and DNA in cell reproduction and their relationship to inherited characteristics.

3.02 Analyze the role of probability in the study of heredity.

3.03 Explain how, during reproduction, the sorting and recombination of parents' genetic material produces potential variation among offspring.

3.04 Summarize the genetic transmittance of disease.

3.05 Analyze the issues raised by selective breeding and biomedical research.

COMPENTENCY GOAL 4: The learner will build an understanding of the general properties and interactions of matter.

Objectives

4.01 Classify substances based on their properties:
- Elements.
- Compounds.
- Mixtures.

4.02 Relate state of matter to the arrangement and motion of atoms or molecules.

4.03 Analyze the suitability of materials for use in technological design:
- Conductivity.
- Density.
- Magnetism.
- Solubility.
- Rigidity.
- Flexibility.

4.04 Classify objects based on characteristics:
- Density.
- Boiling/Melting points.
- Solubility.

60

4.05 Describe and measure quantities related to chemical/physical changes within a system:

- Temperature.
- Volume.
- Mass.
- Precipitate.
- Gas production.

4.06 Evaluate evidence to support the law of conservation of matter.

GRADE EIGHT

Goal

Eighth grade science builds on the concepts and skills acquired in kindergarten through seventh grade. Instructional design should provide opportunities for understanding the conceptual goals, objectives, and strands. Connections to mathematics, technology, social science, and communication skills also should be considered for instructional design. To assist teachers with instruction, materials explaining the goals, objectives, and strands with specific recommendations for classroom, laboratory, and/or field experiences are available through the Department of Public Instruction's Publications Section.

It is important that the nature of the adolescent be at the core of all curricula. Middle school students are undergoing extensive psychological, physiological, and social changes, which make them curious, energetic, and egocentric. Middle school science provides opportunities to channel the interests and concerns of adolescents, provided it maximizes their exposure to high-interest topics. Middle school learners need to see a direct relationship between science education and daily life. Investigations designed to help students learn about themselves (human biology/health issues) and their world (environmental quality/space exploration/technology) motivate them.

Designing technological solutions and pondering benefits and risks should underlie the middle school science experience. As students take the initiative to learn science, they will learn about themselves, their community and possible careers. The confidence to pursue such personal goals can be instilled through successful science experience.

Nature of Science

Science is a human endeavor that relies on reasoning, insight, skill, and creativity. A parallel reliance on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas is crucial to the advancement of science and technology. Science would be a stagnant body of knowledge, were it not for humans continually seeking to understand and explain the natural world and their role in it. Capitalizing on the continuous public review of science and technology, middle school students should understand that the very nature of science is for some ideas to be constant yet tentative, probabilistic, historic, and replicable. The natural world can be understood through systematic study of the rules, patterns, and cycles in nature.

Many of science's universal laws are very old ideas that still apply. In addition, using history to trace the technology evolution that led us from an agricultural to an industrial to an information and communication-based society illustrates the nature of science. Public acceptance of modified or new ideas exemplifies the struggle of scientists who attempt to advance scientific knowledge or make breakthroughs. The learner should appreciate the efforts of past scientists that have given rise to modern science and technology.

A solid conceptual base of scientific principles, as well as knowledge of science safety is necessary for inquiry. Students should be given a supportive learning environment based on how scientists and engineers work. Adherence to all science safety criteria and guidelines for classroom, field, and laboratory experiences is imperative.

Science as Inquiry

Traditional laboratory experiences provide opportunities to demonstrate how science is constant, historic, probabilistic, and replicable Although there are no fixed steps that all scientists follow, scientific investigations usually involve collections of relevant evidence, the use of logical reasoning, and the application of imagination to devise hypotheses and explanations to make sense of collected evidence. Student engagement in scientific investigation provides background for understanding the nature of scientific inquiry. In addition, the science process skills necessary for inquiry are acquired through active experience. The process skills support development of reasoning and problem-solving ability and are the core of scientific methodologies. Students should:

- Structure questions that can be answered through scientific investigations.
- Clarify ideas that guide and influence the inquiry.
- Design and conduct scientific investigations to test ideas.
- Apply safe and appropriate abilities to manipulate materials, equipment, and technologies.
- Control and manipulate variables.
- Use appropriate resources and tools to gather, analyze, interpret, and communicate data.
- Use mathematics to gather, organize, and present data.
- Make inferences from data.
- Use evidence to offer descriptions, predictions and models.
- Think critically and logically to bridge the relationships between evidence and explanations.
- Recognize and evaluate alternative explanations.

- Review experimental procedures.
- Communicate scientific procedures, results, and explanations.
- Formulate questions leading to further investigations.

Science and Technology

Science is the foundation of technology and new technology is necessary for the advancement of science. This reciprocity of science and technology should be emphasized with middle school learners. Current media topics, emerging technologies, and research issues provide a real-world context for understanding and applying targeted grade-level skills and concepts.

A single problem often has both scientific and technological aspects. For example, investigating the salinity of the water in North Carolina's sounds is the pursuit of science, while creating a way to make this salt water drinkable is the pursuit of technology. In other words, while science tries to understand the natural world, technology tries to solve practical problems. Technology expands our capacity to understand the world and to control the natural and human-made environment. Technology asks questions like "How does this work?" and "How can it be improved?"

The word "technology" has many definitions. It may, for example, mean a particular way of doing things, and or it may denote a specific object. Stephen Kiln, Professor of Mechanical Engineering at Stanford University has four definitions of technology (Kiln, 1985):

- Artifact or hardware. (e.g., an aspirin, chair, computer, or video tape)
- Methodology or technique. (e.g., painting, using a microscope or calculator)
- System of production. (e.g., the automobile assembly line, a process for manufacturing a product or an entire industry)
- Social-technical system. (an airplane, for example, suggests a plethora of interrelated devices, human resources, and artifacts such as airports, passengers and pilots, fuel, regulations and ticketing)

Technology provides tools for understanding natural phenomena and often sparks scientific advances. It has always played a role in the growth of scientific knowledge. The techniques for shaping, producing or manufacturing tools, for example, are seen as the primary evidence of the beginning of human culture. Applying scientific knowledge of materials and processes to the benefit of people has been a determining factor in shaping our culture.

While understanding the connection of science and technology is critical, the ability to distinguish between the work of engineers and scientists also should be explored. Scientists propose explanations for questions about the natural world, while engineers propose solutions relating to human problems, needs, and aspirations. Technology design skills are parallel to inquiry skills in science.

It is critical that students understand that technology enables us to design adaptations to the natural world but not without both positive and negative consequences. The limits on science's ability to answer all questions, and on technology's ability to design solutions for all adaptive problems, also must be stressed. Design requires that technological solutions adhere to the universal laws of nature. Constraints such as gravity or the properties of the materials to be used are critical to the success of a technological solution. Other constraints, including cost, time, politics, society, ethics, and aesthetics, also define parameters and limit choices. Students should analyze benefits and costs of technological solutions. Fundamental understandings necessary for technological design include the abilities to:

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- Implement a proposed design.
- Evaluate completed design or product.
- Analyze the risks and benefits of the solution.
- Communicate the process of technological design.
- Review the process of technological design.

Science in Personal and Social Perspectives

The ultimate goal for a scientifically literate person is the ability to use appropriate scientific principles and processes in making personal decisions. Therefore, making personal and societal connections to scientific challenges is imperative for middle school learners. Concepts, skills and theories for middle school science afford opportunities to develop scientific understanding for many aspects of personal and societal health. Opportunities that nurture students' abilities to think creatively and scientifically abound, as students connect science to personal decision making. Personal and societal connections can be made as eighth grade students conduct in-depth investigations which:

- Conceptualize inherent problems and solutions related to population growth.
- Evaluate the theories of biological, geological, and technological evolution.
- Analyze information from technologies utilized to monitor the earth from space.
- Evaluate the importance of water quality.
- Investigate everyday applications of forces and laws of motion.

66

SCIENCE – Grade 8

Constancy and Change

Learners will study the constancy and change of natural and technological systems. The strands provide a context for teaching content throughout all goals. In-depth studies include:

- Hydrosphere.
- Population Dynamics.
- Evolution Theory.
- Motion and Forces.

Strands: Nature of Science. Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives.

COMPETENCY GOAL 1: The learner will build an understanding of the hydrosphere.

Objectives

1.01 Explain the composition, properties, and structure of the hydrosphere.

1.02 Analyze hydrospheric data over time to predict the health of a water system:
- Temperature.
- Dissolved oxygen.
- pH.
- Alkalinity.
- Nitrates.

1.03 Evaluate evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms.

1.04 Assess human impact on water quality.

1.05 Evaluate the effects of point and non-point sources of pollution on North Carolina water.

COMPETENCY GOAL 2: The learner will build an understanding of population dynamics.

Objectives

2.01 Evaluate data related to population growth, along with problems and solutions:
- Waste disposal.
- Food supplies.
- Disease control.
- Resource availability.
- Transportation.

2.02 Conclude that some ecosystem resources are finite.

2.03 Explain how changes in habitat may affect organisms:

2.04 Analyze practices that affect the use, availability, and management of natural resources:

- Land use.
- Urban growth.
- Manufacturing.

COMPETENCY GOAL 3: The learner will build an understanding of evidence of change or constancy in organisms and landforms over time.

Objectives

3.01 Interpret ways in which rocks, fossils, and ice cores record Earth's geologic history and the evolution of life.

3.02 Evaluate evolutionary theories and processes:

- Biological.
- Geological.
- Technological.

3.03 Examine evidence that the movement of continents has had significant global impact:

- Distribution of living things.
- Major geological events.

3.04 Evaluate the forces which shape the lithosphere:

- Constructive.
- Destructive.
- Earthquakes.

3.05 Analyze information from technology used to monitor Earth from space.

3.06 Analyze factors that determine Earth's climate.

Competency Goal 4: The learner will build an understanding of motion and forces.

Objectives

4.01 Analyze gravity as a universal force.

4.02 Demonstrate ways that simple machines can change force.

4.03 Analyze simple machines for mechanical advantage and efficiency.

4.04 Determine how the force of friction retards motion.

4.05 Develop an understanding that an object's motion is always judged relative to some other object or point.

4.06 Describe and measure quantities that characterize moving objects and their interactions within a system:

- Time.
- Distance.
- Mass.
- Force.
- Velocity.
- Center of mass.

4.07 Apply Newton's Laws of Motion to the way the world works:

- Inertia.
- Acceleration.
- Gravitation.
- Action/Reaction.

4.08 Investigate electricity and magnetism as universal forces:

- Basic properties.
- Relationship between.
- Technological applications.

Strands – Grades 9–12

The *Standard Course of Study* for Grades 9 – 12 provides unifying threads of understanding throughout the content areas of high school science. The strands include the following goals: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspective.

Nature of Science

As a result of activities in grades 9 – 12, all students should develop an understanding of:

- Science as a human endeavor.
- Nature of scientific knowledge.
- Historical perspectives.

Science as Inquiry

As a result of activities in grades 9 – 12, all students should develop:

- The ability to do scientific inquiry.
- Understanding about scientific inquiry.
- Abilities to perform safe and appropriate manipulation of materials, equipment, and technologies.
- Mastery of integrated process skills.
  -acquiring, processing, and interpreting data.
  -identifying variables and their relationships.
  -designing investigations.
  -experimenting.
  -analyzing investigations.
  -constructing hypotheses.
  -formulating models.

Science and Technology

As a result of activities in grades 9 – 12, all students should develop:

- An understanding of technology.
- The ability to perform technological design.
- An understanding of the connection between science and technology.

Science in Personal and Social Perspectives

As a result of activities in grades 9 – 12, all students should develop an understanding of:

- Personal and community health.
- Population growth.
- Natural resources.
- Environmental quality.
- Natural and human induced hazards.
- Science and technology in local, national, and global challenges.
- Careers in science and technology.

71

Goal

Instructionally, these concepts should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Nature of Science

This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Biology is particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific understanding.

Science as a Human Endeavor

Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work collaboratively in groups, to design investigations, formulate hypothesis, collect data, reach conclusions, and present their findings to their classmates.

The content studied in biology provides an opportunity to present science as the basis for medicine, ecology, forensics, biotechnology, and environmental studies. The diverse biology content allows for looking at science as a vocation. Scientist, artist, and technician are just a few of the many careers in which a biology background is necessary.

Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.

Historical Perspectives

Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge-building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances. For example, from Mendel's story, to the work of Watson and Crick, to modern breakthroughs in gene manipulation for therapeutic purposes, history illustrates every important facet of the nature of science.

As students explore original writing by and about scientists, they will uncover human drama, such as the obscurity of Mendel's work until after his death, and the interpersonal struggles involved in the discovery of DNA. They will understand that knowledge generated by one generation usually is expanded, modified, or even discarded by the next generation.

Nature of Scientific Knowledge

Much of what is understood about the nature of science must be explicitly addressed:

- All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use.

- Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories just become stronger as more supporting evidence is gathered. They provide a context for further research and give us a basis for prediction. For example, the theory of biological evolution is an explanation for phenomena such as diversity of species. Gene theory is an explanation for relationships we observe between one generation and the next.

- Laws are fundamentally different from theories. They are universal generalizations based on observations of the natural world, such as the nature of gravity, the relationship of forces and motion and the nature of planetary movement. Scientists, in their quest for the best explanations of natural phenomena, employ rigorous methods. Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanations of 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." (1995, National Science Education Standards)

Science as Inquiry

Inquiry should be the central theme in biology. Inquiry is an integral part of the learning experience and may be used in both traditional class problems and laboratory experiences. The essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students to build knowledge and communicate what they have learned. Inquiry is the application of creative thinking to new and unfamiliar situations. Students should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event or ones that challenge students' intuitions have been successful. Classical experiments confirming well-accepted scientific principles may be necessary to reinforce constructed understandings and to teach safe and proper use of laboratory techniques and instruments, but they should not be the whole laboratory experience.

Instead, laboratory experience should provide a foundation for exploring new questions. In biology, for example, traditional labs such as dissection and observation of plant and animal cells may be quite appropriate. They should, however, lead to open-ended explorations such as the study of a particular animal's anatomy in relation to its environment and behavior, or the effect of changing environmental conditions on the growth of yeast (or other) cells. These kinds of activities teach student how science is done – how to clarify questions, how to design and experiment, how to record and display data, how to communicate knowledge generated. If this time investment means that a memorization of the parts of the cells and their function is left undone, consider the long-term value for students and make the necessary trade-offs. A student can always consult a book if he/she needs to know about a cell organelle, but a book will not provide the experience of generating new knowledge through scientific exploration.

Biology provides potential for many inquiries. "Does the earthworm respond to light?" "Why?" "Does temperature affect the metabolic activity of yeast?" "Why?" The process of inquiry, experimental design, investigation, and analysis is as important as finding the correct answer. Students will master much more than facts and manipulative skills; they will learn to be critical thinkers.

Science and Technology

It would be impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology.

The methods of scientific inquiry and technological design share many common elements – objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design differs from inquiry in that it must operate within the limitations of materials, scientific laws, economics, and the demands of society. Together, science and technology present many solutions to problems of survival and enhance the quality of life. Technological design plays an important role in building knowledge in biology. For example, electron microscopes, graphing calculators, personal computers, and magnetic resonance images have changed our lives, increased our knowledge of biology, and improved our understanding of the universe.

Science in Personal and Social Perspectives

This strand is designed to help students formulate basic understanding and implied actions for many issues facing our society. The fundamental concepts that form the basis for this strand include:

Personal and Community Health

Biology is an excellent context for investigating the factors that affect the health of organisms in general and humans in specific. Persuading adolescents to adopt personal habits that contribute to long-term health is not always easy. Looking at issues such as nutrition, exercise, rest, and substance abuse from the perspective of an organism's needs and responses provides a less emotional atmosphere for considering health issues relevant to teenagers.

Population Growth

Biology students should develop the ability to assess the carrying capacity of a given environment and its implied limits on population growth, as well as how technology allows environmental modifications to adjust its carrying capacity.

Environmental Quality

The role of biological sciences is particularly relevant to areas where humans affect and are affected by other organisms and the non-living environment. The curriculum offers opportunities for students to make decisions based on evidence in the areas of environmental stewardship and economic realities.

Science and Technology in Local, National, and Global Challenges

This strand examines the involvement of human decisions in the use of scientific and technological knowledge. Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science-and technology-related challenges. However, understanding science alone will not resolve local, national, or global challenges. Students should understand the appropriateness and value of basic questions "What can happen?" – "What are the Odds?"– and "How do scientists and engineers know what will happen?' " (NSES)

Students should understand the causes and extent of science-related challenges. They should become familiar with the advances and improvements that proper application of scientific principles and products have brought to environmental enhancement, wise energy use, reduced vehicle emissions, and improved human health.

Biology - Grades 9 - 12

The Biology curriculum is designed to continue student investigations of the biological sciences begun in grades K – 8. High school inquiry is expanded to include more abstract concepts such as the function of DNA, biological evolution, and the interdependence of organisms. The curriculum includes inquiry into the following content areas:

- The cell
- Molecular basis of heredity
- Biological evolution
- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Strands: The strands are: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. The strands provide the context for teaching of the content Goals and Objectives.

COMPETENCY GOAL 1: The learner will develop an understanding of the physical, chemical and cellular basis of life.

Objectives

1.01 Analyze the matter-energy relationships of living and non-living things including:
- Chemical processes and regulatory mechanisms of cells.
- Bonding patterns.
- Energy use and release in biochemical reactions.

1.02 Describe the structure and function of cell organelles.

1.03 Compare and contrast the structure and function of prokaryotic and eukaryotic cells.

1.04 Assess and explain the importance of water to cells, as well as transport into and out of cells.

1.05 Describe the structure and function of enzymes and explain their importance in biological systems.

1.06 Analyze the bioenergetic reactions:
- Aerobic respiration.
- Anaerobic respiration.
- Photosynthesis.
- Chemosynthesis.

COMPETENCY GOAL2: The learner will develop an understanding of the continuity of life and the changes of organisms over time.

Objectives

2.01 Analyze the molecular basis of heredity/DNA including:
- Replication.
- Protein synthesis (transcription, translation).

2.02 Compare and contrast the characteristics of asexual and sexual reproduction.

2.03 Interpret and use the laws of probability to predict patterns of inheritance.

2.04 Assess the application of DNA technology to forensics, medicine, and agriculture.

2.05 Analyze and explain the role of genetics and environment in health and disease.

2.06 Examine the development of the Theory of Biological Evolution including:
- The origins of life.
- Patterns.
- Variation.
- Natural selection.

COMPETENCY GOAL3: The learner will develop an understanding of the unity and diversity of life.

Objectives

3.01 Relate the variety of living organisms to their evolutionary relationships.

3.02 Classify organisms according to currently accepted systems.

3.03 Determine the form and function of organisms including:
- Organ systems of animals.
- Functional systems of plants including: transport, reproduction, and regulation.

3.04 Compare and contrast the processes of reproduction, growth, development, and regulation of major phyla of organisms.

3.05 Determine the internal and external factors that influence the growth and development of organisms.

COMPETENCY GOAL 4: The learner will develop an understanding of ecological relationships among organisms.

Objectives

4.01 Identify the interrelationships among organisms, populations, communities, ecosystems, and biomes.

4.02 Analyze the cycling of matter: water, carbon, and nitrogen in systems.

4.03 Explain the flow of energy through ecosystems.

4.04 Assess and describe successional changes in ecosystems.

4.05 Assess and explain human activities that influence and modify the environment:

- Global warming.
- Human population growth.
- Pesticide use.

COMPETENCY GOAL 5: Students will develop an understanding of the behavior of organisms, resulting from a combination of heredity and environment.

Objectives

5.01 Evaluate the survival of organisms and suitable adaptive responses to environmental pressures.

5.02 Assess and examine plant tropism and other responses.

5.03 Assess, describe, and explain types of animal behaviors (taxis, reflexes, instincts, and learned behavior).

5.04 Analyze the biological clocks and rythmic behavior of organisms.

5.05 Evaluate and explain the evolution of behavioral adaptations and survival of populations.

CHEMISTRY

Goals

This explanation introduces teachers to the strands. Instructionally, these concepts should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Nature of Science

This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Chemistry is particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific knowledge.

Science as a Human Endeavor

Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work in groups, design investigations, formulate hypothesis, collect data, reach conclusions, and present their findings to their classmates.

The content studied in chemistry provides an opportunity to present science as the basis for engineering, ecology, computer science, health sciences and the technical trades. The diversity of chemistry content allows for looking at science as a vocation. Scientist, artist, and technician are just a few of the many careers in which a chemistry background is necessary.

Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.

Historical Perspectives

Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances.

The philosophical perspective of Democritus (who produced no experimental evidence) to the genius of Dalton's inferences from his observation of gases, a historical view, makes chemistry come alive. In other examples, the history of Aristotle's philosophy of matter, and of Dalton's and Bohr's models of atomic theory, emphasize the value of a scientific model in enabling researchers to explore an unseen entity by starting with certain assumptions posited by the model.

Nature of Scientific Knowledge

Much of what is understood about the nature of science must be explicitly addressed.

- All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use.

- Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories just become stronger as more supporting evidence is gathered. They provide a context for further research and give us a basis for prediction. For example, atomic theory is an explanation for the behavior of matter based on the existence of tiny particles. Kinetic molecular theory explains, among other things, the expansion and contraction of gases.

Laws are fundamentally different from theories. They are universal generalizations based on observations we have made of the natural world, such as the nature of gravity, the relationship of forces and motion, and the nature of planetary movement. Scientists, in their quest for the best explanations of natural phenomena, employ rigorous methods Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanations of 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." (1995, National Science Education Standards)

Science as Inquiry

Inquiry should be the central theme in chemistry. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory work. Because of the unique safety issues that arise in the chemistry lab, students must be given well-supervised experience in basic laboratory techniques, including safe use of materials and equipment. However, the essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students build knowledge and communicate what they have learned.

Inquiry applies creative thinking to new and unfamiliar situations. Students should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event or ones that challenge students' intuition have been successful. Classical experiments confirming well-accepted scientific principles may be necessary to reinforce constructed understandings and to teach safe and proper use of laboratory techniques and instruments, but they should not be the whole laboratory experience. Instead, laboratory experience should be a foundation for exploring new questions. Experiments such as measurement of physical properties, decomposition of compounds, and observation of the behavior of gases should be preliminary to open-ended investigations in which students are charged with posing questions, designing experiments, recording and displaying data, and communicating. For example, after measuring physical properties, students might investigate the relationship between the density of certain liquids and their boiling points. Although original research by students traditionally has been relegated to a yearly science fair project, ongoing student involvement in this process contributes to their understanding of scientific enterprise and to their problem-solving abilities.

Science and Technology

It is impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology.

The methods of scientific inquiry and technological design share many common elements – objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design differs from inquiry in that it must operate within the limitations of materials, scientific laws, economics, and the demands of society. Together, science and technology present many solutions to problems of survival and enhance the quality of life.

Technological design plays an important role in building chemistry knowledge. For example, electron microscopes, super-colliders, personal computers, and spectroscopes have changed our lives, increased our knowledge of chemistry, and improved our understanding of the universe.

Science in Personal and Social Perspectives

This strand is designed to help students formulate basic understandings and implied actions for many current issues facing our society. The fundamental concepts that form the basis for this strand include:

Environmental Quality

Studies indicate that the general public associates "chemicals" with materials that may harm humans and/or the environment. For that reason, it is particularly important to lead students to approach such issues scientifically. There are, obviously, both negative and positive impacts from man-made chemicals, and students can gain much from conducting cost/benefit analyses of selected uses. Such tasks emphasize the use of evidence in decision-making, a skill that transfers to every aspect of students' lives.

There are many available resources that promote one point of view or another about the use of chemicals. Having students analyze such materials for accuracy, possible bias, and misleading statements equip them to make decisions as consumers and voters. Scientists from local industries or colleges and universities can provide excellent help in evaluating such publications and, at the same time, provide information about careers in chemistry.

Science and Technology in Local, National, and Global Challenges

This strand examines the involvement of human decisions in the application of scientific and technological knowledge "Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology-related challenges. However, understanding science alone will not resolve local, national, or global challenges. Students should understand the appropriateness and value of basic questions 'What can happen?' – 'What are the Odds?'– and, 'How do scientists and engineers know what will happen?' " (1995, National Science Education Standards)

Students should understand the causes and extent of science-related challenges. They should become familiar with the advances and improvements that proper application of scientific principles and products have brought to environmental enhancement, wise energy use, reduced vehicle emissions, and improved human health.

The relationship between science and technology is easily seen in the discipline of chemistry. As students explore chemistry from a historical perspective, they can easily investigate the technology that contributed to knowledge in specialized areas. A relevant assignment might ask students to identify the technology used by researchers in exploring the atom and the relationships of the technology to the sophistication of the knowledge gained. Another assignment might be for students to compare the relative simplicity of Rutherford's gold foil apparatus to the space-age technology of modern super-colliders. Interviews with scientists and technicians in all areas of chemistry could provide a rich listing of the newest research instruments and the kinds of questions they seek to answer.

Chemistry - Grades 9 -12

The chemistry course encourages students to continue their investigation of the structure of matter along with chemical reactions and the conservation of energy in these reactions. Inquiry is applied to the study of the transformation, composition, structure, and properties of substances. The course focuses on basic chemical concepts and incorporates activities that promote investigations to reinforce the concepts.

The curriculum includes inquiry into the following content areas:

- Structure of atoms.
- Structure and properties of matter.
- Chemical reactions.
- Conservation of energy and matter.
- Interaction of energy and matter.

Strands: The strands are: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. They provide the context for teaching of the content Goals and Objectives.

COMPETENCY GOAL 1: The learner will build an understanding of the structure and properties of matter.

Objectives

1.01 Summarize the development of current atomic theory.

1.02 Examine the nature of atomic structure:
- Protons.
- Neutrons.
- Electrons.
- Atomic mass.
- Atomic number.
- Electron configuration.
- Energy levels.
- Isotopes.

1.03 Apply the language and symbols of chemistry.

1.04 Identify substances using their physical properties:
- Melting points.
- Boiling points.
- Density.
- Color.
- Solubility.

1.05 Analyze and explain the nature and behavior of the atomic nucleus including radioactive isotopes and their practical application.

1.06 Analyze the basic assumptions of kinetic molecular theory and its applications:
- Ideal Gas Equation.
- Combined Gas Law.
- Graham's Law.
- Dalton's Law of Partial Pressures.

1.07 Assess the structure of compounds relating bonding and molecular geometry to chemical and physical properties;
- Ionic bonds.
- Covalent bonds.
- Metallic bonds.

COMPETENCY GOAL 2: The learner will build an understanding of regularities in chemistry.

Objectives

2.01 Analyze periodic nature of trends in chemical properties and examine the use of the Periodic Table to predict properties of elements;
- Symbols.
- Groups(families).
- Periods.
- Transition elements.
- Ionization energy.
- Atomic and ionic radii.
- Electronegativity.

2.02 Analyze the mole concept and Avogadro's number and use them to calculate:
- Mole to molecule.
- Mass to moles.
- Volume of a gas to moles.
- Molarity of solutions.

2.03 Identify various types of chemical equations and balance those equations:
- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.
- Combustion.

2.04 Calculate quantitative relationships in chemical reactions (stoichiometry)
- Identify the indicators of chemical change:
- Formation of a precipitate.
- Evolution of a gas.
- Color change.
- Absorption or release of heat.

2.05 Track the transfer of electrons in oxidation/reduction reactions and assign oxidation numbers:
- Identify the oxidizing and reducing agents.
- Assess practical applications of oxidation and reduction reactions.

COMPETENCY GOAL 3: The learner will build an understanding of energy changes in chemistry.

Objectives

3.01 Observe and interpret changes (emission/absorption) in electron energies in the hydrogen atom including the quantized levels and their relationship to atomic spectra:
- Electromagnetic radiation.
- Light.
- Photons.

3.02 Analyze the Law of Conservation of Energy, energy transformation, and various forms of energy involved in chemical reactions.

3.03 Compare and contrast the nature of heat and temperature.

3.04 Analyze calorimetric measurement in simple systems and the energy involved in changes in state.

3.05 Analyze the relationship between energy transfer and disorder in the universe:
- Nuclear.
- Fossil fuels.
- Solar.
- Alternative sources.

COMPENTENCY GOAL 4: The learner will build an understanding of equilibrium and kinetics

Objectives

4.01 Explain the dynamics of physical and chemical equilibria:
- Phase changes.
- Forward and reversible reactions.

4.02 Explain the factors that alter the equilibrium in a chemical reaction.

4.03 Assess reaction rates and factors that affect reaction rates.

4.04 Compare and contrast the nature, behavior, concentration, and strength of acids and bases:
- Acid-base neutralization.
- Degree of dissociation or ionization.
- Electrical conductivity.
- pH.

Goals

Instructionally, these strands should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Nature of Science

This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. The earth and environmental sciences are particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific understanding.

Science as a Human Endeavor

Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work collaboratively in groups to design investigations, formulate hypotheses, collect data, reach conclusions, and present their findings to their classmates.

The content studied in earth/environmental science is an opportunity to present science as the basis for civil engineering, mining, geology, oceanography, astronomy, and the environmental technical trades. The content diversity lets us look at science as a vocation. Scientist and technician are just two of the many careers in which an earth and environmental sciences background is necessary.

Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.

Historical Perspectives

Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances. Some examples are Eratosthenes' determination of the size of the earth, Wegeners' apparent "fit" of the continents, Kepler's laws of planetary motion, and James Hutton's simple yet powerful idea that the earth history must be explained by what we see happening now. Today, Hutton's uniformity of process principle is used to interpret the structure of landing sites on Mars.

Nature of Scientific Knowledge

Much of what is understood about the nature of science must be explicitly addressed:

- All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use.
- Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories just become stronger as more supporting evidence is gathered. They provide a context for further research and give us a basis for prediction. For example, the Theory of Plate Tectonics explains the movement of lithospheric plates.

- Laws are fundamentally different from theories. They are universal generalizations based on observations of the natural world, such as the nature of gravity, the relationship of forces and motion, and the nature of planetary movement. Scientists, in their quest for the best explanations of natural phenomena, employ rigorous methods. Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanations of 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." (1995, National Science Education Standards)

Science as Inquiry

Inquiry should be the central theme in earth/environmental science. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory experiences. The essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students build knowledge and communicate what they have learned. Inquiry applies creative thinking to new and unfamiliar situations. Students should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event or ones that challenge students' intuitions have been successful. For example, traditional labs, which emphasize observation of the sun or identification and classification of sediments, may be quite appropriate. These labs should, however, lead to open-ended explorations such as investigation of sun spot activity or the factors that influence the sorting of sediments. Although original student research has often been relegated to a yearly science fair project, continuing student research contributes immensely to their understanding of the process of science and to their problem-solving abilities. Earth/environmental science provides many opportunities for inquiry. "Why does the location of sunrise or sunset change through the year?" "Why are sedimentary rock layers tipped at an angle?" "Why do sunspots move faster near the sun's equator?" The processes of inquiry, experimental design, investigation, and analysis are as important as finding the correct answer. Students will acquire much more than facts and manipulative skills; they will learn to be critical thinkers.

Science And Technology

It is impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology. The methods of scientific inquiry and technological design share many common elements – objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design differs from inquiry in that it must operate within the limitations of materials, scientific laws, economics, and the demands of society. Together, science and technology present many solutions to problems of survival and enhance the quality of life. Technological design plays an important role in earth/environmental science. For example, telescopes, lasers, satellites, transistors, graphing calculators, personal computers, and seismographs have changed our lives, increased our knowledge of earth/environmental science, and improved our understanding of the universe.

Science in Personal and Social Perspectives

This strand helps students formulate a basic understanding of and implied actions for many issues facing our society. The fundamental concepts that form the basis for this strand include:

Population Growth

Students should develop the ability to assess the carrying capacity of a given environment and its implied limits for population growth, as well as how technology allows environment modification to adjust its carrying capacity.

Environmental Quality

Students should develop an appreciation for factors that influence their need and responsibility to maintain environmental quality, including waste disposal and recycling of limited natural resources. The ability to make wise-use decisions based on cost-risk analysis is an integral part of the study of earth and environmental science. "Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth." (1995, National Science Education Standards)

Natural and Human –Induced Hazards	The study of earth and environmental science encourages students to investigate the effects of natural phenomena on society. This is particularly true of spectacular natural phenomena such as earthquakes, volcanic eruptions, severe weather, and the slow changes in water quality. Students will acquire the ability to assess natural and human induced hazards – ranging from relatively minor risks to catastrophic events with major risk, as well as the accuracy with which these events can be predicted. It is particularly important for students to relate such phenomena to North Carolina and its citizens. Investigations of the economic impact of severe storms and the effectiveness of early warning systems in saving lives and property in North Carolina would be an effective way to implement this strand.
Science and Technology in Local, National, and Global Challenges	Along with the need to understand the causes and extent of environmental challenges related to natural and man-made phenomena, students should become familiar with the advances proper application of scientific principles and products have brought to environmental enhancements. Topics such as improved energy use, reduced vehicle emissions, and improved crop yields are just some examples of how the proper application of science has improved the quality of life. This strand will help students make rational decisions in the use of scientific and technological knowledge. "Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology–related challenges. However, understanding science alone will not resolve local, national, or global challenges. Students should understand the appropriateness and value of basic questions "What can happen? – What are the odds? – and How do scientists and engineers know what will happen?" (1995 National Science Education Standards)

The earth/environmental science curriculum focuses on the function of the earth's systems. Emphasis is placed on matter, energy, crustal dynamics, environmental awareness, materials availability, and the cycles that circulate energy and material through the earth system. The areas of inquiry include:

- Energy in the earth system.
- Geochemical cycles.
- Origin and evolution of the earth system.
- Origin and evolution of the universe.
- Predictability of a dynamic earth.
- Human interactions with the earth's geologic and environmental systems.

Strands: The strands are: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. They provide the context for teaching of the content Goals and Objectives.

COMPETENCY GOAL 1: The learner will build an understanding of lithospheric materials, processes, changes, and uses with concerns for good stewardship.

Objectives

1.01 Analyze the dependence of the physical properties of minerals on the arrangement and bonding of their atoms.

1.02 Classify the three major groups of rocks according to their origin, based on texture, mineral composition, and the processes responsible for their formation.

1.03 Assess the importance of the economic development of earth's finite rock, mineral, fossil fuel and other natural resources to society and our daily lives:
- Availability.
- Geographic distribution.
- Wise use.
- Conservation.
- Recycling.
- Challenge of rehabilitation of previously disturbed lands.

1.04 Analyze the importance of soils:
- Soil use and conservation.
- Products from soil.
- Relate land use capabilities and major soil types in North Carolina.

1.05 Evaluate geologic hazards and their relationship to geologic processes and materials:
- Volcanoes.
- Earthquakes.
- Mass wasting.
- Flooding.

1.06 Interpret topographic, soil, geologic, and other maps and images for:
- The location and identification of soils and rock types
- The identification of erosional and depositional landforms.
- The evaluation of landforms resulting from tectonic activity.

COMPETENCY GOAL 2: The learner will develop an understanding of tectonic processes and their human impacts.

Objectives

2.01 Analyze the evidence for the development of the Theory of Plate Tectonics:
- Propelling forces.
- Plate boundary interactions.
- Features of the sea floor.

2.02 Evaluate the forces that propel tectonic plates.

2.03 Analyze the model of the earth's interior resulting from the study of earthquake waves.

2.04 Analyze the nature, location of epicenters, and magnitude of earthquakes:
- Folds.
- Faults.
- Level of seismic activity in North Carolina.

COMPETENCY GOAL 3: The learner will build an understanding of the origin and evolution of the earth system.

Objectives

3.01 Interpret the order and impact of events in the geologic past:
- Origin of the earth system.
- Origin of life.
- Relative and absolute dating techniques.
- Statistical models of radioactive decay.
- Diversity of life through time.
- Fossils evidence of past life.
- Evolution/extinction of species.

3.02 Assess evidence for and the influence on the divisions of geologic time of the major geologic events and paleoclimatic changes in global geologic history:
- Uniformitarianism.
- Unconformities.
- Stratigraphic principles.
- Floral and faunal succession.

3.03 Evaluate the geologic history of North Carolina and the Appalachian orogen.

COMPETENCY GOAL 4: The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality.

Objectives

4.01 Evaluate the stream erosion and depositional processes:
- Land forms resulting from natural erosion, deposition, and mass wasting.

- Formation of stream channels with respect to the work being done by the stream (i.e. down cutting, lateral erosion, and transportation).
- Nature and characteristics of sediments.
- Ability of running water to sort sediments.

4.02 Evaluate water beneath the earth's surface:
- Storage and movement.
- Environmental impact of a growing human population.
- Impact of building and development.
- Causes of natural and manmade contamination.

4.03 Analyze the mechanisms for generating ocean currents:
- Temperature.
- Deep ocean circulation.
- Salinity.
- Planetary wind belts.

4.04 Analyze the mechanisms that produce the various types of shorelines and their resultant landforms:
- Nature of underlying geology.
- Long and short term sea-level history.
- Adjacent topography.

4.05 Assess the formation and breaking of waves and their effect on shorelines, particularly the North Carolina coast.

4.06 Evaluate environmental issues and solutions for North Carolina's wetlands, inland, and tidal environments:
- Floodplains.
- Fresh and brackish water marsh.
- Estuaries.
- Barriers.
- Inlets.

4.07 Evaluate the phenomenon of upwelling in the oceans and its influence on weather.

4.08 Evaluate the ecological services provided by a healthy ocean:
- A carbon sink.
- The largest watershed.
- Climate control.

COMPETENCY GOAL 5: The learner will build an understanding of the dynamics and composition of the atmosphere and its local and global processes influencing climate and air quality.

Objectives

5.01 Analyze the formation of the atmosphere and hydrosphere as a result of the phenomena of out-gassing as the primordial earth cooled.

5.02 Analyze the structure of the atmosphere:
- Temperature.
- Pressure.
- Water vapor.
- Atmospheric transparency.

5.03 Analyze weather systems:
- Movement.
- Humidity.
- Cloud formation.
- Precipitation.

5.04 Analyze atmospheric pressure:
- Planetary wind systems.
- Pressure cells.
- Altitude.
- Local breezes.

5.05 Analyze air masses and the life cycle of weather systems:
- Air masses.
- Frontal systems.
- Hazardous weather.
- Warning systems and their effectiveness.

5.06 Evaluate meteorological observing, analysis, and prediction:
- Worldwide observing systems.
- Meteorological data depiction.

5.07 Analyze the effects of human activity on the environment and the influence of issues on weather and climate.

COMPETENCY GOAL 6: The learner will acquire an understanding of the earth in the solar system and its position in the universe.

Objectives

6.01 Analyze the formation of the solar system.

6.02 Analyze planetary motion and the physical laws that explain that motion:
- Rotation.
- Revolution.
- Apparent diurnal motions of the sun and stars.
- Tilt of the earth's axis.
- Parallelism of the earth's axis.

6.03 Evaluate astronomers' use of various instruments to extend their senses:
- Optical telescopes.
- Radio telescopes.
- Spectroscope.
- Cameras.

6.04 Assess the current scientific theories of the origin of the universe.

6.05 Examine the sources of stellar energies.

6.06 Assess the spectra generated by stars and our sun as indicators of motion:
- Doppler effect.
- Red and blue shifts.

6.07 Evaluate Hubble's Law and the concept of an ever-expanding universe

6.08 Evaluate the life cycle of stars in the Hertzsprung – Russell Diagram (H-R Diagram).

COMPETENCY GOAL 7: The learner will build an understanding of alternative choices facing human societies in their stewardship of the earth.

Objectives

7.01 Analyze the relationship between the potential of technology to improve the quality of life and the possible causes of stress on the environment.

7.02 Analyze the interdependence of Earth's natural resources and systems, including land, air, and water, with the need to support human activity and reduce environmental impacts.

7.03 Assess how society weighs the choices of economic progress, population growth and environmental stewardship and selects a balanced responsible course of action.

PHYSICAL SCIENCE

Goal

Instructionally, these strands should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Nature of Science

This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Physical science is particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific understanding.

Science as a Human Endeavor

Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work collaboratively in groups to design investigations, formulate hypotheses, collect data, reach conclusions, and present their findings to their classmates.

The content studied in physical science is an opportunity to present science as a basis for engineering, electronics, computer science, astronomy and the technical trades. The diversity of physical science content allows for looking at science as a vocation. Scientist, artist, and technician are just a few of the many careers in which a physical science background is necessary.

Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.

Historical Perspectives

Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances. Galileo's struggle to correct the misconceptions arising from Aristotle's explanation of the behavior of falling bodies led to Newton's deductive approach to motion in *The Principia*. Today, Newton's Law of Universal Gravitation and his laws of motion are used to predict the landing sites for NASA's space flights.

Nature of Scientific Knowledge

Much of what is understood about the nature of science must be explicitly addressed:

- All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use.

- Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories just become stronger as more supporting evidence is gathered. They provide a context for further research and give us a basis for prediction. For example, in physical science, atomic theory explains the behavior of matter based on the existence of tiny particles. And kinetic theory explains, among other things, the expansion and contraction of gases.

- Laws are fundamentally different from theories. They are universal generalizations based on observations of the natural world, such as the nature of gravity, the relationship of forces and motion, and the nature of planetary movement. Scientists, in their quest for the best explanations of natural phenomena, employ rigorous methods. Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanations of 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." (1995 National Science Education Standards)

Understanding Science as Inquiry

Inquiry should be the central theme in physical science. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory work. The essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students to build knowledge and communicate what they have learned. Inquiry is the application of creative thinking to new and unfamiliar situations. Students should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event or ones that challenge students' intuitions have been most successful.

Classical experiments such measuring inertia and the speed of falling bodies need not be excluded. Rather, they should be a prelude to open-ended investigations in which the students have the chance to pose questions, design experiments, record and analyze data, and communicate their findings. For example, after measuring the relationships among force, mass, and acceleration of falling bodies, students might investigate the phenomenon of "weightlessness", or, after measuring physical properties, they might investigate the connection (if any) between the density of certain liquids and their boiling point.

Although original student research is often relegated to a yearly science fair project, continuing student involvement in research contributes immensely to their understanding of the process of science and to their problem-solving abilities. Physical science provides much potential for inquiries. "Does the aluminum baseball bat have an advantage over a wooden baseball bat?" "Why?" "Is one brand of golf ball better than another brand?" "Why?" The processes of inquiry, experimental design, investigation, and analysis are as important as finding the correct answer. Students will master much more than facts and acquisition of manipulative skills; they will learn to be critical thinkers.

Understanding Science and Technology

It is impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology.

The methods of scientific inquiry and technological design share many common elements – objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design differs from inquiry in that it must operate within the limitations of materials, scientific laws, economics, and the demands of society. Together, science and technology present many solutions to problems of survival and enhance the quality of life.

Technological design is important to building knowledge in physical science. Telescopes, lasers, transistors, graphing calculators, personal computers, and photogates, for example, have changed our lives, increased our knowledge of physical science, and improved our understanding of the universe.

Science in Personal and Social Perspective

This strand helps students in making rational decisions in the use of scientific and technological knowledge. "Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology–related challenges. However, understanding science alone will not resolve local, national, or global challenges. Students should understand the appropriateness and value of basic questions What can happen? – What are the odds? and How do scientists and engineers know what will happen? (1995, National Science Education Standards)

Students should understand the causes and extent of science-related challenges. They should become familiar with the advances that proper application of scientific principles and products have brought to environmental enhancement, better energy use, reduced vehicle emissions, and improved human health.

Physical Science Grades 9 - 12

The Physical Science curriculum is designed to continue the investigation of the concepts that guide inquiry in the practice of science begun in earlier grades. The Physical Science course will provide a rich knowledge base to provide a foundation for the continued study of science. The investigations should be approached in a qualitative manner in keeping with the mathematical skills of the students. The curriculum will integrate the following topics from both chemistry and physics:

- Structure of atoms
- Structure and properties of matter
- Motions and forces
- Conservation of energy, matter and charge

Strands: The strands are: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. They provide the context for teaching of the content Goals and Objectives.

COMPETENCY GOAL 1: The learner will construct an understanding of mechanics.

Objectives

1.01 Analyze uniform and accelerated motion:
- Uniform motion is motion at a constant speed in a straight line. (constant velocity)
- The rate of change in velocity is acceleration.

1.02 Analyze forces and their relationship to motion, Newton's Three Laws of Motion.

1.03 Analyze the conservation of energy and work:
- Work.
- Power.
- Kinetic Energy.
- Potential energy.
- Conservation of mechanical energy.
-

COMPETENCY GOAL 2: The learner will build an understanding of thermal energy.

Objectives

2.01 Assess molecular motion as it relates to temperature and phase changes:
- Thermal energy .
- Expansion and contraction.
- Temperature.
- Phase change, heats of fusion and vaporization.
- Specific heat.

2.02 Analyze the conservation of the total amount of energy, including heat energy, in a closed system; the First Law of Thermodynamics.

2.03 Analyze the Second Law of Thermodynamics:
- Heat will not flow spontaneously from a cold to a hot body.
- It is impossible to build a machine that does nothing but convert heat into useful work.

COMPETENCY GOAL 3: The learner will construct an understanding of electricity and magnetism.

Objectives

3.01 Analyze the nature of static electricity and the conservation of electrical charge:
- Positive and negative charges.
- Opposite charges attract and like charges repel.

3.02 Analyze the electrical charging of objects due to the transfer of electrons by friction, induction, or conduction.

3.03 Analyze direct current electrical circuits:
- Electrical potential difference.
- Resistance.
- Ohm's Law.
- Simple direct current circuits.
- Series circuit.
- Parallel circuit.

3.04 Analyze the practical applications of magnetism and its relationship to the movement of electrical charge.

3.05 Analyze permanent magnetism and the practical applications of the characteristics of permanent magnets.

COMPETENCY GOAL 4: The learner will develop an understanding of wave motion and the wave nature of sound and light.

Objectives

4.01 Analyze the characteristics of waves;
- Wavelength.
- Frequency.
- Period.
- Amplitude.

4.02 Analyze the phenomena of reflection, refraction, interference and diffraction.

4.03 Compare and contrast the frequency and wavelength of sound produced by a fixed source with a moving source of sound, the Doppler Effect.

COMPETENCY GOAL 5: The learner will build an understanding of the structure and properties of matter.

Objectives

5.01 Analyze development of current atomic theory.
- Dalton.
- J.J. Thompson.
- Rutherford.
- Bohr.

5.02 Examine the nature of atomic structure:
- Protons.
- Neutrons.
- Electrons.
- Atomic mass.
- Atomic number.
- Isotopes.

5.03 Describe radioactivity and its practical application as an alternative energy source:
- Alpha, Beta, and Gamma decay.
- Fission.
- Fusion.

5.04 Assess the use of physical properties in identifying substances:
- Density.
- Specific heat.
- Melting point.
- Boiling point.

5.05 Analyze the formation of simple inorganic compounds from elements.

5.06 Analyze the periodic trends in the physical and chemical properties of elements.
- Symbols.
- Groups(families).
- Periods.

COMPETENCY GOAL 6: The learner will build an understanding of regularities in chemistry.

Objectives

6.01 Identify and classify the common chemical reactions that occur in our physical environment and in our bodies:
- Oxidation and reduction.
- Polymerization and depolymerization.

6.02 Identify the reactants and products and balance simple equations of various types:
- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.
- Combustion.

6.03 Measure the temperature, pressure, and volume of gases and assess their Interrelationship:
- Boyle's Law.
- Charles' Law.

6.04 Analyze aqueous solutions and solubility:
- Ionic substances.
- Covalent substances.

6.05 Assess the indicators of chemical change including:
- Development of a gas.
- Formation of a precipitate.
- Change in color.

6.06 Compare and contrast the composition of strong and weak solutions of acids or bases:

- Degree of dissociation or ionization.
- Electrical conductivity.
- pH.
- Strength.
- Concentration.

Goal

Instructionally, these strands should be woven through the content goals and objectives of the course. Supplemental materials providing a more detailed explanation of the goals, objectives, and strands, with specific recommendations for classroom and/or laboratory implementation are available through the Department of Public Instruction's Publications Section.

Nature of Science

This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. Physics is particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of scientific understanding.

Science as a Human Endeavor

Intellectual honesty and an ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work collaboratively in groups to design investigations, formulate hypotheses, collect data, reach conclusions, and present their findings to their classmates.

The content studied in physics provides an opportunity to present science as the basis for engineering, electronics, computer science, astronomy and the technical trades. The diversity of physics content allows for looking at science as a vocation. Scientist, artist, and technician are just a few of the many careers in which a physics background is necessary.

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Science as Inquiry

Inquiry should be the central theme in physics. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory work. The essence of the inquiry process is to ask questions that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students to build knowledge and communicate what they have learned. Inquiry is the application of creative thinking to new and unfamiliar situations.

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Physics - Grades 9 –12

Physics, the most fundamental of the natural sciences, is quantitative in nature and uses the language of mathematics to describe natural phenomena. Inquiry is applied to the study of matter and energy and their interaction. The following topics are "uncovered" in this curriculum:

- Conservation of mass and energy.
- Conservation of momentum.
- Waves.
- Fields.
- Interactions of matter and energy.

Strands: The strands are: Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. They provide the context for teaching of the content Goals and Objectives.

COMPETENCY GOAL 1: The learner will build an understanding of linear motion.

Objectives

1.01 Analyze velocity as a rate of change of position:
- Average velocity.
- Instantaneous velocity.

1.02 Compare and contrast as scalar and vector quantities:
- Speed.
- Velocity.

1.03 Analyze graphs to describe instantaneous velocity as motion at a point in time.

1.04 Analyze acceleration as rate of change in velocity.

1.05 Analyze graphically and mathematically the relationships among position, velocity, acceleration, and time.

COMPETENCY GOAL 2: The learner will build an understanding of two-dimensional motion.

Objectives

2.01 Evaluate the measurement of two-dimensional motion (projectile and circular) in a defined frame of reference.

2.02 Assess the two dimensional motion of objects by using their component vectors.

2.03 Assess the independence of the horizontal and vertical vector components of projectile motion.

2.04 Analyze and evaluate uniform circular motion.

COMPETENCY GOAL 3: The learner will develop an understanding of forces.

Objectives

3.01 Assess, measure and calculate the conditions required to maintain a body in a state of static equilibrium.

3.02 Assess, measure and calculate the nature and magnitude of gravitational forces (Newton's Law of Universal Gravitation).

3.03 Assess, measure and calculate the nature and magnitude of frictional forces.

3.04 Analyze and evaluate the nature of centripetal forces.

COMPETENCY GOAL 4: The learner will develop an understanding of Newton's Laws of Motion.

Objectives

4.01 Determine that an object will continue in its state of motion unless acted upon by a net outside force (Newton's 1st Law of Motion, The Law of Inertia).

4.02 Assess, measure, and calculate the relationship among the force acting on a body, the mass of the body, and the nature of the acceleration produced (Newton's 2nd Law of Motion).

4.03 Analyze and mathematically describe forces as interactions between bodies (Newton's 3rd Law of Motion) .

COMPETENCY GOAL 5: The learner will develop an understanding of the nature of mechanical energy.

Objectives

5.01 Analyze energy of position:
- Gravitational potential energy.
- Elastic potential energy.

5.02 Analyze energy of motion, kinetic energy.

5.03 Analyze, evaluate ,and apply the principle of conservation of mechanical energy

5.04 Analyze and measure the transfer of mechanical energy through work.

COMPETENCY GOAL 6: The learner will build an understanding of impulse and momentum.

Objectives

6.01 Assess the vector nature of momentum and its relation to the mass and velocity of an object.

6.02 Compare and contrast impulse and momentum.

6.03 Analyze the factors required to produce a change in momentum.

6.04 Analyze interactions between objects and recognize the total momentum is conserved in both collision and recoil situations.

6.05 Assess real world applications of the impulse and momentum including but not limited to sports and transportation.

COMPETENCY GOAL 7: The learner will develop an understanding of wave motion and the wave nature of sound and light.

Objectives

7.01 Analyze the relationship among the characteristics of waves:
- Wavelength.
- Frequency.
- Period.
- Amplitude.

7.02 Describe the behavior of waves in various media.

7.03 Analyze the behavior of waves at boundaries between media :
- Reflection.
- Refraction.

7.04 Analyze the diffraction of waves.

7.05 Analyze the relationship between the phenomena of interference and the principle of superposition.

7.06 Analyze the frequency and wavelength of sound produced by a moving source (the Doppler Effect).

COMPETENCY GOAL 8: The learner will build an understanding of basic elementary principles of thermodynamics.

Objectives

8.01 Analyze the relationship among temperature, internal energy, and the random motion of atoms, molecules, and ions.

8.02 Assess the conservation of energy using the First Law of Thermodynamics.

8.03 Analyze the Second Law of Thermodynamics:
- Heat will not flow spontaneously from a cold to a hot body.
- It is impossible to build a machine that does nothing but convert heat into useful work.

COMPETENCY GOAL 9: The learner will build an understanding of static electricity.

Objectives

9.01 Assess the inverse square relationship among force, charge, and distance in Coulomb's Law.

9.02 Analyze the nature of electrical charges and the conservation of electric charge.

9.03 Analyze the relationship between moving electric charges and magnetic fields.

COMPETENCY GOAL 10: The learner will build an understanding of direct current electrical circuits.

Objectives

10.01 Analyze and measure the relationship among potential difference, current, and resistance in a direct current circuit.

10.02 Analyze and measure the relationship among current, voltage, and resistance in series and parallel circuits.

10.03 Analyze and measure the nature of power in an electrical circuit.

GLOSSARY

Attitude- tendency to respond positively or negatively to an idea, object, or person; influences ability to succeed in science; attitude towards science is influenced by how science is experienced

Classifying- the sorting or ordering of objects according to their properties or similarities and differences; based on observational relationships that exist between objects or events

Cognitive science-the study of how learning takes place

Communicating- the transmission of observable data; examples include spoken or written words, graphs, drawings, diagrams, maps, mathematical equations; skills such as asking questions, discussing, explaining, reporting, and outlining can aid in the development of communication skills

Conceptual understanding-includes the body of scientific knowledge that students draw upon when conducting a scientific investigation or engaging in scientific reasoning; involves a variety of information including events from science instruction and experiences with the natural environment; scientific concepts, principles, laws, and theories that scientists use to explain and predict observations about the world

Controlling variables-managing the conditions or factors in an experiment necessary for the results of experimentation to be reliable

Curriculum-what students should understand and/or be able to do

Defining operationally-stating definitions in working terms

Evolving-change over time; may refer to biological changes, geological changes; and/or technological changes

Experimenting-testing a hypothesis under controlled conditions; basic to the total scientific process; uses all process skills

Hypothesis-forming a generalization / question based on observations; involves asking questions, making inferences and predictions; must be testable/tested to establish credibility

Inferring-using logic to draw conclusions from observations; suggests explanations, reasons, and/or causes for events; based on judgements; and may not always be valid

Inquiry-a set of interrelated processes by which students and scientists pose questions about the natural world and investigate phenomena; a critical component of a science program at all grade levels and in every domain of science; allows students to learn science in a way that reflects how science actually works (NSES, p. 214)

Instruction-methods used to structure learning opportunities to teach concepts

Interpreting data-integrated process skill; involves making predictions, inferences, and hypotheses from a set of data; revision of interpretations may be necessary when additional data are obtained

Measuring-ordering of things by magnitude, such as area, length, volume, mass; processes to quantify observations; involves the use of instruments and the skills needed to use them effectively

Models-useful way of describing and explaining interrelationships of ideas; can be mental, physical, and/or verbal representation of an idea; represent what we know about an idea or concept; under constant change as new data are obtained

Nature of science-incorporates the historical development of science, habits of mind that characterize science, and methods of inquiry and problem solving

Nature of technology-encompasses the issues of design, application of science to real-world problems, and trade-offs or compromises that need to be considered for technological solutions

Observing-using one or more of the senses in perceiving properties or similarities and differences in objects and events; can be made directly with the senses or indirectly through the use of simple or complex instruments; influenced by the previous experience of the observer

Practical reasoning-probing students' ability to use and apply science understanding in new, real world applications

Predicting- suggesting what will occur in the future; based on observations, measurements, and inferences about relationships between or among observed variables; speculation of what will happen based on past experiences; accuracy of a prediction is affected by the accuracy of the observation; conjecture about how a particular system will behave, followed by observations to determine if the system did behave as expected within a specified range of situations

Scientific investigation-probes students' ability to use the tools of science, including both cognitive and laboratory tools; students acquire new information, plan appropriate tests, use a variety of scientific tools, and communicate the results of the investigations

Standards-criteria used to judge quality

Systems-complete, predictable cycles, structures, or processes occurring in natural phenomena; may also be an artificial construction created to represent or explain a natural occurrence; system boundaries and interrelationships of subsystems exist; input to and outputs from.

Technological design- abilities that include identifying appropriate problems, designing a solution or product, implementing a proposed design, evaluating completed solutions or products, communicating the process of design.

Themes-big ideas of science that transcend various scientific disciplines

Theory- an always tentative explanation of phenomena that we observe; never proven; representative of the most logical explanation based on currently available evidence; becomes stronger as more supporting evidence is gathered; provides a context for predictions.

Using numbers-quantifying variables, measurements, and/or comparisons; needed to manipulate measurements and to order and classify objects.

Using space/time relations-describing the spatial relationships of objects and their change with time; examples are motion, direction, spatial arrangement, symmetry, and shape.

BIBLIOGRAPHY

Allen, N.L., Swinton, S.S., Ishman, S.P., Zelenak, C.A., *Technical Report of the NAEP 1996 State Assessment Program in Science*, Washington, D.C., National Center for Education Statistics, 1997.

American Association for the Advancement of Science, *Benchmarks for Science Literacy, Project 2061*, New York, Oxford University Press, 1993.

American Association for the Advancement of Science, *Project 2061, Science for All Americans*., Washington, D.C, 1989.

American Association For The Advancement Of Science, *Resources for Science Literacy: Professional Development*, New York, Toronto, Oxford University Press, 1997.

American Association of Physics Teachers, "The Implications of Cognitive Studies for Teaching Physics," *American Journal of Physics*, 1994.

Biological Sciences Curriculum Study (BSCS), *Developing Biological Literacy*, Colorado Springs, 1993.

Bourque, M.L., Champagne, A.B., Crissman, S., *1996 Science Performance Standards: Achievement Results for the Nation and the States*, Washington, D.C., National Assessment Governing Board, 1997.

Bruer, J. T., "Education and the Brain: A Bridge Too Far," *Educational Researcher.*

Burke, James, *Connections,* Boston, Toronto, Little, Brown and Company, 1978.

Bybee, Rodger W. (ed.), *National Standards & The Science Curriculum: Challenges, Opportunities, & Recommendations*, Iowa, Kendall Hunt Publishing Company, 1996.

Carey, S., "Cognitive Development," *Invitation to Cognitive Sciences, Thinking* ,vol. 3, ch. 6, Cambridge, MIT Press, 1990.

Chiappetta, E. L. "Inquiry Based Science: Strategies and Techniques for Encouraging Inquiry in the Classroom," *The Science Teacher,* October 1997, p. 22 – 26.

Chiappetta, E. L., Koballa, T. R. Jr., & Collette, A.T. *Science Instruction: In the Middle and Secondary Schools*, 4th ed., New Jersey, Prentice Hall, Inc., 1998.

Cothron, J. H., Giese, R. N. & Rezba, R. J., *Students and Research: Practical Strategies for Science Classrooms and Competitions* (Second Ed.), Dubuque, IA, Kendall Hunt Publishing Company, 1989, 1993.

Eisenhower National Clearinghouse for Mathematics and Science Education, http://www.enc.org. (web-site), Columbus.

"Tolls for Discussion: Attaining Excellence Through TIMSS," *Eisenhower National Clearinghouse for Mathematics and Science Education*, (CD-ROM).

Feynman, R. P., "What is Science," *The Physics Teacher*, September 1969, p. 313 – 320.

Hackett, J., "Means and Ends: Using the Standards to Define Inquiry Methods and Outcome." *The Science Teacher*, September 1998, p. 34 – 37.

Hausman, H. J., "Choosing a Science Program for the Elementary School", *Occasional Papers*, no. 24.

Hazen, R. M., Trefil, J., *Science matters: Achieving Scientific Literacy*, New York, Doubleday, 1991.

International Association for the Evaluation of Educational Achievement, *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study*, Boston, Center for the Study of Testing, Evaluation, and Educational Policy, Boston College, 1996.

Karplus, R., "Science Teaching and the Development of Reasoning," *Journal of Research in Science Teaching*, John Wiley & Sons, Inc., vol. 14, no.2, p. 169 – 175, 1977.

Kyle, William C. Jr. (ed.), *Journal of Research in Science Teaching*, New York, John Wiley & Sons, Inc., 1996.

Lowery, Lawrence F. (ed.), *NSTA Pathways To the Science Standards*, Elem. School Ed., Virginia, NSTA, 1997.

Lowery, L. F., *The Scientific Thinking Process*, Berkeley, University of California, Lawrence Hall of Science, 1990.

McComas, W. F. (ed.)., *The Nature of Science and Science Education*, Netherlands, Kluwer Academic Publishers, 1998 p. 3 – 39.

McComas, W. F., "15 Myths of Science: Lessons of Misconceptions and Misunderstandings from a Science Educator," *Skeptic Magazine*, vol. 5, no. 2, 1997, p. 88 – 95.

McNeely, Margaret E. (ed.)., *Guidebook To Examine School Curricula.*, U.S. Department of Education, 1997.

Mestre, J. P., "3 Cognitive Aspects of Learning and Teaching Science," *Teacher Enhancement for Elementary and Secondary Science and Mathematics: Status, Issues, and Problems*, ch. 3, p 1 – 44.

National Academy of Sciences, *Every Child a Scientist: Achieving Scientific Literacy for All.*, Washington, D.C., National Academy Press, 1998.

National Academy Of Sciences, *Teaching About Evolution and the Nature of Science,* Washington, D.C., National Academy Press, 1998.

National Assessment of Educational Progress, *Learning by Doing* (Report No: 17-HOS-80), Princeton, Educational Testing Service, 1987.

National Center for Education Statistics, *A Profile of American Eighth-Grade Mathematics of Science Instruction* (NCES 92-486), Washington, D.C., U.S. Department of Education, 1992.

National Research Council, *Education and Learning to Think*, Washington, D.C., National Academy Press, 1987.

National Research Council, *Improving Teacher Preparation and Credentialing Consistent with the National Science Education Standards: Report of a Symposium*, Washington, D.C., National Academy Press, 1997.

National Science Foundation, *Indicators of Science & Mathematics Education*, Washington, D.C., Author, 1992.

National Science Resources Center, National Academy of Sciences, Smithsonian Institution, *Science For all Children: A Guide to Improving Elementary Science Education in Your School District*, Washington, D.C., National Academy Press, 1997.

North Carolina Department of Public Instruction, *North Carolina Public Schools Statistical Profile*, Raleigh, 1996.

North Carolina Mathematics and Science Coalition, *A Shared Vision for Mathematics and Science Education in North Carolina*, Chapel Hill, The University of North Carolina at Chapel Hill, 1993.

O'Sullivan, C.Y, Reese, C.M., Mazzeo, J., *NAEP 1996 Science Report Card for the Nation and the States*, Washington, D.C., National Center for Education Statistics. 1997.

O'Sullivan, C.Y., Weiss, A.R., Askew, J.M., *Students Learning Science: A Report on Policies and Practices in U.S. Schools*, Washington, D.C., National Center for Education Statistics, 1998.

Rakow S. J., *NSTA Pathways to the Science Standards* (Middle School Ed.), Arlington, NSTA, 1998.

Rhoton, Jack and Bowers, Patricia (ed.), *Issues in Science Education*, Virginia, National Science Teachers Association, 1996.

Schmidt, William H., McKnight, Curtis C., and Raizen, Senta A., *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, Dordrecht, Boston, London, Kluwer Academic Publishers, 1997.

Subcommitee on Global Change Research, Committee on Environment and Natural Resources of the National Science and Technology Council, *Our Changing Planet: An Investment in Science for the Nation's Future*, 1996 FY Budget.

"The Total Science Safety System," Secondary, 8th ed., *JaKel, Inc.* (Microsoft, Works, and Macintosh Datadisk), 1996.

University of California, Lawrence Hall of Science, *Science Teaching and the Development of Reasoning: General Science*, Berkeley, 1977.

U.S. Department of Education and National Center for Education Statistics, *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics And Science Achievement in International Context*, Washington, D.C., U.S. Government Printing Office, 1997.

U.S. Department of Education, National Center for Education Statistics, *Pursuing Excellence*, NCES 97-198, Washington, D.C., U.S. Government Printing Office, 1996.

U.S. Department of Education, Office of Educational Research and Improvement, *Attaining Excellence: A Video Presentation of Pursuing Excellence: U.S. Eighth Grade Findings From the Third International Mathematics and Science Study* (Video).

U.S. Department of Education, Office of Educational Research and Improvement, *Introduction To TIMMSS: The Third International Mathematics And Science Study*, 1997.

Wahl, G. H., Jr. (Ed.), *Reduction of Hazardous Waste for High School Chemistry Laboratories*, Raleigh, NC, North Carolina Department of Natural Resources and Community Development.

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