Sciences in the Primary Program

Common Understandings

It is instinctive for the primary child to search out, describe, and explain patterns of events experienced in the natural and physical world. Primary science is based upon exploration. Children develop an understanding of science as they investigate and interact with real objects and phenomena. They are natural scientists: curious, observant, and questioning. Their knowledge of science grows out of an attempt to find meaning in their environment.

Effective teachers of science not only provide a supply of engaging, relevant materials, but they also give learners conceptual support. They state what is known; paraphrase, redirect, and question ideas and approaches; provide information for the students' consideration (or arrange for learners to have access to a source that provides information); and assist with problem solving. Tinkering is pivotal to later investigation, as it provides the basis from which children formulate questions and set about finding answers.

Yelland, 2000

Children make sense of the world by relating new experiences to some prior knowledge. They organize their unique experiences in ways that make sense to them, such as the following:

- Objects have particular size, color, shape, and texture
- Objects float, sink, roll, live, and grow
- Living things change form as they grow and develop

Children need opportunities to present their views to other children and adults. By exchanging opinions with others, children begin to move from an egocentric point of view and compare their views with those of others. They relate their concepts of what happens in school science to what happens in their personal experience. Their concepts about the natural world are expanded and enhanced through sharing of experiences.

The science curriculum provides for a balance among the dimensions and disciplines of and the approaches to science education for primary children. The development of Dispositions, skills, processes, knowledge, and understanding is given equal emphasis. The curriculum provides for a balance among the three broad disciplines of life science, physical science, and earth/space science. Each year children should have experiences in each of these disciplines.

A balanced approach should remain during the primary years with topic areas addressed at different points and in a variety of ways. Schools should plan experiences to avoid duplication of learning

activities. The curriculum, the resources that support it, and the programs and activities that are developed in classrooms should together describe a balance in approaches to instruction. These approaches should include hands-on, activity-centered experiences that consider the interests, abilities, and needs of children.

Science as an Integral Part of the Primary Program

Thematic units of study are used in many primary classrooms to explore ideas and develop understanding. In designing a theme, a teacher considers a number of curricular areas, developing relationships among disciplines to provide for greater meaning and relevance. For example, in a science theme about "color," children could explore the possibilities in literature, writing, speaking, visual art, music, and movement, in addition to science. Thus, the teacher satisfies a multitude of curricular objectives within a single theme.

Where to Begin?

A child might bring something to school that has the potential for some science study and that catches the interest of the class. Children might generate lists of what they already know about the item and what they would like to find out. Thus, the teacher embarks upon a topic or theme with the class that arises from the interests of the children. When developing the theme, the teacher plans experiences that enhance development in each of the dimensions of science, Dispositions, skills, and knowledge, and which address the three broad disciplines of biological, physical, and earth/space science. The following are content standards recommended by the National Science Education Standards for grades K–4.

Life science
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

Physical science
- Properties of objects
- Position and motion of objects
- Light, heat, electricity, and magnetism

Earth/space science
- Properties of earth materials
- Objects in the sky
- Changes in earth and sky

Considerations

- **Science for all students.** Early impressions about who learns and does science appear to be persistent and lasting. Science should be modeled as an activity involving all kinds of people and affecting all people in their daily lives. Models must be free of gender and ethnic bias.

- **Science as inquiry**. From the earliest grade levels, students should experience science in a form that engages them in the active construction of ideas and explanations to enhance their opportunities to develop the abilities of doing science.

- **Science/technology/society connection.** Science is not something that happens in a book, on a screen, or in a laboratory far away. It is part of the everyday experience. Advances in science

have made possible the technology accessible to us; technology has made marked changes to the society in which we live. Society's demands have encouraged further technological and scientific development, some considered beneficial, others not. There are many issues and points of view to be considered for every topic, and children should be assisted in recognizing that there are many consequences to decisions and to progress.

- **Experimentation.** The active process of science is learned, not taught. Children should be provided with a variety of opportunities for playing, questioning, exploring, demonstrating, investigating, and experimenting. Experimentation also adds opportunities for hypothesizing and predicting, observing, collecting data over time, formulating conclusions, and comparing results with the original hypothesis/prediction. Each of these approaches can be appropriate for different children of different interests and abilities, using a variety of themes. Some of these approaches have implications for materials, supplies, and equipment that must be readily available to the children.

- **Resources.** The curriculum supports each child at his or her level of interest, ability, and comfort with science. The resources, too, must support the flexibility and variety of the curriculum. It is neither possible nor desirable to anticipate resources for the entire range of interests that could arise. However, the teacher should feel supported by enough quality materials to begin to provide for a range of interests and abilities, as well as feel encouraged to identify, acquire, and develop resources to more fully meet the needs of children. When designing a combination most appropriate to the needs of the children, the teacher should consult a range of sources including resources of the school and district, organizations and associations, and commercial suppliers. The need for resources extends to supplies and equipment for daily classroom use.

Learning Through Science

Science Content and Possibilities

There are numerous sources of science content on which teachers can draw. The children, reflecting their interests and concerns, should also generate topics. These are perhaps the most dynamic sources of content. A balance of content should be selected for science activities. Experiences should include topics in the life, physical, and earth/space sciences. Content possibilities include:

Life Science

Living Things	**You and Your Body**	**You and the Environment**
Plants	Food/nutrition	Animal communities
Growing seeds	Senses	Pond life
Plants and seasons	Ourselves	Grasslands
Animal behavior	Your body	Woodlands
Animals and seasons	Health	Recycling
Animal babies	Drugs	Endangered animals
Aquatic studies		Rain forests
Farming and seasons		

Physical Science

Properties of Matter	**Heat and Temperature**	**Light and Color**
Solids, liquids, gases	Ice cubes	Light
Water play	Hot and cold	Shadows
Changes in matter	Melting	Rainbows
Magnets	Freezing	
Simple machines		

Earth and Space Science

Earth Materials	**Atmosphere and Weather**	**Astronomy and Space**
Soil	Air and wind	Day and night
Rocks	Air pressure	The moon
Minerals	Kites	Sunlight
Fossils	Weather	Things in space
Water	Seasons	Planets
		U.S. space program
		Satellites

Active Learning in Science

Themes and supporting activities should be:

- **Learner-centered.** At the heart of the primary program, the study of primary science should be linked to the child's interests. Children construct their own meanings from their experiences in order to make sense of the world around them. By incorporating their ideas into instructional strategies, it becomes possible for teachers to guide children toward accommodating their experiences into a more scientific view.

- **Activity-centered.** Concrete, hands-on experiences using everyday objects, children's objects, and outdoor experiences permit children to construct their own realistic understanding of what science is. Approaches should include the use of real-life experiences and manipulation of materials and equipment. Access to a variety of living things encourages dispositions of caring and responsibility.

- **Modeled by teachers.** The importance of modeling a positive attitude toward science has been well documented. Open-minded, enthusiastic teachers who encourage science to happen foster those dispositions in children. In this way, all children may be challenged to pursue their interests to the fullness of their potential. The different approaches of diverse cultures and the contributions made by different societies, including those of U.S. scientists, should be integral to science programs.

Learning Dimensions in Primary Science

Science supports each of the goals of the primary program in several ways. Science activities stimulate both cognitive and affective growth and development in children. The investigative nature of science is conveyed through inductive, concrete, and manipulative learning experiences. These experiences stimulate curiosity, inquiry, and problem solving. Science experiences also encourage scientific Dispositions, develop the ability to use the processes and skills of science, introduce a body of scientific knowledge, and promote critical, rational, and creative thinking.

The following dimensions of primary science education are from the British Columbia curriculum and reflected in the National Science Education Standards. Examples of activities and experiences are suggested for each one.

Dispositions: The primary program provides opportunities for the learner to develop appropriate dispositions toward science:

- Awareness and appreciation of science-interest in science and its relationship to the world and the future; the child interacts respectfully in support of the local environment.
- Curiosity—to question and to persevere in seeking solutions; the child observes and questions the ongoing changes in the growth of sugar crystals.
- Adaptability in a changing world—a willingness to expect and accept scientific change; the child modifies pre-conceptions on the basis of school experiences in science.

Processes and Skills: The primary program provides opportunities for children to develop the skills and processes of science:

Processes

- Observation—the perception of characteristics, similarities, differences, and changes through use of the senses; the child uses the senses to describe and distinguish among common rocks, foods, or other items.
- Classification—the organization of materials, events, and phenomena into logical groupings. At first, classification is a sorting process; the child sorts a group of blocks into sets according to common characteristics. Later, the child develops multi-stage sets and subsets to categorize different insects.
- Measurement—comparison of objects or events to standards of length, area, volume, mass, temperature, and time; the child measures each day's growth of sprouting seeds.
- Communication—presentation and explanation to others of objects or events, using various media. This communication is often in the form of diagrams, numbers, or graphs; using charts and graphs, the child explains similarities and differences among various seeds and their growth.
- Inference—the derivation of premises or conclusions concerning data, using past experience. Inferring from a set of data may lead to several non-conclusive inferences; the child suggests an explanation as to why frost remains longer on some areas of the schoolyard.

Skills

- Safe and appropriate use of equipment, materials, and techniques; the child handles the classroom hamster in a careful manner.
- The location, organization, and documentation of information; the child organizes a science presentation using displays, posters, and an oral report.
- The selection and use of methods to solve problems; the child investigates the problem of how to make a better ice-cube melter.

Thinking Skills: The primary program provides opportunities for children to develop thinking skills:

- Creativity—fluency in generating a number of ideas or solutions, flexibility in generating a wide variety of ideas, originality in generating unique ideas or solutions; the child suggests different uses for a cup.
- Rationality—the ability to look for natural causes of events; the child investigates causes of change in shadows over the course of a day; critical thinking—the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence.
- Recognize stereotypes and biases to identify essential, variable, and adequate data and to draw conclusions; the child is able to suggest some benefits and problems associated with the transportation of industrial chemicals.

Knowledge: The primary program provides opportunities for children to develop scientific knowledge:

- Facts, concepts, and understanding; the child describes the body parts of a spider and how it uses its spider web for survival.
- Scientific vocabulary; the child explains the meaning of the words like *melting, freezing, evaporation,* and *condensing.*
- Relationships among various scientific disciplines, the child recognizes what effects cold temperature has in animal behavior, in the freezing of water, and in the weathering of rocks.
- The history and nature of science, particularly in the American context, the child investigates Thomas Edison's contribution to the utilization of electricity in the U.S.
- The applications and limitations of science in the practical world, the child recognizes that science has provided immunization for many childhood diseases, although colds and flus persist.

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Descriptors of Learning in Science

Early Primary	Later Primary
Dispositions **Life, Physical, and Earth/Space**	
The child: ▪ Demonstrates curiosity about and interest in the natural world: • Asks questions and brings objects of a scientific nature and handles them with respect and enjoyment ▪ Demonstrates an appreciation of the patterns and diversity of the natural world: • Is aware of patterns found in nature (patterns in a leaf, day and night) ▪ Demonstrates safety measures when handling materials and equipment (uses care in handling magnifying glass and wears safety glasses when appropriate) ▪ Demonstrates a positive attitude toward the environment: • Shows care and concern for the immediate environment ▪ Demonstrates receptivity to change (shares early conceptions about the natural world)	The child: ▪ Demonstrates curiosity about and interest in the natural world: • Perseveres in seeking solutions to questions of a scientific nature (observes and questions changes in the growth of sugar crystals) ▪ Demonstrates an appreciation of the patterns and diversity of the natural world: • Investigates and applies knowledge of pattern to new situations (cycle of the moon, poetry, print-making, pattern in story) ▪ Demonstrates safety measures when handling materials and equipment (uses proper procedures when using microscope and wears safety glasses when appropriate) ▪ Demonstrates a positive attitude towards the environment: • Adjusts behavior to reflect a wider environmental consciousness ▪ Demonstrates receptively to change and other points of view: • Expects and accepts scientific change (modifies preconceptions on the basis of experiences in science)
Skills **Life, Physical, and Earth/Space**	
The child: ▪ Observes characteristics, similarities, differences, and changes: • Notes and discusses difference in materials, events, and phenomena	The child: ▪ Observes characteristics, similarities, differences, and changes: • Notes/records differences, similarities, commonalities in materials, events, phenomena

Descriptors of Learning in Science

Early Primary	Later Primary
Skills **Life, Physical, and Earth/Space**	
The child: ▪ Classifies materials, events, and phenomena: • Sorts according to non-traditional criteria (like/dislike, color, size, simple patterns) ▪ Makes measurements according to length, area, volume, mass, temperature and time: • Measures using non-traditional units (uses unit blocks to measure self and others) ▪ Manipulates materials, supplies, and equipment safely and appropriately to the investigation (uses eye dropper appropriately to mix colored liquids) ▪ Communicates information in a variety of ways: • Presents information by talking, drawing, building, or dramatizing ▪ Draws inferences from prior knowledge and experiences and makes predictions: • Explanations are based on direct observation and concrete experience ▪ Demonstrates the ability to look for natural causes of events [rationality] (investigates the formation of shadows) ▪ Demonstrates creativity and critical thinking when exploring science problems: • Generates a variety of unique ideas and solutions • Selects from generated ideas and solutions, and defends selections	The child: ▪ Classifies materials, events, and phenomena: • Sorts and verbalizes according to standard criteria (texture, mass, structure) ▪ Makes measurements according to length, area, volume, mass, temperature and time: • Measures and records using standard units (measuring temperature in degrees Fahrenheit, graphing over a period of time) ▪ Manipulates materials, supplies, and equipment safely and appropriately to the investigation (uses the balance scale to determine mass of different materials) ▪ Communicates information in a variety of ways: • Presents information using charts, graphs, or models ▪ Draws inferences from prior knowledge and experiences and make predictions: • Hypothesizes from experience and observations ▪ Demonstrates ability to look for natural causes of events [rationality] (e.g. relates the length and the position of the shadow to the time of day) ▪ Demonstrates creativity and critical thinking when exploring science problem: • Evaluates evidence, draws conclusions and takes appropriate action(based on evidence gathered through scientific exploration, child creates and suggest means by which school can reduce its paper consumption)

Descriptors of Learning in Science

Early Primary	Later Primary
Knowledge **Life, Physical, and Earth/Space**	
The child: ▪ Demonstrates an understanding of the relevant facts and concepts of the scientific world ▪ Understands the needs of living things: • Describes the basic needs of plants and animals ▪ Describes physical properties of common materials and phenomena: • Uses simple terms to describe properties (bright, dull, color) ▪ Gains understanding of the natural world and its operation: • Uses simple terms to describe immediate environment ("water changes to ice when it gets cold") ▪ Uses appropriate scientific vocabulary related to topics being explored: • Names parts of a plant (tree, trunk, bark, leaf) ▪ Demonstrates awareness of the relationships among the science disciplines (could we live on Mars) ▪ Demonstrates knowledge of the nature of science (science is a means of learning about the world around us) ▪ Recognizes the applications and limitations of science in the practical world (refrigeration preserves food but only for a limited time)	The child: ▪ Demonstrates an understanding of the relevant facts and concepts of the scientific world ▪ Understands the needs of living things: • Understands and discusses the relationships between and among living things ▪ Describes physical properties of common materials and phenomena: • Uses scientific terms to describe properties (opaque, translucent, transparent) ▪ Gains understanding of the natural world and its operations: • Discusses the scientific concepts evident in the immediate environment ("water freezes at 32° Fahrenheit") ▪ Uses appropriate scientific vocabulary related to topics being explored: • Uses proper scientific names (deciduous, conifer) ▪ Demonstrates awareness of the relationships among the science disciplines (recognizing effects of cold in animal behavior, in freezing of water, and weathering of rocks) ▪ Demonstrates knowledge of the nature and history of science ▪ Recognizes the applications and limitations of science in the practical world (science has provided immunization for many diseases, while cold and flus persist)