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 unifying concepts of science, the strands, conceptual goals and objectives. Connections to mathematics, technology, social science, and communication skills should be considered for instructional design. To assist teachers with instruction, materials explaining the Unifying Concepts, Strands, Goals, and Objectives 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 and their world motivate them.

Designing technological solutions and pondering benefits and risks should be an integral part of the middle school science experience. As students take the initiative to learn science and technology, they will learn about themselves, their community and potential career paths. 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.

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. Contact the Science Section at DPI for information and professional development opportunities regarding North Carolina specific Science Safety laws, codes, and standards. The Science Section is spearheading a statewide initiative entitled *NC-The Total Science Safety System.*

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, 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.

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- 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 benefits and knowledge gained from space exploration.
- investigate the importance of soil quality.

Science – Grade 6

Learners will study natural and technological systems. All goals should focus on the unifying concepts of science defined by the *National Science Education Standards*: Systems, Order, and Organization; Evidence, Models, and Explanation; Constancy, Change, and Measurement; Evolution and Equilibrium; and Form and Function. The skills of inquiry and technological design are targeted for mastery. The concepts for which in-depth studies should be designed at sixth grade level include: Scientific Inquiry, Technological Design, Lithosphere, Cycling of Matter, Solar System, Energy Transfer/Transformation, and Population Dynamics.

Strands: The Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives Strands provide the context for content goals.

COMPETENCY GOAL 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

Objectives

1.01 Identify and create questions and hypotheses that can be answered through scientific investigations.

1.02 Develop appropriate experimental procedures for:
- Given questions.
- Student generated questions.

1.03 Apply safety procedures in the laboratory and in field studies:
- Recognize potential hazards.
- Manipulate materials and equipment.
- Conduct appropriate procedures.

1.04 Analyze variables in scientific investigations:
- Identify dependent and independent.
- Use of a control.
- Manipulate.
- Describe relationships between.
- Define operationally.

1.05 Analyze evidence to:
- Explain observations.
- Make inferences and predictions.
- Develop the relationship between evidence and explanation.

1.06 Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations:
- Measurement.
- Analysis of data.
- Graphing.
- Prediction models.

1.07 Prepare models and/or computer simulations to:
- Test hypotheses.
- Evaluate how data fit.

1.08 Use oral and written language to:
- Communicate findings.
- Defend conclusions of scientific investigations.

1.09 Use technologies and information systems to:
- Research.
- Gather and analyze data.
- Visualize data.
- Disseminate findings to others.

1.10 Analyze and evaluate information from a scientifically literate viewpoint by reading, hearing, and/or viewing:
- Scientific text.
- Articles.
- Events in the popular press.

COMPETENCY GOAL 2: The learner will demonstrate an understanding of technological design.

Objectives

2.01 Explore evidence that "technology" has many definitions.
- Artifact or hardware.
- Methodology or technique.
- System of production.
- Social-technical system.

2.02 Use information systems to:
- Identify scientific needs, human needs, or problems that are subject to technological solution.
- Locate resources to obtain and test ideas.

2.03 Evaluate technological designs for:
- Application of scientific principles.
- Risks and benefits.
- Constraints of design.
- Consistent testing protocols.

2.04 Apply tenets of technological design to make informed consumer decisions about:
- Products.
- Processes.
- Systems.

COMPETENCY GOAL 3: The learner will build an understanding of the geological cycles, forces, processes, and agents which shape the lithosphere.

Objectives

3.01 Evaluate the forces that shape the lithosphere including:
- Crustal plate movement.
- Folding and faulting.
- Deposition.
- Volcanic Activity.
- Earthquakes.

3.02 Examine earthquake and volcano patterns.

3.03 Explain the model for the interior of the earth.

3.04 Describe the processes which form and the uses of earth materials.
- Rock cycle.
- Minerals.
- Characteristics of rocks.
- Economic use of rocks and minerals.
- Value of gems and precious metals.
- Common gems, minerals, precious metals and rocks found in N.C.

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

3.06 Evaluate ways in which human activities have affected Earth's pedosphere and the measures taken to control the impact:
- Vegetative cover.
- Agriculture.
- Land use.
- Nutrient balance.
- Soil as a vector.

3.07 Assess the use of technology and information systems in monitoring lithospheric phenomenon.

3.08 Conclude that the good health of environments and organisms requires:
- Monitoring of the pedosphere.
- Taking steps to maintain soil quality.
- Stewardship.

COMPETENCY GOAL 4: The learner will investigate the cycling of matter.

Objectives

4.01 Describe the flow of energy and matter in natural systems:
- Energy flows through ecosystems in one direction, from the sun through producers to consumers to decomposers.
- Matter is transferred from one organism to another and between organisms and their environments.
- Water, nitrogen, carbon dioxide, and oxygen are substances cycled between the living and non-living environments.

4.02 Evaluate the significant role of decomposers.

4.03 Examine evidence that green plants make food.
- Photosynthesis is a process carried on by green plants and other organisms containing chlorophyll.
- During photosynthesis, light energy is converted into stored energy which the plant, in turn, uses to carry out its life processes.

4.04 Evaluate the significance of photosynthesis to other organisms:
- The major source of atmospheric oxygen is photosynthesis.
- Carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.
- Green plants are the producers of food that is used directly or indirectly by consumers.

4.05 Evaluate designed systems for ability to enable growth of certain plants and animals.

COMPETENCY GOAL 5: The learner will build understanding of the Solar System.

Objectives

5.01 Analyze the components and cycles of the solar system including:
- Sun.
- Planets and moons.
- Asteroids and meteors.
- Comets.
- Phases.
- Seasons.
- Day/year.
- Eclipses.

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

5.03 Relate the influence of the sun and the moon's orbit to the gravitational effects produced on Earth.
- Solar storms.
- Tides.

5.04 Describe space explorations and the understandings gained from them including:
- N.A.S.A.
- Technologies used to explore space.
- Historic timeline.
- Apollo mission to the moon.
- Space Shuttle.
- International Space Station.
- Future goals.

5.05 Describe the setting of the solar system in the universe including:
- Galaxy.
- Size.
- The uniqueness of Earth.

5.06 Analyze the spin-off benefits generated by space exploration technology including:
- Medical.
- Materials.
- Transportation.
- Processes.
- Future research.

COMPETENCY GOAL 6: The learner will conduct investigations and examine models and devices to build an understanding of the characteristics of energy transfer and/or transformation.

Objectives

6.01 Determine how convection and radiation transfer energy.

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

6.03 Analyze sound as an example that vibrating materials generate waves that transfer energy.
- Frequency.
- Amplitude.
- Loudness.
- How sound travels through different material.
- Form and function of the human ear.

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

6.05 Analyze the physical interactions of light and matter:
- Absorption.
- Scattering.
- Color perception.
- Form and function of the human eye.

6.06 Analyze response to heat to determine the suitability of materials for use in technological design:
- Conduction.
- Expansion.
- Contraction.

6.07 Analyze the Law of Conservation of Energy:
- Conclude that energy cannot be created or destroyed, but only changed from one form into another.
- Conclude that the amount of energy stays the same, although within the process some energy is always converted to heat.
- Some systems transform energy with less loss of heat than others.

COMPETENCY GOAL 7: The learner will conduct investigations and use technologies and information systems to build an understanding of population dynamics.

Objectives

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

7.02 Investigate factors that determine the growth and survival of organisms including:
- Light.
- Temperature range.
- Mineral availability.
- Soil/rock type.
- Water.
- Energy.

7.03 Explain how changes in habitat may affect organisms.

7.04 Evaluate data related to human population growth, along with problems and solutions:
- Waste disposal.
- Food supplies.
- Resource availability.
- Transportation.
- Socio-economic patterns.

7.05 Examine evidence that overpopulation by any species impacts the environment.

7.06 Investigate processes which, operating over long periods of time, have resulted in the diversity of plant and animal life present today:
- Natural selection.
- Adaptation.