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Saskatchewan Curriculum

Science

2

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Introduction

Science is a Required Area of Study in Saskatchewan's Core Curriculum. The provincial requirement for science is 150 minutes of instruction per week at this grade level (*Core Curriculum: Principles, Time Allocations, and Credit Policy*).

The purpose of this curriculum is to outline the provincial requirements for science at this grade level, including the intended learning outcomes that students are expected to achieve by the end of the year. Indicators are included to provide the breadth and depth of what students should know and be able to do to achieve the learning outcomes.

This renewed curriculum reflects current science education research, updated technology, and is responsive to changing demographics within the province. This curriculum is based on the *Pan-Canadian Protocol for Collaboration on School Curriculum Common Framework of Science Learning Outcomes K to 12* (Council of Ministers of Education, Canada [CMEC], 1997).

Inquiry into authentic student questions generated from student experiences is the central strategy for teaching science.

(National Research Council [NRC], 1996, p. 31)

The philosophy and spirit of science education in Saskatchewan is reflected in this curriculum and in materials designed and utilized to support curriculum implementation. In addition, the philosophy for science education builds on and supports the concept of Core Curriculum in Saskatchewan.

This curriculum includes the following information to support science instruction in Saskatchewan schools:

- connections to Core Curriculum, including the Broad Areas of Learning and Cross-curricular Competencies
- the K-12 aim and goals for science education
- characteristics of an effective science program
- outcomes and indicators for this grade level
- assessment and evaluation
- connections with other areas of study
- a glossary.

Using this Curriculum

Outcomes describe the knowledge, skills, and understandings that students are expected to attain by the end of a particular grade.

Outcomes are statements of what students are expected to know and be able to do by the end of a grade in a particular area of study. The outcomes provide direction for assessment and evaluation, and for program, unit, and lesson planning.

Critical characteristics of an outcome:

- focus on what students will learn rather than what teachers will teach
- specify the skills and abilities, understandings and knowledge, and/or attitudes students are expected to demonstrate
- are observable, assessable, and attainable
- are written using action-based verbs and clear professional language (educational and subject-related)
- are developed to be achieved in context so that learning is purposeful and interconnected
- are grade and subject specific
- are supported by indicators which provide the breadth and depth of expectations
- have a developmental flow and connection to other grades where applicable.

Indicators are a representative list of the types of things a student should know or be able to do if they have attained the outcome.

Indicators are representative of what students need to know and/or be able to do to achieve an outcome. Indicators represent the breadth and depth of learning related to a particular outcome. The list of indicators provided in the curriculum is not an exhaustive list. Teachers may develop additional and/or alternative indicators, reflective of and consistent with the breadth and depth defined by the given indicators.

Within the outcomes and indicators in this curriculum, the terms "including", "such as", and "e.g.," commonly occur. Each term serves a specific purpose.

- The term "including" prescribes content, contexts, or strategies that students must experience in their learning, without excluding other possibilities. For example, an indicator might state that students are to describe the position of an object relative to other positions or stationary objects, including themselves. This means that, although students can describe the position of a variety of objects, describing their own position relative to other positions or stationary objects is mandatory.
- The term "such as" provides examples of possible broad categories of content, contexts, or strategies that teachers or students may choose, without excluding other possibilities. For example, an indicator might include the phrase "such as colour, state, texture,

smell, transparency, and buoyancy" as examples of different properties of liquids and solids. This statement provides teachers and students with possible properties to consider, while not excluding other properties.

- The term "e.g.," offers specific examples of what content, contexts, or strategies might look like. For example, an indicator might include the phrase "e.g., sand, sugar, salt, gravel, dirt, and drink crystals" to refer to examples of solids that should be familiar to the students.

Although the outcomes and indicators in the science curriculum are organized by units, teachers may organize their instruction using disciplinary or interdisciplinary themes. Teachers are not required to structure instruction into four distinct science units.

Core Curriculum

Core Curriculum is intended to provide all Saskatchewan students with an education that will serve them well, regardless of their choices after leaving school. Through its components and initiatives, Core Curriculum supports the achievement of the Goals of Education for Saskatchewan. For current information regarding Core Curriculum, please refer to *Core Curriculum: Principles, Time Allocations, and Credit Policy* on the Saskatchewan Ministry of Education website. For additional information related to the various components and initiatives of Core Curriculum, please refer to the Ministry website at *www.education.gov.sk.ca/policy* for policy and foundation documents.

Broad Areas of Learning

Three Broad Areas of Learning reflect Saskatchewan's Goals of Education. Science education contributes to student achievement of the Goals of Education through helping students achieve knowledge, skills, and attitudes related to these Broad Areas of Learning.

Lifelong Learners

Related to the following Goals of Education:

- *Basic Skills*
- *Lifelong Learning*
- *Positive Lifestyle*

Students who are engaged in constructing and applying science knowledge naturally build a positive disposition towards learning. Throughout their study of science, students bring their curiosity about the natural and constructed world, which provides the motivation to discover and explore their personal interests more deeply. By sharing their learning experiences with others, in a variety of contexts, students develop skills that support them as lifelong learners.

Sense of Self, Community, and Place

Related to the following Goals of Education:

- *Understanding and Relating to Others*
- *Self-Concept Development*
- *Spiritual Development*

Students develop and strengthen their personal identity as they explore connections between their own understanding of the natural and constructed world and the perspectives of others, including scientific and Indigenous perspectives. Students develop and strengthen their understanding of community as they explore ways in which science can inform individual and community decision making on issues related to the natural and constructed world. Students interact experientially with place-based local knowledge to deepen their connection to and relationship with nature.

Engaged Citizens

Related to the following Goals of Education:

- *Career and Consumer Decisions*
- *Membership in Society*
- *Growing with Change*

As students explore connections between science, technology, society, and the environment, they experience opportunities to contribute positively to the environmental, economic, and social sustainability of local and global communities. Students reflect and act on their personal responsibility to understand and respect their place in the natural and constructed world, and make personal decisions that contribute to living in harmony with others and the natural world.

Cross-curricular Competencies

The Cross-curricular Competencies are four interrelated areas containing understandings, values, skills, and processes which are considered important for learning in all areas of study. These competencies reflect the Common Essential Learnings and are intended to be addressed in each area of study at each grade level.

Developing Thinking

Learners construct knowledge to make sense of the world around them. In science, students develop understanding by building and reflecting on their observations and what already is known by themselves and others. By thinking contextually, creatively, and critically, students deepen their understanding of phenomena in the natural and constructed world.

K-12 Goals for Developing Thinking:

- *thinking and learning contextually*
- *thinking and learning creatively*
- *thinking and learning critically.*

Developing Identity and Interdependence

This competency addresses the ability to act autonomously in an interdependent world. It requires the learner to be aware of the natural environment, social and cultural expectations, and the possibilities for individual and group accomplishments. Interdependence assumes the possession of a positive self-concept and the ability to live in harmony with others and with the natural and constructed world. In science, students examine the interdependence among living things within local, national, and global environments, and consider the impact of individual decisions on those environments.

K-12 Goals for Developing Identity and Interdependence:

- *understanding, valuing, and caring for oneself*
- *understanding, valuing, and caring for others*
- *understanding and valuing social, economic, and environmental interdependence and sustainability.*

Developing Literacies

Literacies are multi-faceted and provide a variety of ways, including the use of various language systems and media, to interpret the world and express understanding of it. Literacies involve the evolution of interrelated knowledge, skills, and strategies that facilitate an individual's ability to participate fully and equitably in a variety of roles and contexts – school, home, and local and global communities. In science, students collect, analyze, and represent ideas and understanding of the natural and constructed world in multiple forms.

K-12 Goals for Developing Literacies:

- *developing knowledge related to various literacies*
- *exploring and interpreting the world through various literacies*
- *expressing understanding and communicating meaning using various literacies.*

K-12 Goals for Developing Social Responsibility:

- *using moral reasoning*
- *engaging in communitarian thinking and dialogue*
- *taking social action.*

Developing Social Responsibility

Social responsibility is how people positively contribute to their physical, social, cultural, and educational environments. It requires the ability to participate with others in accomplishing shared or common goals. This competency is achieved by using moral reasoning processes, engaging in communitarian thinking and dialogue, and taking social action. Students in science examine the impact of scientific understanding and technological innovations on society.

Aim and Goals

The aim of K-12 science education is to enable all Saskatchewan students to develop scientific literacy. Scientific literacy today embraces Euro-Canadian and Indigenous heritages, both of which have developed an empirical and rational knowledge of nature. A Euro-Canadian way of knowing about the natural and constructed world is called science, while First Nations and Métis ways of knowing nature are found within the broader category of Indigenous knowledge.

Diverse learning experiences based on the outcomes in this curriculum provide students with many opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment (STSE) that will affect their personal lives, careers, and future.

Goals are broad statements identifying what students are expected to know and be able to do upon completion of the learning in a particular area of study by the end of Grade 12. The four goals of K-12 science education are to:

- **Understand the Nature of Science and STSE Interrelationships:** Students will develop an understanding of the nature of science and technology, their interrelationships, and their social and environmental contexts, including interrelationships between the natural and constructed world.
- **Construct Scientific Knowledge:** Students will construct an understanding of concepts, principles, laws, and theories in life science, physical science, earth and space science, and Indigenous knowledge of nature, then apply these understandings to interpret, integrate, and extend their knowledge.
- **Develop Scientific and Technological Skills:** Students will develop the skills required for scientific and technological inquiry, problem solving, and communicating; for working collaboratively; and for making informed decisions.

- **Develop Attitudes that Support Scientific Habits of Mind:** Students will develop attitudes that support the responsible acquisition and application of scientific, technological, and Indigenous knowledge to the mutual benefit of self, society, and the environment.

Inquiry

Inquiry learning provides students with opportunities to build knowledge, abilities, and inquiring habits of mind that lead to deeper understanding of their world and human experience. Inquiry is more than a simple instructional method. It is a philosophical approach to teaching and learning, grounded in constructivist research and methods, which engages students in investigations that lead to disciplinary and interdisciplinary understanding.

Inquiry builds on students' inherent sense of curiosity and wonder, drawing on their diverse backgrounds, interests, and experiences. The process provides opportunities for students to become active participants in a collaborative search for meaning and understanding.

Elementary students who are engaged in inquiry in science should be able to:

- ask questions about objects, organisms, and events in the environment
- plan and conduct a simple investigation
- employ simple equipment and tools to gather data and extend the senses
- use data to construct a reasonable explanation
- communicate investigations and explanations.

(NRC, 1996, p. 122-123)

Inquiry is intimately connected to scientific questions – students must inquire using what they already know and the inquiry process must add to their knowledge.

(NRC, 2000, p. 13)

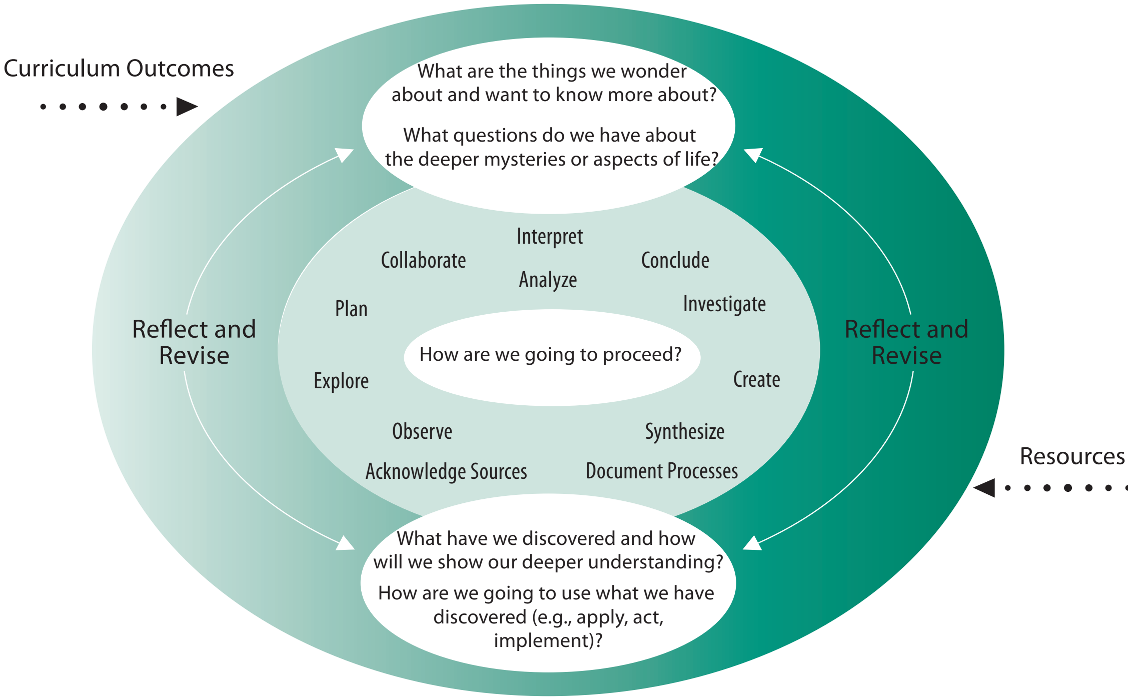
An important part of any inquiry process is student reflection on their learning and the documentation needed to assess learning and make it visible. Student documentation of their inquiries in science may take the form of works-in-progress, reflective writing, journals, reports, notes, models, arts expressions, photographs, video footage, or action plans.

Students do not come to understand inquiry simply by learning words such as "hypothesis" and "inference" or by memorizing procedures such as "the steps of the scientific method".

(NRC, 2000, p. 14)

Inquiry learning is not a step-by-step process, but rather a cyclical process with various phases of the process being revisited and rethought as a result of students' discoveries, insights, and construction of new knowledge. Experienced inquirers will move back and forth among various phases as new questions arise and as students become more comfortable with the process. The following graphic shows various phases of the cyclical inquiry process.

Constructing Understanding Through Inquiry



Good science inquiry provides many entry points – ways in which students can approach a new topic – and a wide variety of activities during student work.

(Kluger-Bell, 2000, p. 48)

Creating Questions for Inquiry in Science

Inquiry focuses on the development of driving questions to initiate and guide the learning process. Students and/or teachers formulate questions to motivate inquiries into topics, problems, and issues related to curriculum content and outcomes.

Well-formulated inquiry questions are broad in scope and rich in possibilities. Such questions encourage students to explore, observe, gather information, plan, analyze, interpret, synthesize, problem solve, take risks, create, conclude, document, reflect on learning, and develop new questions for further inquiry.

In science, teachers and students can use the four learning contexts of Scientific Inquiry, Technological Problem Solving, STSE Decision Making, and Cultural Perspectives (see Learning Contexts on p.17 for further information) as curriculum entry points to begin their inquiry. The process may evolve into interdisciplinary learning opportunities reflective of the holistic nature of our lives and interdependent global environment.

Developing questions evoked by student interests have the potential for rich and deep learning. These questions are used to initiate and guide the inquiry and give students direction for investigating topics, problems, ideas, challenges, or issues under study.

The process of constructing questions for deep understanding can help students grasp the important disciplinary or interdisciplinary ideas that are situated at the core of a particular curricular focus or context. These broad questions lead to more specific questions that can provide a framework, purpose, and direction for the learning activities in a lesson or series of lessons.

Questions give students initial direction for uncovering the understandings associated with a unit of study. Questions can help students grasp the big disciplinary ideas surrounding a focus or context and related themes or topics. They provide a framework, purpose, and direction for the learning activities in each unit and help students connect what they are learning to their experiences and life beyond the classroom. Questions also invite and encourage students to pose their own questions for deeper understanding.

Students should recognize science is generally unable to answer "why" questions; in these instances, scientists rephrase their inquiries into "how" questions.

Essential questions that lead to deeper understanding in science should:

- *center on objects, organisms, and events in the natural world*
- *connect to science concepts outlined in the curricular outcomes*
- *lend themselves to empirical investigation*
- *lead to gathering and using data to develop explanations for natural phenomena.*

(NRC, 2000, p. 24)

An Effective Science Education Program

An effective science education program supports student achievement of learning outcomes through:

- incorporating all foundations of scientific literacy
- using the learning contexts as entry points into student inquiry
- understanding and effectively using the language of science
- engaging in laboratory and field work
- practising safety
- choosing and using technology in science appropriately.

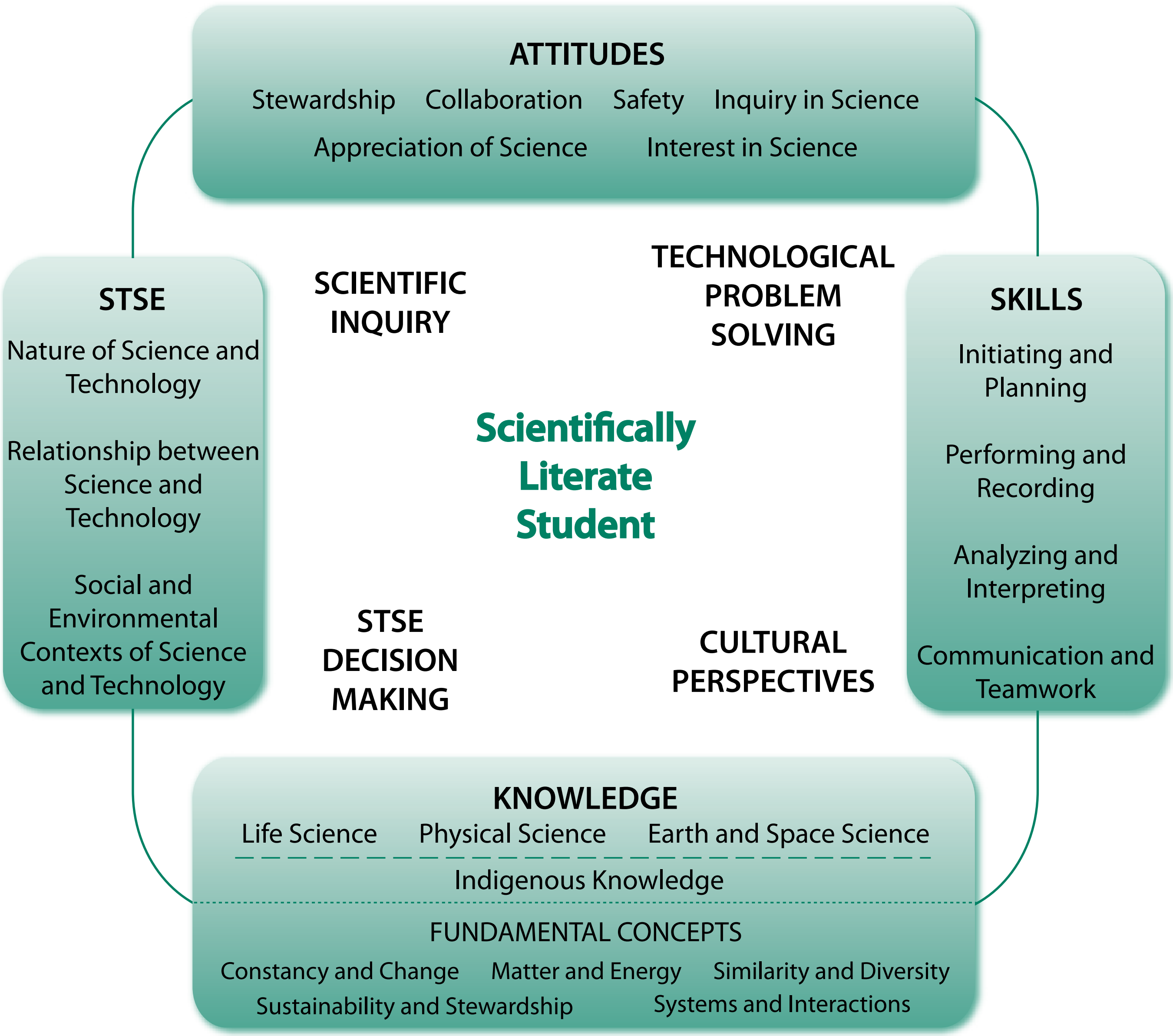
All science outcomes and indicators incorporate one or more foundations of scientific literacy; these are the "what" of the curriculum. The learning contexts represent different processes for engaging students in achieving curricular outcomes; they are the "how" of the curriculum. The four units of study at each grade are an organizing structure for the curriculum.

Scientists construct models to support their explanations based on empirical evidence. Students need to engage in similar processes through authentic investigations. During the investigations, students must follow safe practices.

Technology serves to extend our powers of observation and support the sharing of information. Students should use a variety of technology tools for data collection and analysis, visualization and imaging, and communication and collaboration throughout the science curriculum.

To achieve the vision of scientific literacy outlined in this curriculum, students increasingly must become engaged in the planning, development, and evaluation of their own learning activities. In the process, students should have the opportunity to work collaboratively with others, initiate investigations, communicate findings, and complete projects that demonstrate learning.

Scientific Literacy Framework



Foundations of Scientific Literacy

The K-12 goals of science education parallel the foundation statements for scientific literacy described in the *Common Framework of Science Learning Outcomes K to 12* (CMEC, 1997, p. 6-18). These four foundation statements delineate the critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

Foundation 1: Science, Technology, Society, and the Environment (STSE) Interrelationships

This foundation is concerned with understanding the scope and character of science, its connections to technology, and the social and environmental contexts in which it is developed. This foundation is the driving force of scientific literacy. Three major dimensions address this foundation.

Nature of Science and Technology

Science is a social and cultural activity anchored in a particular intellectual tradition. It is one way of knowing nature, based on curiosity, imagination, intuition, exploration, observation, replication, interpretation of evidence, and consensus-making over this evidence and its interpretation. More than most other ways of knowing nature, science excels at predicting what will happen next, based on its descriptions and explanations of natural and technological phenomena.

Science-based ideas continually are being tested, modified, and improved as new ideas supersede existing ideas. Technology, like science, is a creative human activity concerned with solving practical problems that arise from human and social needs, particularly the need to adapt to the environment and fuel a nation's economy. Research and development leads to new products and processes through the processes of inquiry and design.

Relationships between Science and Technology

Historically, the development of technology has been strongly linked to advances in science, with each making contributions to the other. Where the focus of science is on the development and verification of knowledge, in technology, the focus is on the development of solutions, involving devices and systems that meet a given need within the constraints of the problem. The test of science knowledge is that it helps explain, interpret, and predict; the test of technology is that it works, enabling us to achieve a given purpose.

Social and Environmental Contexts of Science and Technology

The history of science shows that scientific development takes place within a social context that includes economic, political, social, and cultural forces, along with personal biases and the need for peer acceptance and recognition. Many examples demonstrate how cultural and intellectual traditions have influenced the focus and methodologies of science, and how science, in turn, has influenced the wider world of ideas. Today, societal and environmental needs and issues often drive research agendas. As technological solutions emerge from previous research, many new technologies give rise to complex social and environmental issues which increasingly are becoming part of the political agenda. The potential of science, technology, and indigenous knowledge to inform and empower decision-making by individuals, communities, and society is central to scientific literacy in a democratic society.

Foundation 2: Scientific Knowledge

This foundation focuses on the subject matter of science including the theories, models, concepts, and principles that are essential to an understanding of the natural and constructed world. For organizational purposes, this foundation is framed using widely accepted science disciplines.

Life Science

Life science deals with the growth and interactions of life forms within their environments in ways that reflect the uniqueness, diversity, genetic continuity, and changing nature of these life forms. Life science includes the study of topics such as ecosystems, biological diversity, organisms, cell biology, biochemistry, diseases, genetic engineering, and biotechnology.

Physical Science

Physical science, which encompasses chemistry and physics, deals with matter, energy, and forces. Matter has structure, and its components interact. Energy links matter to gravitational, electromagnetic, and nuclear forces in the universe. Physical science also addresses the conservation laws of mass and energy, momentum, and charge.

Earth and Space Science

Earth and space science brings local, global, and universal perspectives to student knowledge. Earth, our home planet, exhibits form, structure, and patterns of change, as do our surrounding solar system and the physical universe beyond. Earth and space science includes geology, hydrology, meteorology, and astronomy.

Traditional and Local Knowledge

A strong science program recognizes that modern science is not the only form of empirical knowledge about nature and aims to broaden student understanding of traditional and local knowledge systems. The dialogue between scientists and traditional knowledge holders has an extensive history and continues to grow as researchers and practitioners seek to understand our complex world. The terms "traditional knowledge", "indigenous knowledge", and "traditional ecological knowledge" are used by practitioners worldwide when referencing local knowledge systems which are embedded within particular worldviews. This curriculum uses the term "indigenous knowledge" and provides the following definitions to show parallels and distinctions between indigenous knowledge and scientific knowledge.

Indigenous Knowledge

"Traditional [Indigenous] knowledge is a cumulative body of knowledge, know-how, practices, and representations maintained and developed by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and worldview" (International Council for Science, 2002, p. 3).

Scientific Knowledge

Similar to Indigenous knowledge, scientific knowledge is a cumulative body of knowledge, know-how, practices, and representations maintained and developed by people (scientists) with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations, and meanings are part and parcel of cultural complexes that encompass language, naming and classification systems, resource use practices, ritual, and worldview.

Fundamental Ideas – Linking Scientific Disciplines

A useful way to create linkages among science disciplines is through fundamental ideas that underlie and integrate different scientific disciplines. Fundamental ideas provide a context for explaining, organizing, and connecting knowledge. Students deepen their understanding of these fundamental ideas and apply their understanding with increasing sophistication as they progress through the curriculum from Kindergarten to Grade 12. These fundamental ideas are identified in the following chart.

Constancy and Change	The ideas of constancy and change underlie understanding of the natural and constructed world. Through observations, students learn that some characteristics of materials and systems remain constant over time whereas other characteristics change. These changes vary in rate, scale, and pattern, including trends and cycles, and may be quantified using mathematics, particularly measurement.
Matter and Energy	Objects in the physical world are comprised of matter. Students examine materials to understand their properties and structures. The idea of energy provides a conceptual tool that brings together many understandings about natural phenomena, materials, and the process of change. Energy, whether transmitted or transformed, is the driving force of both movement and change.
Similarity and Diversity	The ideas of similarity and diversity provide tools for organizing our experiences with the natural and constructed world. Beginning with informal experiences, students learn to recognize attributes of materials that help to make useful distinctions between one type of material and another, and between one event and another. Over time, students adopt accepted procedures and protocols for describing and classifying objects encountered, thus enabling students to share ideas with others and to reflect on their own experiences.
Systems and Interactions	An important way to understand and interpret the world is to think about the whole in terms of its parts and, alternately, about its parts in terms of how they relate to one another and to the whole. A system is an organized group of related objects or components that interact with one another so that the overall effect is much greater than that of the individual parts, even when these are considered together.
Sustainability and Stewardship	Sustainability refers to the ability to meet our present needs without compromising the ability of future generations to meet their needs. Stewardship refers to the personal responsibility to take action to participate in the responsible management of natural resources. By developing their understanding of ideas related to sustainability, students are able to take increasing responsibility for making choices that reflect those ideas.

Foundation 3: Scientific and Technological Skills and Processes

This foundation identifies the skills and processes students develop in answering questions, solving problems, and making decisions. While these skills and processes are not unique to science, they play an important role in the development of scientific and technological understanding and in the application of acquired knowledge to new situations. Four broad skill areas are outlined in this foundation. Each area is developed further at each grade level with increasing scope and complexity of application.

Initiating and Planning

These are the processes of questioning, identifying problems, and developing preliminary ideas and plans.

Performing and Recording

These are the skills and processes of carrying out a plan of action, which involves gathering evidence by observation and, in most cases, manipulating materials and equipment. Gathered evidence can be documented and recorded in a variety of formats.

Both scientific and Indigenous knowledge systems place value on attitudes, values, and ethics. These are more likely to be presented in a holistic manner in Indigenous knowledge systems.

Analyzing and Interpreting

These are the skills and processes of examining information and evidence, organizing and presenting data so that they can be interpreted, interpreting those data, evaluating the evidence, and applying the results of that evaluation.

Communication and Teamwork

In science and technology, as in other areas, communication skills are essential whenever ideas are being developed, tested, interpreted, debated, and accepted or rejected. Teamwork skills also are important because the development and application of ideas rely on collaborative processes both in science-related occupations and in learning.

Foundation 4: Attitudes

This foundation focuses on encouraging students to develop attitudes, values, and ethics that inform a responsible use of science and technology for the mutual benefit of self, society, and the environment. This foundation identifies six categories in which science education contributes to the development of scientific literacy.

Appreciation of Science

Students will be encouraged to critically and contextually appreciate the role and contributions of science and technology in their lives and to their community's culture, and be aware of the limits of science and technology and their impact on economic, political, environmental, cultural, and ethical events.

Interest in Science

Students will be encouraged to develop curiosity and continuing interest in the study of science at home, in school, and in the community.

Inquiry in Science

Students will be encouraged to develop critical beliefs concerning the need for evidence and reasoned argument in the development of scientific knowledge.

Collaboration

Students will be encouraged to nurture competence in collaborative activity with classmates and others, inside and outside of the school.

Stewardship

Students will be encouraged to develop responsibility in the application of science and technology in relation to society and the natural environment.

Safety

Students engaged in science and technology activities will be expected to demonstrate a concern for safety and doing no harm to themselves or others, including plants and animals.

Learning Contexts

Learning contexts provide entry points into the curriculum that engage students in inquiry-based learning to achieve scientific literacy. Each learning context reflects a different, but overlapping, philosophical rationale for including science as a Required Area of Study:

- The **scientific inquiry** learning context reflects an emphasis on understanding the natural and constructed world using systematic empirical processes that lead to the formation of theories that explain observed events and facilitate prediction.
- The **technological problem-solving** learning context reflects an emphasis on designing, constructing, testing, and refining prototypes to solve practical human problems using an engineering approach.
- The **STSE decision-making** learning context reflects the need to engage citizens in thinking about human and world issues through a scientific lens to inform and empower decision making by individuals, communities, and society.
- The **cultural perspectives** learning context reflects a humanistic perspective on examining and understanding the knowledge systems that other cultures use, and have used, to describe and explain the natural world.

These learning contexts are not mutually exclusive; thus, well-designed instruction may incorporate more than one learning context. Students need to experience learning through each learning context at each grade; it is not necessary, nor advisable, for each student to attempt to engage in learning through each learning context in each unit. Learning within a classroom may be structured to enable individuals or groups of students to achieve the same curricular outcomes through different learning contexts.

Each learning context is identified with a two-or three-letter code. One or more of these codes are listed under each outcome as a suggestion regarding which learning context(s) most strongly support the intent of the outcome.

A choice of learning approaches also can be informed by recent well-established ideas on how and why students learn:

- Learning occurs when students are treated as a community of practitioners of scientific literacy.
- Learning is both a social and an individual event for constructing and refining ideas and competences.

- Learning involves the development of new self-identities for many students.
- Learning is inhibited when students feel a culture clash between their home culture and the culture of school science.

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work.

(NRC, 1996, p. 23)

Scientific Inquiry [SI]

Inquiry is a defining feature of the scientific way of knowing nature. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. Inquiry is a multi-faceted activity that involves:

- making observations, including watching or listening to knowledgeable sources
- posing questions or becoming curious about the questions of others
- examining books and other sources of information to see what is already known
- reviewing what is already known in light of experimental evidence and rational arguments
- planning investigations, including field studies and experiments
- acquiring the resources (financial or material) to carry out investigations
- using tools to gather, analyze, and interpret data
- proposing critical answers, explanations, and predictions
- communicating the results to various audiences.

By participating in a variety of inquiry experiences that vary in the amount of student self-direction, students develop competencies necessary to conduct inquiries of their own – a key element to scientific literacy.

Technological design is a distinctive process with a number of defined characteristics; it is purposeful; it is based on certain requirements; it is systematic; it is iterative; it is creative; and there are many possible solutions.

(International Technology Education Association, 2000, p. 91)

Technological Problem Solving [TPS]

The essence of the technological problem-solving learning context is that students seek answers to practical problems. This process is based on addressing human and social needs, and typically is addressed through an iterative design-action process that involves steps such as:

- identifying a problem
- identifying constraints and sources of support
- identifying alternative possible solutions and selecting one on which to work
- planning and building a prototype or a plan of action to resolve the problem
- testing and evaluating the prototype or plan.

By participating in a variety of technological and environmental problem-solving activities, students develop capacities to analyze and resolve authentic problems in the natural and constructed world.

STSE Decision Making [DM]

Scientific knowledge can be related to understanding interrelationships among science, technology, society, and the environment. Students also must consider values or ethics when addressing a question or issue. STSE decision making involves steps such as:

- clarifying an issue
- evaluating available research and different viewpoints on the issue
- generating possible courses of action or solutions
- evaluating the pros and cons for each action or solution
- identifying a fundamental value associated with each action or solution
- making a thoughtful decision
- examining the impact of the decision
- reflecting back on the process of decision making.

Students may engage with STSE issues through research projects, student-designed laboratory investigations, case studies, role playing, debates, deliberative dialogues, and action projects.

To engage with science and technology toward practical ends, people must be able to critically assess the information they come across and critically evaluate the trustworthiness of the information source.

(Aikenhead, 2006, p. 2)

Cultural Perspectives [CP]

Students should recognize and respect that all cultures develop knowledge systems to describe and explain nature. Two knowledge systems emphasized in this curriculum are First Nations and Métis cultures (Indigenous knowledge) and Euro-Canadian cultures (science). In their own way, both of these knowledge systems convey an understanding of the natural and constructed worlds, and they create or borrow from other cultures' technologies to resolve practical problems. Both knowledge systems are systematic, rational, empirical, dynamically changeable, and culturally specific.

Cultural features of science, in part, are conveyed through the other three learning contexts, and when addressing the nature of science. Cultural perspectives on science also can be taught in activities that explicitly explore Indigenous knowledge or knowledge from other cultures.

Addressing cultural perspectives in science involves:

- recognizing and respecting knowledge systems that various cultures have developed to understand the natural world and the technologies they have created to solve human problems

For First Nations people, the purpose of learning is to develop the skills, knowledge, values and wisdom needed to honour and protect the natural world and ensure the long-term sustainability of life.

(Canadian Council on Learning, 2007, p. 18)

For the Métis people, learning is understood as a process of discovering the skills, knowledge and wisdom needed to live in harmony with the Creator and creation, a way of being that is expressed as the 'Sacred Act of Living a Good Life'.

(Canadian Council on Learning, 2007, p. 22)

- recognizing science, as one of those knowledge systems, evolved within Euro-Canadian cultures
- valuing place-based knowledge to solve practical problems
- honouring protocols for obtaining knowledge from a knowledge keeper and taking responsibility for knowing it.

By engaging in explorations of cultural perspectives, scientifically literate students begin to appreciate the worldviews and belief systems fundamental to science and Indigenous knowledge.

The Language of Science

Science is a way of understanding the natural world using internally consistent methods and principles that are well-described and understood by the scientific community. The principles and theories of science have been established through repeated experimentation and observation and have been refereed through peer review before general acceptance by the scientific community. Acceptance of a theory does not imply unchanging belief in a theory or denote dogma. Instead, as new data become available, previous scientific explanations are revised and improved or rejected and replaced. There is a progression from a hypothesis to a theory using testable, scientific laws. Many hypotheses are tested to generate a theory. Only a few scientific facts are considered natural laws (e.g., the Law of Conservation of Mass).

Scientists use the terms "law", "theory", and "hypothesis" to describe various types of scientific explanations about phenomena in the natural and constructed world. These meanings differ from common usage of the same terms.

The terms "law", "theory", and "hypothesis" have special meaning in science.

- Law – A law is a generalized description, usually expressed in mathematical terms, that describes some aspect of the natural world under certain conditions.
- Theory – A theory is an explanation for a set of related observations or events that may consist of statements, equations, models, or a combination of these. Theories also predict the results of future observations. A theory becomes a theory once the explanation is verified multiple times by different groups of researchers. The procedures and processes for testing a theory are well-defined within each scientific discipline, but they vary between disciplines. No amount of evidence proves that a theory is correct. Rather, scientists accept theories until the emergence of new evidence that the theory is unable to explain adequately. At this point, the theory is discarded or modified to explain the new evidence. Note that theories never become laws; theories explain laws.

- Hypothesis – A hypothesis is a tentative, testable generalization that may be used to explain a relatively large number of events in the natural world. It is subject to immediate or eventual testing by experiments. Hypotheses must be worded in such a way that they can be falsified. Hypotheses are never proven correct, but are supported by empirical evidence.

Scientific models are constructed to represent and explain certain aspects of physical phenomenon. Models are never exact replicas of real phenomena; rather, models are simplified versions of reality, generally constructed to facilitate study of complex systems such as the atom, climate change, and biogeochemical cycles. Models may be physical, mental, or mathematical, or contain a combination of these elements. Models are complex constructions that consist of conceptual objects and processes in which the objects participate or interact. Scientists spend considerable time and effort building and testing models to further understanding of the natural world.

When engaging in the processes of science, students constantly are building and testing their own models of understanding the natural world. Students may need help in learning how to identify and articulate their own models of natural phenomena. Activities that involve reflection and metacognition are particularly useful in this regard. Students should be able to identify the features of the physical phenomena their models represent or explain. Just as importantly, students should identify which features are not represented or explained by their models. Students should determine the usefulness of their model by judging whether the model helps in understanding the underlying concepts or processes. Ultimately, students realize that different models of the same phenomena may be needed to investigate or understand different aspects of the phenomena.

Classroom and Field Work

The National Research Council (2006, p. 3) defines a school laboratory investigation as an experience in the laboratory, the classroom, or the field that provides students with opportunities to interact directly with natural phenomena or with data collected by others using tools, materials, data collection techniques, and models. These experiences should be designed so that all students – including students with intensive needs – are able to participate authentically in and benefit from those experiences.

Classroom and field experiences help students develop scientific and technological skills and processes including:

- initiating and planning
- performing and recording
- analyzing and interpreting
- communication and teamwork.

Ideally, laboratory work should help students to understand the relationship between evidence and theory, develop critical thinking and problem-solving skills, as well as develop acceptable scientific attitudes.

(Di Giuseppe, 2007, p. 54)

Well-planned investigations help students understand the nature of science, specifically that explanations and predictions must be consistent with observations. Similarly, student-centered investigations help emphasize the need for curiosity and inquisitiveness as part of the scientific endeavour. The National Science Teachers Association [NSTA] position statement, *The Integral Role of Laboratory Investigations in Science Instruction* (2007), provides further information about laboratory investigations.

A strong science program includes a variety of individual, small, and large group classroom and field experiences for students. Most importantly, these experiences need to go beyond conducting confirmatory "cook-book" experiments. Similarly, computer simulations and teacher demonstrations can support, but should not replace, hands-on student activities.

Assessment and evaluation of student performance must reflect the nature of the experience by addressing scientific and technological skills. Students should document their observations and processes using science journals and narrative reports. The narrative report enables students to tell the story of their process and findings by addressing four questions:

- What was I looking for?
- How did I look for it?
- What did I find?
- What do these findings mean?

Student responses to these questions may be shared using illustrations, oral language, or written text.

Safety

Safety in the classroom is of paramount importance. Other components of education (resources, teaching strategies, facilities) attain their maximum utility only in a safe classroom. Creating a safe classroom requires a teacher to be informed, aware, and proactive, and that the students listen, think, and respond appropriately.

Safe practice in or out of the classroom is the joint responsibility of the teacher and students. The teacher's responsibilities are to provide a safe environment and ensure students are aware of safe practice. The students' responsibility is to act intelligently based on the advice which is given and which is available in various resources.

Safety cannot be mandated soley by rule of law, teacher command, or school regulation. Safety and safe practice are an attitude.

Kwan and Texley (2003) suggest that teachers, as professionals, consider four Ps of safety: prepare, plan, prevent, and protect. The following points are adapted from those guidelines and provide a starting point for thinking about safety in the science classroom:

Prepare

- Keep up-to-date with personal safety knowledge and certifications.
- Be aware of national, provincial, division, and school level safety policies and guidelines.
- Create a safety contract with students.

Plan

- Develop learning plans that ensure all students learn effectively and safely.
- Choose activities that are best suited to the learning styles, maturity, and behaviour of all students, and that include all students.
- Create safety checklists for in-class activities and field studies.

Prevent

- Assess and mitigate hazards.
- Review procedures for accident prevention with students.
- Teach and review safety procedures with students, including the need for appropriate clothing.
- Do not use defective or unsafe equipment or procedures.
- Do not allow students to eat or drink in science areas.

Protect

- Ensure students have sufficient protective devices such as safety glasses.

- Demonstrate and instruct students on the proper use of safety equipment and protective gear.
- Model safe practice by insisting that all students and visitors use appropriate protective devices.

The definition of safety includes consideration of the well-being of all components of the biosphere, such as plants, animals, earth, air, and water. From knowing what wild flowers can be picked to considering the disposal of toxic wastes from chemistry laboratories, the safety of our world and our future depends on our actions and teaching in science classes. Students also must practise ethical, responsible behaviours when caring for and experimenting with live animals. For further information, refer to the NSTA position statement, *Responsible Use of Live Animals and Dissection in the Science Classroom* (2008).

WHMIS regulations govern storage and handling practices of chemicals in schools.

The Chemical Hazard Information Table in Safety in the Science Classroom (Alberta Education, 2005) provides detailed information including appropriateness for school use, hazard ratings, WHMIS class, storage class, and disposal methods for hundreds of chemicals.

Safety in the science classroom includes the storage, use, and disposal of chemicals. The Workplace Hazardous Materials Information System (WHMIS) regulations under the Hazardous Products Act govern storage and handling practices of chemicals in schools. All school divisions must comply with the provisions of the act. Chemicals should be stored in a safe location according to chemical class, not just alphabetically. Appropriate cautionary labels must be placed on all chemical containers, and all school division employees using hazardous substances should have access to appropriate Materials Safety Data Sheets (MSDS). Under provincial WHMIS regulations, all employees involved in handling hazardous substances must receive training by their employer. Teachers who have not been informed about or trained in this program should contact their Director of Education. Further information related to WHMIS is available through Health Canada and Saskatchewan Labour Relations and Workplace Safety.

Technology in Science

Technology should be used to support learning in science when:

- *it is pedagogically appropriate*
- *it makes scientific views more accessible*
- *it helps students to engage in learning that otherwise would not be possible.*

(Flick & Bell, 2000)

Technology-based resources are essential for instruction in the science classroom. Technology is intended to extend our capabilities and, therefore, is one part of the teaching toolkit. Individual, small group, or class reflection and discussions are required to connect the work with technology to the conceptual development, understandings, and activities of the students. Choices to use technology, and choices of which technologies to use, should be based on sound pedagogical practices, especially those that support student inquiry. These technologies include computer technologies, as described below, and non-computer based technologies.

Some recommended examples of using computer technologies to support teaching and learning in science include:

Data Collection and Analysis

- Data loggers, such as temperature probes and motion detectors, permit students to collect and analyze data, often in real-time, and to collect observations over very short or long periods of time, enabling investigations that otherwise would be impractical.
- Graphing software can facilitate the analysis and display of student-collected data or data obtained from other sources.

Visualization and Imaging

- Students may collect their own digital images and video recordings as part of their data collection and analysis, or they may access digital images and video online to help enhance understanding of scientific concepts.
- Simulation and modeling software provide opportunities to explore concepts and models which are not readily accessible in the classroom, such as those that require expensive or unavailable materials or equipment, hazardous materials or procedures, levels of skills not yet achieved by the students, or more time than is possible or appropriate in a classroom.

Communication and Collaboration

- Students can use word-processing and presentation tools to share the results of their investigations with others.
- The Internet can be a means of networking with scientists, teachers, and other students by gathering information and data, posting data and findings, and comparing results with students in different locations.
- Students can participate in authentic science projects by contributing local data to large-scale web-based science inquiry projects such as Journey North (www.learner.org/north) or GLOBE (www.globe.gov).

Outcomes and Indicators

Life Science – Animal Growth and Changes (AN)
AN2.1 Analyze the growth and development of familiar animals, including birds, fish, insects, reptiles, amphibians, and mammals, during their life cycles.
AN2.2 Compare the growth and development of humans with that of familiar animals.
AN2.3 Assess the interdependence of humans and animals in natural and constructed environments.

Physical Science – Liquids and Solids (LS)
LS2.1 Investigate properties (e.g., colour, taste, smell, shape, and texture) of familiar liquids and solids.
LS2.2 Investigate interactions between liquids and solids, and technologies based on those interactions.

Physical Science – Motion and Relative Position (MP)
MP2.1 Analyze methods of determining the position of objects relative to other objects.
MP2.2 Investigate factors, including friction, which affect the motion of natural and constructed objects, including self.

Earth and Space Science – Air and Water in the Environment (AW)
AW2.1 Investigate properties of air and water (in all three states of matter) within their environment.
AW2.2 Assess the importance of air and water for the health and survival of living things, including self, and the environment.

Life Science: Animal Growth and Changes (AN)

All outcomes in this unit contribute to the development of all K-12 science goals.

Outcomes	Indicators
AN2.1 Analyze the growth and development of familiar animals, including birds, fish, insects, reptiles, amphibians, and mammals, during their life cycles. ***[CP, SI]***	a. Pose questions about the growth and development of familiar animals. b. Use a variety of resources (e.g., Elder, naturalist, zookeeper, park warden, pet store, books, pictures, and videos) to find information about the life cycles of living things. c. Identify the names of the offspring (e.g., cub, pup, calf, kitten, chick, fawn, fingerling, maggot, tadpole, gosling, and infant) of familiar animals. d. Recognize the cyclic nature of Mother Earth expressed by the Medicine Wheel, including life cycles and seasonal behaviours of animals. e. Compare the length and stages of life cycles of familiar animals. f. Describe the characteristics common to each stage (e.g., birth, youth, adulthood, and old age) of the life cycle of familiar animals (e.g., dog, cat, beaver, frog, fish, bird, ant, wasp, and chicken). g. Analyze which traits (e.g., body size, head size to body ratio, and number of limbs) remain relatively constant and which change in specific animals as they grow and develop. h. Create a physical, visual, or dramatic representation of the growth and development of familiar animals during their life cycles. i. Predict how big a specific animal will grow based on observed patterns of animal growth and changes. j. Design an animal suited for life in a particular environment (real or imaginary) and represent its growth and changes throughout its life cycle.
AN2.2 Compare the growth and development of humans with that of familiar animals. ***[CP, SI]***	a. Pose questions about similarities and differences between animal and human growth. b. Predict ways in which humans change as they grow. c. Create representations of changes in the growth and development of humans throughout their life cycle (e.g., baby, preschooler, elementary student, teenager, adult, and elderly person).

Outcomes	Indicators
AN2.2 continued	d. Sequence pictures or illustrations of humans and familiar animals according to stage of life cycle. e. Compare patterns in human growth and development to that of familiar animals. f. Examine the implications of traditional and contemporary food choices and eating habits on human growth and development. g. Compare the food choices and eating habits of various familiar animals as they relate to growth and development. h. Communicate personal thoughts and feelings related to personal growth and change, including transitions that are celebrated in various cultures.
AN2.3 Assess the interdependence of humans and animals in natural and constructed environments. ***[CP, DM]***	a. Predict which animals live in various locations (e.g., tree, underground, nest, cave, water, and soil) within a variety of natural and constructed environments. b. Observe familiar animals in natural (e.g., tree, stream, pond, forest, and beneath a rock) and constructed (e.g., garden, sports field, zoo, aquarium, and city) environments safely and respectfully. c. Examine the importance and sacredness of animals in First Nations, Métis, and other cultures. d. Assess features of natural (e.g., woodland, stream, grassland, and forest) and constructed (e.g., backyard, zoo, schoolyard, and classroom) environments that support or hinder the health and growth of familiar animals. e. Analyze ways in which human activities intentionally or unintentionally can help or harm wild and domesticated animals. f. Examine ways in which humans and animals interact with each other (e.g., pet, companionship, transportation guide dog, search and rescue, and providing food), including ways in which animals can cause harm to humans. g. Discuss the care and handling of wild and domesticated animals (e.g., fish, dog, bird, horse, cow), including keeping animals as pets, housing animals in zoos and aquariums, and identifying careers related to animal care.

Physical Science: Liquids and Solids (LS)

All outcomes in this unit contribute to the development of all K-12 science goals.

Outcomes	Indicators
LS2.1 Investigate properties (e.g., colour, taste, smell, shape, and texture) of familiar liquids and solids. ***[SI]***	a. Pose questions that lead to investigation and exploration of the properties of familiar liquids and solids. b. Classify objects in various natural and constructed environments as liquids or solids. c. Identify examples of how liquids, in all three states of matter, are used at home, in the school, and throughout their communites. d. Interpret safety symbols (e.g., WHMIS and consumer chemical hazard symbols) and labels that are used on hazardous product containers for liquids and solids. e. Select and safely use materials and tools (e.g., magnifier, scale, measuring cup, and spatula) to carry out explorations of the observable physical properties of familiar liquids and solids. f. Record and compare observable physical properties (e.g., colour, taste, smell, shape, texture, transparency, and ability to adapt to the shape of container) of familiar liquids and solids. g. Distinguish between properties of familiar liquids and solids. h. Demonstrate that liquids and solids are matter because they have mass and take up space. i. Investigate to determine whether properties of familiar liquids and solids depend on factors such as the amount of substance present. j. Group or sequence liquids and solids according to one or more observable physical properties (e.g., colour, state, texture, smell, transparency, and buoyancy). k. Predict and test changes in characteristics (e.g., shape, colour, and volume) of liquids when they are changed into solids or gases.

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Outcomes

LS2.2 Investigate interactions between liquids and solids, and technologies based on those interactions.

[CP, SI, TPS]

Indicators

a. Pose questions that lead to exploration and investigation of combining liquids and solids.

b. Investigate how liquids change when they are poured into different containers.

c. Describe examples of useful objects and materials in their environment that are made by combining different liquids or solids and liquids.

d. Investigate and describe the changes in characteristics of familiar solids and liquids resulting from processes such as mixing and dissolving liquids with liquids, solids with solids, and liquids with solids.

e. Distinguish between familiar solids (e.g., sand, sugar, salt, gravel, soil, and drink crystals) that dissolve in water and those that do not.

f. Carry out an investigation to determine the relative viscosity of different liquids (e.g., water, milk, and syrup) when placed on various surfaces (e.g., paper, paper towel, cotton, plastic, and wax paper).

g. Design and carry out an investigation to determine the rate and ability of various materials (e.g., paper, paper towel, cotton, plastic, and wax paper) to absorb liquids and explain how these capabilities determine their uses.

h. Use a variety of sources (e.g., newspapers, Elders, anglers, books, videos, and Internet) to gather information about objects that sink and float (e.g., canoes, kayaks, barges, boats, buoys, and fishing lures).

i. Demonstrate an understanding of sinking and floating by solving a related practical problem such as building an object that will float, carry a load, and be stable.

j. Assess ways people use knowledge of solids and liquids to maintain a clean and healthy environment (e.g., filtering water, sorting solids for recycling, cleaning up a kitchen spill, washing dishes, cleaning paint brushes, using hand cleaners, wearing a paint smock).

Physical Science: Motion and Relative Position (MP)

All outcomes in this unit contribute to the development of all K-12 science goals.

Outcomes	Indicators
MP2.1 Analyze methods of determining the position of objects relative to other objects. ***[SI]***	a. Describe the position of an object relative to other positions or stationary objects, including themselves, using appropriate vocabulary such as *above*, *below*, *between*, *beside*, *on top*, *close to*, *far from*, *behind*, *in front of*, *to the right of*, and *to the left of*. b. Place an object in an identified position (e.g., four steps to the right and one step forward, close, far, right, left, forward, back, up, down) relative to another object or position. c. Assess the use of common objects (e.g., hand, step, and book) to describe the position of an object using non-standard units. d. Use appropriate tools (e.g., rulers and string) safely for observing and recording objects' positions. e. Record observations and measurements of an object's position, using oral and written language, diagrams, and tables. f. Represent the position of objects as seen from different perspectives (e.g., top, side, and bottom) using words, diagrams, and actions. g. Collaborate with other students to describe the position of an object from different positions using drawings, and written and oral descriptions. h. Explore how changing one's own position affects one's perspective of position relative to self and other objects. i. Create a set of directions (e.g., treasure hunt map) that other students can follow to locate a specified position. j. Follow directions to move in a specified way to different positions.

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Outcomes	Indicators
MP2.2 Investigate factors, including friction, which affect the motion of natural and constructed objects, including self. ***[SI]***	a. Pose questions about the motion of natural and constructed objects in their environment (e.g., How do we know if something is moving? What are some different types of motion? Why is it difficult to walk on some surfaces?). b. Describe examples of the motion of natural (e.g., birds flying, leaves falling, tree branches swaying, icicles melting, fish swimming, wind blowing, and creeks flowing) and constructed (e.g., vehicles moving, clock hands rotating, balls bouncing, playground swings, and tools operating) objects in their environment. c. Describe the motion of an object in terms of a change in position relative to other objects (e.g., faster, slower, towards, away, closer, and further). d. Examine a variety of toys, playground equipment, and other objects that move or which have components that move and ask questions that lead to exploration and investigation of the motion of objects. e. Investigate, describe, and represent different patterns of movement (e.g., walking, running, swinging, bouncing, sliding, rotating, spinning, crawling, and rolling) of familiar objects, including themselves. f. Relate the types of motion (e.g., crawling, walking, running, flying, swimming, slithering, galloping, crab walking, and rolling) to the physical characteristics of humans and familiar animals. g. Demonstrate how pushes and pulls can cause an object to speed up, slow down, stop, or change direction. h. Describe the movement of a specified object using appropriate vocabulary so that other students can duplicate the movement. i. Carry out a procedure to investigate the effects of pushes and pulls on the motion of objects using various objects and surfaces (e.g., paper, carpet, sandpaper, desktop, tile floor, wooden board, ice, sidewalk, grass, soil, and sand). j. Observe and record the effects of different textured surfaces on the friction between two objects or surfaces. k. Provide examples of technologies (e.g., skate, snowshoe, bicycle, ski, kayak, curling slider, and wheelchair) that are designed to make it easier for people and constructed objects to move on different surfaces. l. Generate new questions about the motion of objects that arise from what was learned (e.g., Do objects move the same way in space or in water or in another liquid? What causes motion?).

Physical Science: Air and Water in the Environment (AW)

All outcomes in this unit contribute to the development of all K-12 science goals.

Outcomes	Indicators
AW2.1 Investigate properties of air and water (in all three states of matter) within their environment. ***[SI, TPS]***	a. Observe, using all of their senses, physical properties of air (e.g., generally invisible, odourless, and fills and assumes shape of container) and of water (e.g., assumes shape of container, clear, tasteless, and odourless). b. Select appropriate tools (e.g., thermometer, wind sock, rain gauge, garden hose, fan, oar, propeller, and vacuum) and materials to carry out safely their own explorations of air and water in their environment through processes such as collecting dew, rainfall, and snow; measuring wind speed; and measuring temperature. c. Measure amounts of air and water using non-standard measurements (e.g., dropper, spoonful, container, pop bottle, garbage can, aquarium, straw, and zip-lock bag). d. Provide evidence indicating air takes up space, has mass, and can be felt when it moves. e. Categorize examples of water in indoor and outdoor environments, and in living things, including themselves, according to state of matter (i.e., solid, liquid, and gaseous). f. Investigate physical (e.g., mass, shape, texture, colour, and odour) changes in water during each change of state (i.e., freezing, melting, evaporation, condensation, sublimation, and deposition). g. Carry out procedures to investigate methods of increasing or decreasing the rate water changes state (i.e., freezing or boiling). h. Collaboratively design and construct a device that is powered by wind or water and that meets a student-identified purpose. i. Classify or sequence materials according to attributes such as how quickly they absorb water, how much water they absorb, and whether they are waterproof or water repellent. j. Communicate procedures and results of observations of the physical properties of air and water, using drawings, demonstrations, and written and oral descriptions.

Outcomes	Indicators
AW2.2 Assess the importance of air and water for the health and survival of living things, including self, and the environment. ***[CP, DM]***	a. Pose questions that lead to exploration and investigation about air and water conditions (e.g., Why does skin feel wet in the summer? Why is it harder to breathe in winter than in summer? Why might people wear a filter over their nose and mouth?). b. Describe changes in the location, amount, and form of moisture in different locations in the environment, and factors such as exposure to heat and moving air that can affect these conditions. c. Recognize the importance of air and water as two of the four elements (i.e., air, water, earth, fire) in Mother Earth in First Nations, Métis, and other cultures. d. Explain how living things, including humans, require clean air and water for breathing, cooling, drinking, cooking, bathing, and prevention of illness to maintain a healthy body. e. Explain how water is obtained, distributed, and used in personal, local, and regional environments (e.g., home, classroom, school, town, city, and province). f. Communicate questions, ideas, and intentions while conducting personal and group explorations of air and water in the environment. g. Record, using tables, diagrams, pictographs, or bar graphs, individual, classroom, and/or household use of water for a given period. h. Suggest explanations for how air and water in the environment can become polluted. i. Suggest ways that individuals can contribute to protecting and improving the quality of air and water in their environment (e.g., conserving water, not pouring chemicals down the drain, not burning hazardous materials, and reducing travel via motorized vehicles). j. Propose an answer to a question or problem related to the importance of air and water for living things.

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Assessment and Evaluation of Student Learning

Assessment and evaluation require thoughtful planning and implementation to support the learning process and inform teaching. All assessment and evaluation of student achievement must be based on the outcomes in the provincial curriculum.

Assessment involves the systematic collection of information about student learning with respect to:

- achievement of provincial curriculum outcomes
- effectiveness of teaching strategies employed
- student self-reflection on learning.

Evaluation compares assessment information against criteria based on curriculum outcomes for the purpose of communicating to students, teachers, parents/caregivers, and others about student progress, and making informed decisions about the teaching and learning process.

Reporting of student achievement must be in relation to curriculum outcomes. Assessment information unrelated to outcomes (e.g., attendance, behaviour, general attitude, completion of homework, and effort) can be gathered and reported to complement the reported achievement related to curricular outcomes.

We assess students for three interrelated purposes. Each type of assessment, systematically implemented, contributes to an overall picture of an individual student's achievement.

Assessment for learning involves the use of information about student progress to support and improve student learning, inform instructional practices, and:

- is teacher-driven for student, teacher, and parent use
- occurs throughout the teaching and learning process using a variety of tools
- engages teachers in providing differentiated instruction, feedback to students to enhance learning, and information to parents in support of learning.

Assessment as learning actively involves student reflection on learning, monitoring her/his own progress, and:

- engages students in critically analyzing learning related to curricular outcomes (metacognition)
- is student-driven with teacher guidance for personal use
- occurs throughout the learning process.

Assessment of learning involves teachers' use of evidence of student learning to make judgements about student achievement and:

- provides the opportunity to report evidence of achievement related to curricular outcomes
- occurs at the end of a learning cycle using a variety of tools
- provides the foundation for discussions on placement or promotion.

Connections with Other Areas of Study

Although some learning outcomes or subject-area knowledge may be achieved through discipline-specific instruction, deeper understanding may be attained through the integration of the disciplines. Some outcomes for each area of study complement each other and offer opportunities for subject-area integration. Integrating science with another area of study can help students develop in a holistic manner by addressing physical, emotional, mental, and spiritual dimensions.

By identifying a particular context to use as an organizer, the outcomes from more than one subject area can be achieved, and students can make connections across areas of study. Integrated, interdisciplinary instruction, however, must be more than just a series of activities. An integrated approach must facilitate students' learning of the related disciplines and understanding of the conceptual connections. The learning situations must achieve each individual subject area's outcomes and ensure that in-depth learning occurs. If deep understanding is to occur, the experiences cannot be based on superficial or arbitrarily connected activities (Brophy & Alleman, 1991, p. 66). The outcomes and activities of one area of study must not be obscured by the outcomes or activities of another area of study (Education Review Office, 1996, p. 13).

Many possibilities for the integration of science and other subject areas exist. In doing this integration, however, teachers must be cautious not to lose the integrity of any of the subjects. Integration gives students experience with transfer of knowledge and provides rich contexts in which the students are able to make sense of their learning. A few of the ways in which science can be integrated into other subject areas (and other subject areas into science) at grade two follow.

Arts Education

The conceptual focus for Grade 2 Arts Education is "Community". This focus includes investigations of how works of art are created in the student's community, or in response to an event in or characteristic of the community. Connections between arts education and science may include:

- Representing the position and movement of objects, including self, from different perspectives through dance and visual art.
- Creating sketches, drawings, and other appropriate representations of the life cycles of humans and familiar animals.
- Examining ways in which others have represented their scientific understanding of the importance of air and water for the survival of living things through visual art, drama, dance, and music.

English Language Arts (ELA)

As students gather and evaluate information, construct and refine knowledge, and share what they know with a variety of audiences, they use and develop their language skills. The environment/technology context in English language arts can provide students with an opportunity to learn and apply science knowledge. Some specific examples of connections between ELA and science at grade two include:

- Throughout the science curriculum, students should view, listen to, read, comprehend, and respond to a variety of texts, including fiction, non-fiction, videos, websites, and summarize the main ideas and supporting details of those texts.
- Students should understand that the structure of science texts differs from the structure of other types of texts. By gaining an understanding of that structure, students will be able to read those texts efficiently and effectively for a variety of purposes, including gathering information, following directions, understanding information, and for enjoyment.
- Students should present the results of their science inquiries using a variety of text forms, including expository, informational, and procedural texts (e.g., document the design, construction, and evaluation of a prototype of a wind- or water-powered device), descriptive texts (e.g., describe the changes in characteristics of familiar solids and liquids when they are mixed or combined), and persuasive texts (e.g., propose actions that individuals can take to contribute to protecting and improving the quality of air and water in their environment).
- Students should reflect on and critique their choices of grade-appropriate strategies for communicating their science learning.

Health Education

Connections often can be found between the topics in health education and science, even though students may conduct their inquiries into these topics from different disciplinary "worlds". Examples of the connection between these areas of study at grade two include:

- Discussing the importance of ways in which traditional and contemporary food choices contribute to personal growth and development.
- Demonstrating respect for animals and the environment when investigating animal growth and development and air and water in the environment.

- Discussing and following appropriate safety practices when investigating the movement of objects and when using materials and tools to explore physical properties of familiar liquids and solids.

Mathematics

A key connection between mathematics and science is the search for patterns and relationships in the natural and constructed world. Inquiries in science require students to collect, analyze, and display data, which require the application of a variety of mathematical skills and processes, including measuring, counting, and data analysis skills. When students construct mathematical and physical models in science to represent and explain natural phenomena, they apply mathematical skills related to number. Some specific examples of these connections in grade two include:

- Examining repeating patterns in the growth and development of humans and familiar animals.
- Collecting, organizing, and displaying data when conducting investigations into the viscosity or absorbency of various liquids.
- Recording quantitative measurements, using non-standard length units, of the relative position and movement of objects, including self.
- Investigating relationships between 3-D objects and the amount of space they occupy.

Physical Education

Both science and physical education involve understanding of the human body, albeit within different disciplinary "worlds". Understanding scientific principles related to movement can serve to enhance skillful movement of the human body; in contrast, the analysis of human movement can contribute to a deeper understanding of the underlying scientific principles. Specific examples of connections between these areas of study at grade two include:

- Using a variety of movement skills to speed up, slow down, or change direction safely.
- Demonstrating how muscles and joints move to cause people and animals to speed up, slow down, or change direction.
- Discussing the importance of nutrition, clean air, and water for personal health and development.

Social Studies

The content of social studies and science often can be used to connect the two areas of study, particularly with respect to connections between the environment and all living things, including humans. This connection is emphasized through the STSE (Science-Technology-Society-Environment) foundation of scientific literacy and the STSE Decision Making learning context. Some specific examples of these connections in grade two include:

- Examining how the absence or presence of water in the natural environment influences community development.
- Investigating the importance of air and water in traditional First Nations worldviews.

Glossary

Absorbency is the incorporation of a substance in one state of matter into another substance of a different state.

Cultural perspectives is the learning context that reflects a humanistic perspective which views teaching and learning as cultural transmission and acquisition.

Force is a push or pull that causes an object to move.

Friction is the force resisting movement of surfaces against each other.

Physical properties are aspects of a material that can be measured or observed without changing the identity of the material (e.g., smell, colour, texture, transparency, viscosity, and absorbency).

Scientific inquiry is the learning context that reflects an emphasis on understanding the natural and constructed world using systematic empirical processes that lead to the formation of theories that explain observed events and facilitate prediction.

Scientific literacy is an evolving combination of the knowledge of nature, skills, processes, and attitudes that students need to develop inquiry, problem solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about and responsibility towards the natural and constructed world.

STSE, or Science-Technology-Society Environment, is the foundation of scientific literacy that is concerned with understanding the scope and character of science, its connections to technology, and the social context in which it is developed.

STSE decision making is the learning context that reflects the need to engage citizens in thinking about human and world issues through a scientific lens to inform and empower decision making by individuals, communities, and society.

Technological problem solving is the learning context that reflects an emphasis on designing and building to solve practical human problems.

Viscosity is the measure of a fluid's resistance to flow.

WHMIS is the Workplace Hazardous Materials Information System, which provides standardized information about hazardous materials.

References

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. New York, NY: Teachers College Press.

Alberta Education. (2005). *Safety in the science classroom*. AB: Author.

Brophy, J. & Alleman, J. (1991). A caveat: Curriculum integration isn't always a good idea. *Educational Leadership*, 49, 66.

Canadian Council on Learning. (2007). *Redefining how success is measured in First Nations, Inuit and Métis learning, Report on learning in Canada 2007*. Ottawa, ON: Author.

Copple, C. & Bredekamp, S. (Eds.). (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8 (3rd ed.)*. Washington, DC: National Association for the Education of Young Children.

Council of Ministers of Education, Canada. (1997). *Common framework of science learning outcomes K to 12*. Toronto, ON: Author.

Di Giuseppe, M. (Ed). (2007). *Science education: A summary of research, theories, and practice: A Canadian perspective*. Toronto, ON: Thomson Nelson.

Education Review Office. (1996). *Science in schools – Implementing the 1995 science curriculum* (5). Wellington: Crown Copyright.

Flick, L. & Bell, R. (2000). Preparing tomorrow's science teachers to use technology: Guidelines for science educators. *Contemporary Issues in Technology and Teacher Education*, 1, 39-60.

International Council for Science. (2002). *ICSU series on science for sustainable development No 4: Science, traditional knowledge and sustainable development*. Paris, France: Author

International Technology Education Association. (2000). *Standards for technological literacy: Content for the study of technology*. Reston, VA: National Science Foundation.

Kluger-Bell, B. (2000). *Recognizing inquiry: Comparing three hands-on teaching techniques*. In Inquiry – Thoughts, Views, and Strategies for the K-5 Classroom (Foundations - A monograph for professionals in science, mathematics and technology education. Vol. 2). Washington, DC: National Science Foundation.

Kwan, T. & Texley, J. (2003). *Inquiring safely: A guide for middle school teachers*. Arlington, VA: NSTA Press.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: National Academy Press.

National Research Council. (2006). *America's lab report: Investigations in high school science*. Washington, DC: National Academy Press.

National Science Teachers Association (NSTA). 2007. *NSTA position statement: The integral role of laboratory investigations in science instruction*. Available online at http://www.nsta.org/about/positions/laboratory.aspx.

National Science Teachers Association (NSTA). 2008. *NSTA position statement: Responsible use of live animals and dissection in the science classroom*. Available at http://www.nsta.org/about/positions/animals.aspx.

Saskatchewan Learning. (2009). *Core curriculum: Principles, time allocations, and credit policy*. SK: Author.

Suggested Reading

Aikenhead, G.S. & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539-591.

Allen, R. (2007). *The essentials of science, grades 7-12: Effective curriculum, instruction, and assessment*. Alexandria, VA: ASCD.

American Association for the Advancement of Science, Project 2061. (1994). *Benchmarks for scientific literacy*. Washington, DC: Author.

American Association for the Advancement of Science, Project 2061. (2001). *Atlas of scientific literacy, Volume 1*. Washington, DC: Author.

American Association for the Advancement of Science, Project 2061. (2007). *Atlas of scientific literacy, Volume 2*. Washington, DC: Author.

Atkin, J.M. & Coffey, J.E. (Eds.). (2003). *Everyday assessment in the science classroom*. Arlington, VA: NSTA Press.

Bell, R.L., Gess-Newsome, J., & Luft, J. (Eds.). (2008). *Technology in the secondary science classroom*. Arlington, VA: NSTA Press.

British Columbia Ministry of Education. (2003). *Science safety resource manual*. BC: Author.

Cajete, G.A. (1999). *Igniting the sparkle: An indigenous science education model*. Skyland, NC: Kivaki Press.

Douglas, R., Klentschy, M.P., Worth, K., & Binder, W. (Eds.). (2006). *Linking science and literacy in the K-8 classroom*. Arlington, VA: NSTA Press.

Gilbert, S. & Watt Iron, S. (2003). *Understanding models in earth and space science*. Arlington, VA: NSTA Press.

Hammerman, E. & Musial, D. (2008). *Integrating science with mathematics & literacy: New visions for learning and assessment* (2nd ed). Thousand Oaks, CA: Corwin Press.

Kwan, T. & Texley, J. (2002). *Exploring safely: A guide for elementary teachers*. Arlington, VA: NSTA Press.

Kwan, T. ,Texley, J., & Summers, J. (2004). *Investigating safely: A guide for high school teachers*. Arlington, VA: NSTA Press.

LaMoine, L.M., Biehle, J.T., & West, S.S. (2007). *NSTA guide to planning school science facilities* (2nd ed). Arlington, VA: NSTA Press.

Michell, H., Vizina, Y., Augusta, C., & Sawyer. J. (2008). *Learning Indigenous science from place*. Aboriginal Education Research Centre, University of Saskatchewan.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8*. Committee on Science Learning, Kindergarten through Eighth Grade. Richard A. Duschl, Heidi A. Schweingruber, and Andrew A. Shouse, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Saul, W.E. (Ed.). (2004). *Crossing borders in literacy and science instruction: Perspectives on theory and practice*. Arlington, VA: NSTA Press.

Feedback Form

The Ministry of Education welcomes your response to this curriculum and invites you to complete and return this feedback form.

Grade 2 Science Curriculum

1. Please indicate your role in the learning community:

☐ parent ☐ teacher ☐ resource teacher

☐ guidance counsellor ☐ school administrator ☐ school board trustee

☐ teacher librarian ☐ school community council member

☐ other ____

What was your purpose for looking at or using this curriculum?

2. a) Please indicate which format(s) of the curriculum you used:

☐ print

☐ online

b) Please indicate which format(s) of the curriculum you prefer:

☐ print

☐ online

3. Please respond to each of the following statements by circling the applicable number.

The curriculum content is:	Strongly Agree	Agree	Disagree	Strongly Disagree
appropriate for its intended purpose	1	2	3	4
suitable for your use	1	2	3	4
clear and well organized	1	2	3	4
visually appealing	1	2	3	4
informative	1	2	3	4

4. Explain which aspects you found to be:

Most useful:

Least useful:

5. Additional comments:

6. Optional:

   Name: ____

   School: ____

   Phone: _____________________ Fax: _____________________

Thank you for taking the time to provide this valuable feedback.

Please return the completed feedback form to:

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