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Saskatchewan Curriculum

Science

3

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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 recently developed resources, 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, in the resources developed to support the new 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.

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.

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 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 examine the importance of agriculture in Saskatchewan, including the variety of plants and plant-related products. This means that, although other aspects of agriculture can be examined, examining the variety of plants and plant-related products 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 spoons, hand lenses,

jars, and filters" as examples of tools students can use to analyze soil samples . This statement provides teachers and students with possible tools to consider, while not excluding other tools.

- 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., igloo, bike helmet, balloon, and drink can" to refer to examples of different types of shell structures.

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)

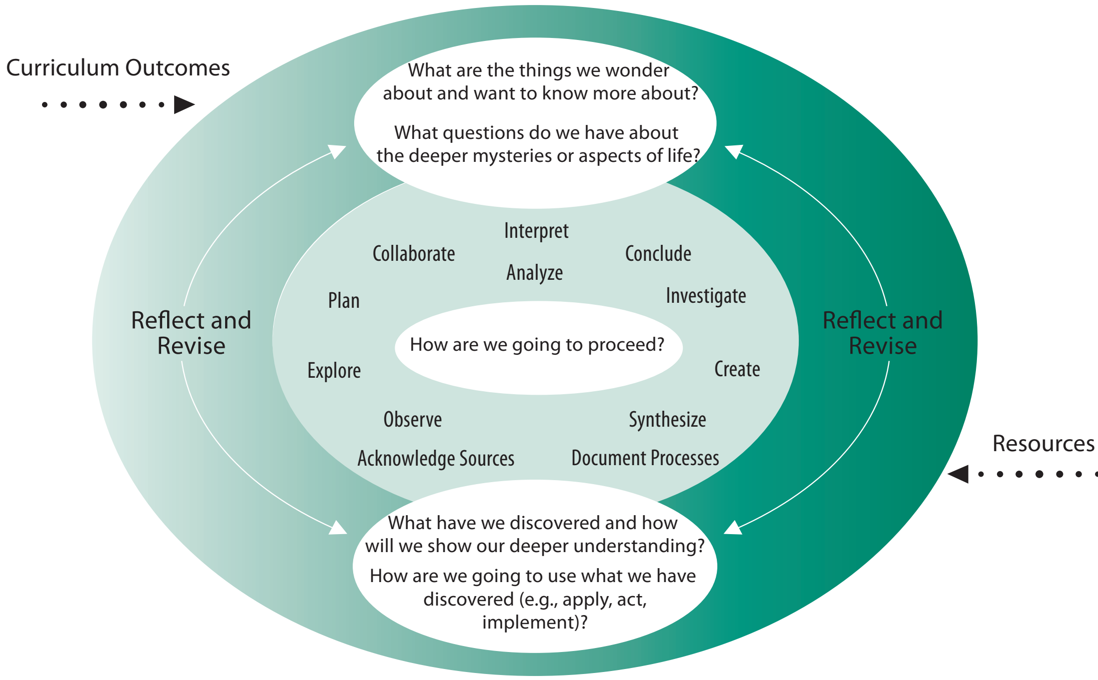
An important part of any inquiry process is student reflection on their learning and the documentation needed to assess learning and make it visible. Student documentation of their inquiries in science may take the form of works-in-progress, reflective writing, journals, reports, notes, models, arts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

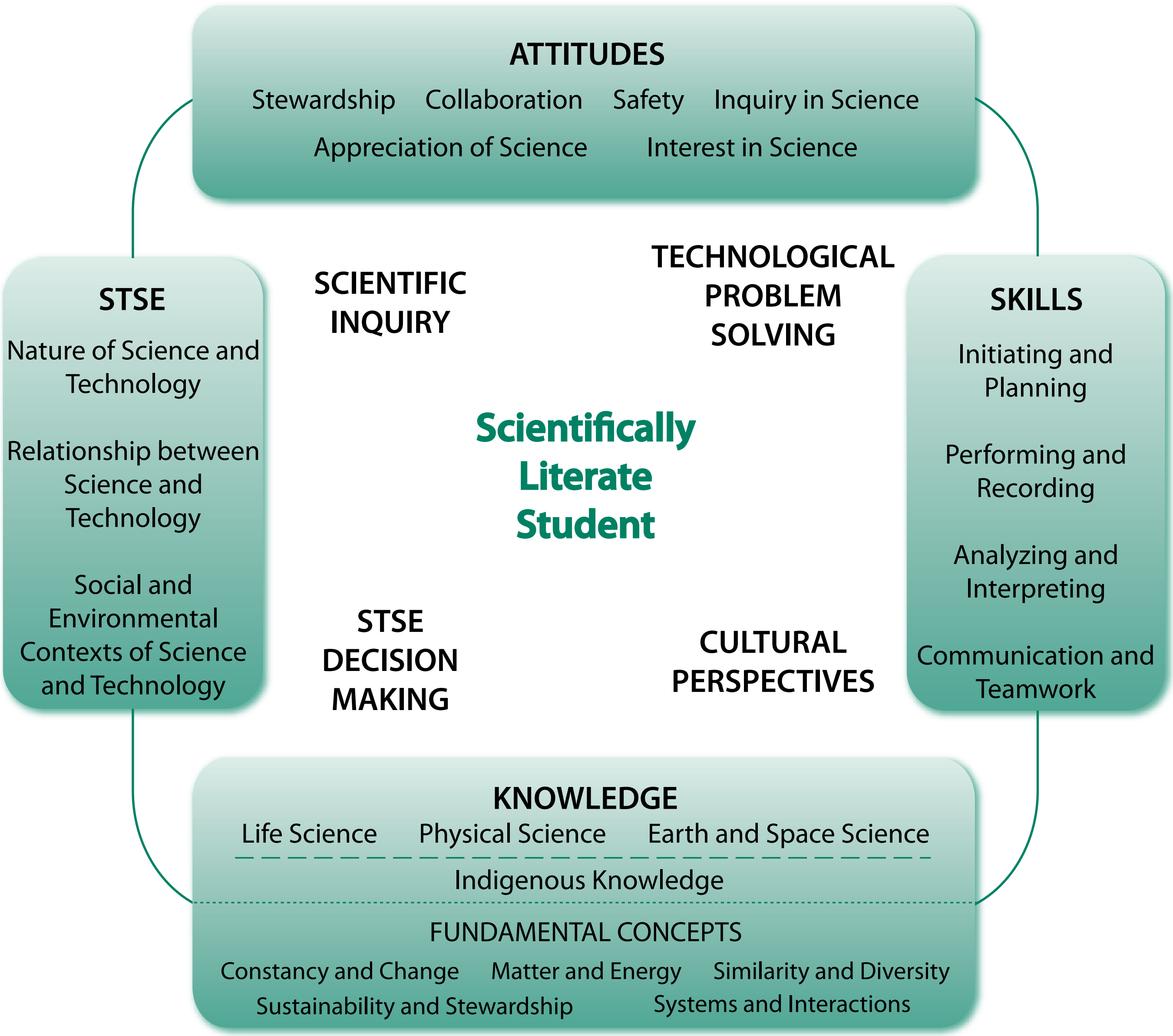
All science outcomes and indicators incorporate one or more foundations of scientific literacy; these are the "what" of the curriculum. The learning contexts represent different processes for engaging students in achieving curricular outcomes; they are the "how" of the curriculum. The four units of study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

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

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.

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.

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.

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.

Technology in Science

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.

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)

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 – Plant Growth and Changes (PL)
PL3.1 Investigate the growth and development of plants, including the conditions necessary for germination.
PL3.2 Analyze the interdependence among plants, individuals, society, and the environment.

Physical Science – Structures and Materials (SM)
SM3.1 Investigate properties of materials and methods of joinery used in structures.
SM3.2 Assess the function and characteristics of strong, stable, and balanced natural and human-built structures.

Physical Science – Magnetism and Static Electricity (ME)
ME3.1 Investigate the characteristics of contact (e.g., push, pull, and friction) and non-contact (e.g., magnetic and static electric) forces.
ME3.2 Assess effects of practical applications of magnetic and static electric forces on individuals and society.

Earth and Space Science – Exploring Soils (ES)
ES3.1 Investigate the characteristics, including soil composition and ability to absorb water, of different types of soils in their environment.
ES3.2 Analyze the interdependence between soil and living things, including the importance of soil for individuals, society, and all components of the environment.

Life Science: Plant Growth and Changes (PL)

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

Outcomes	Indicators
PL3.1 Investigate the growth and development of plants, including the conditions necessary for germination. ***[CP, SI]***	a. Pose questions related to plant growth (e.g., How do very young plants look different from grown plants? How much water do plants need to grow? Do all plants grow in the same way?). b. Observe and explain the function of the major structures (i.e., root, stem, flower, leaf, and fruit or seed) of a variety of plants. c. Relate characteristics such as the number and shape of leaves, flower colour, height, and presence and type of fruit in different types of plants to the plant's environment. d. Sort and classify plants and/or seeds according to one or more student-selected attributes. e. Observe and represent, using written language, pictures, and charts, changes that occur through the life cycle of a flowering plant. f. Compare the basic needs of plants to the basic needs of animals and humans. g. Research ways in which plants rely on animals and abiotic factors (e.g., gravity, wind, and water) to support plant reproduction by dispersing seeds. h. Predict and investigate conditions such as the temperature, available sunlight, available nutrients in soil, and available water, which are necessary for plant germination and growth. i. Care for a flowering plant throughout its life cycle, tracking its growth and changes. j. Estimate, record, and display relevant measurements of plant growth, using rulers, tables, and bar graphs. k. Suggest explanations for patterns and discrepancies in the growth rate of similar plants grown in varying conditions. l. Explain the importance of water and light for plant growth and the mechanisms by which plants obtain water and light from the environment. m. Identify characteristics that remain constant and those that change throughout the life cycle of a flowering plant. n. Pose new questions about conditions necessary for plant growth, based on what was learned.

Outcomes	Indicators
PL3.2 Analyze the interdependence among plants, individuals, society, and the environment. ***[CP, DM, SI]***	a. Observe, safely and respectfully, plants in local environments (e.g., classroom, flower garden, school yard, community garden, forest, field, park, and nature preserve). b. Research traditional and contemporary uses of plants or parts of plants, such as food, beverages, medicine, arts, seed banks, shade, wind breaks, erosion protection, cultural celebrations, and products like dyes, shelter, and clothing. c. Examine the significance to some First Nations and Métis people of offering tobacco during harvesting and how that purpose differs from using the tobacco plant for smoking. d. Examine the importance of agriculture in Saskatchewan, including the variety of plants and plant-related products. e. Describe examples of plant biodiversity (e.g., trees, shrubs, bushes, herbs, grasses, vines, and mosses) in various ecosystems throughout the world. f. Explain how to determine whether plants are healthy and discuss the impacts of diseased plants on society and the environment. g. Describe ways that plants and animals depend on each other. h. Assess the impact of natural (e.g., animal migration, fire, competition, and decay) and human activity (e.g., burning land, logging, fertilizing, soil compaction, and picking endangered plants) on the biodiversity of plant species. i. Examine the type and quantity of plants and plant matter in the diets of people who live in various communities and/or represent various cultures. j. Explain how and why plants are replenished naturally (e.g., forest fires and pollination) and artificially (e.g., tree farms, planting seedlings, and seed banks). k. Defend a position related to plant use (e.g., picking plants, harvesting crops, fertilizing, and planting invasive species) and protection (e.g., establishing conservation areas, planting native species, and developing alternatives to plant-based products). l. Imagine a world without plants and describe the impact on animals, people, and the environment. m. Respond to and acknowledge the ideas of others regarding the importance of plants to self and society. n. Research lifestyles (e.g., farming, fishing, and logging) and jobs (e.g., florist, crop scientist, landscaper, gardener, fruit grower, ecologist, logger, and nursery worker) that depend on understanding and working with plants and plant-related products.

Physical Science: Structures and Materials (SM)

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

Outcomes	Indicators
SM3.1 Investigate properties of materials and methods of joinery used in structures. ***[CP, TPS]***	a. Identify problems to be solved relating to the properties of materials in structures (e.g., What is the purpose of the structure? What materials are appropriate for constructing the structure? What are appropriate methods of joinery?). b. Examine the properties of materials used in natural and human-built structures (e.g., beaver lodge, bird nest, wasps' nest, honeycomb, ant hill, tipi, house, marionette, circus float, umbrella, ladder, bridge, earthlodge, quinzhee, drink can, hockey puck, playground equipment, and toys). c. Compare the properties of materials used historically and currently throughout the world to construct structures such as houses, bridges, towers, and roads. d. Sort materials for use in constructing structures according to one or more physical properties such as strength, texture, colour, flexibility, and durability. e. Analyze how various similar and dissimilar materials can be joined (e.g., gluing, nailing, screwing, stapling, taping, Velcroing and tying) and identify the most appropriate methods for joining specific materials for an identified use. f. Use appropriate tools (e.g., hammer, nail, glue, and scissors) to cut, shape, make holes, sew, and assemble materials safely. g. Develop and carry out a plan, including making predictions, identifying variables, and recording relevant observations, to test the strength of various materials (e.g., straws, toothpicks, masking tape, string, cotton balls, wooden blocks, Styrofoam, cloth, clay, and spaghetti). h. Assess the suitability of various materials for constructing structures, including methods of strengthening those materials (e.g., adding more layers, tying or gluing together, triangulation, cross-bracing, and changing the shape of the materials). i. Examine the suitability of using recycled materials to construct structures (e.g., tires as highway surfacing, and reclaimed lumber or straw bales for houses).

Outcomes

SM3.2 Assess the function and characteristics of strong, stable, and balanced natural and human-built structures.

[CP, TPS]

Indicators

a. Analyze the purpose or function of various natural and human-built structures.

b. Examine how some human-built structures are modeled on shapes and structures found in nature.

c. Assess how 2-D shapes (e.g., rectangle, triangle, circle, square, hexagon, and octagon) and 3-D objects (e.g., dome, arch, and cylinder) provide strength, stability, and balance to natural and human-built structures.

d. Compare the characteristics of solid (e.g., sand castle, mountain, and dam), frame (e.g., partition wall, hockey net, and spider web), and shell (e.g., igloo, bike helmet, balloon, and drink can) structures.

e. Classify natural and human-built structures as solid, frame, or shell structures.

f. Compare the characteristics of different types of shelter (e.g., tent, igloo, hut, boat, castle, tipi, yurt, and house) constructed by people throughout the world, past and present.

g. Examine the characteristics and significance of historical structures such as Stonehenge, the Parthenon, Petra, the Great Wall of China, Angkor Wat, Machu Picchu, the Taj Mahal, the Pyramids, and Easter Island moai.

h. Analyze how various shapes contribute to balance and stability in humans and various animals.

i. Develop and carry out a plan to construct a simple structure such as a tower, bridge, tipi, or bird feeder that meets teacher- or student-specified criteria related to strength, stability, and function.

j. Estimate measurements to select appropriate quantities of required materials for constructing a structure.

k. Follow safety procedures and rules while constructing structures and explain the need for such procedures and rules.

l. Illustrate the construction process for a simple structure, including descriptions of the components of the structure, using labelled drawings, written and oral explanations, and demonstrations.

Outcomes	Indicators
SM3.2 continued	m. Assess the strength, stability, and balance of personally-constructed structures and make changes to improve the structure as deemed necessary. n. Identify materials or parts of a structure that failed and hypothesize why they failed. o. Assess natural and human-built structures to determine if they are effective, safe, make efficient use of materials, meet user's needs, and minimize the impact on the environment. p. Research jobs and hobbies that contribute to the design, building, and maintenance of natural and human-built structures.

Physical Science: Magnetism and Static Electricity (ME)

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

Outcomes	Indicators
ME3.1 Investigate the characteristics of contact (e.g., push, pull, and friction) and non-contact (e.g., magnetic and static electric) forces. ***[SI]***	a. Pose questions related to the characteristics of magnetic and static electric forces (e.g., Do all magnets attract objects? Do all magnets have a North pole? Why do I get a shock when I rub my shoes on a carpet and touch a door knob?). b. Demonstrate how contact and non-contact forces are able to cause objects to start moving, speed up, slow down, and stop; cause moving objects to change direction; and cause changes to the shape of objects. c. Compare the characteristics of contact, magnetic, and static electric forces, including the range over which they act, and propose methods of increasing or decreasing the effects of these forces. d. Group materials according to criteria such as their attraction to magnets and ability to be magnetized based on personal observation. e. Compare the characteristics and effects of different types and shapes of magnets (e.g., horseshoe, disc, bar, cylindrical, and block), including the location and type of magnetic poles (if any exist), and the shape of the magnetic field produced by the magnet.

Outcomes	Indicators
ME3.1 continued	f. Predict and test the number of objects a magnet can pick up under different conditions (e.g., distance between magnet and object, number of identical magnets, solids between magnet and object) and develop simple conclusions about conditions that affect strength of magnetic forces. g. Investigate how charged materials interact with each other and with uncharged objects. h. Demonstrate ways to use materials found in their environment (e.g., balloon, cotton, fur, wool, confetti, acetate strip, ebonite rod, and Scotch tape) to investigate conditions which affect the strength of static electric forces. i. Make and record relevant observations during investigations to identify conditions (e.g., humidity, type of materials, and distance between charged objects) that affect the strength of static electric forces, and develop simple conclusions about these conditions.
ME3.2 Assess effects of practical applications of magnetic and static electric forces on individuals and society. ***[CP, TPS]***	a. Investigate how magnets are used at home and school, and in business and industrial applications (e.g., refrigerator magnet, magnetic cupboard door latches, credit card magnetic strip, radio speakers, navigation, motorized devices, scrap yard crane, magnetic levitation trains, jewellery, tools, and toys). b. Classify magnets that are used at home and school, and in business and industrial applications as natural, temporary, and permanent. c. Explore how magnetic compasses can provide evidence for and information about magnetic fields, including those created by current traveling through a conductor, and the Earth's magnetic field. d. Design, construct, and test an object such as a toy or game whose function depends on attractive or repulsive magnetic forces. e. Describe the operation of a toy or game whose function depends on magnetic forces using terms such as *attract*, *repel*, *push*, and *pull*. f. Explain safety procedures to be followed when interacting with magnetic and static electric forces. g. Describe the effects of static electric forces in daily life (e.g., static cling, sparks when touching metal objects after walking across carpeted surfaces, and photocopiers).

Outcomes

ME3.2 continued

Indicators

h. Explain the purpose of technologies which are designed to minimize static electric forces (e.g., fabric softeners and dryer sheets, antistatic bags, chains hanging from combines, antistatic safety boots, grounding straps on cars, and dusters).

i. Investigate methods of using magnetic and static electric forces to create artistic expressions (e.g., mobiles, kinetic sculptures, painting, and drama).

j. Generate new questions from what has been learned about applications of magnetic and static electric forces.

Earth and Space Science: Exploring Soils (ES)

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

Outcomes

ES3.1 Investigate the characteristics, including soil composition and ability to absorb water, of different types of soils in their environment.

[SI]

Indicators

a. Pose questions and make predictions about the characteristics and composition of soils that lead to exploration and investigation (e.g., What colours are soil? What does soil feel like? Where does soil come from? Is there water in soil?).

b. Examine physical characteristics (e.g., particle size, texture, moisture, particle size distribution, colour, and ability to hold together) of soils from different locations (e.g., garden, flower pot, river bed, slough, hill top, grassy field, lawn, ditch, and forest) in their environment.

c. Classify soils in their environment according to location and type (e.g., clay, sand, silt, and loam).

d. Analyze soil samples using tools such as spoons, hand lenses, jars, and filters appropriately and safely.

e. Make and record observations and measurements in investigations related to soil composition using techniques such as notes in point form, diagrams, tables, bar graphs, photographs, and video.

f. Make predictions about the capability of different types of soil to absorb water and test these predictions through exploration and investigation.

g. Collect and display data, using tables and bar graphs, to show the amount of water absorbed by different types of soil.

Outcomes	Indicators
ES3.1 continued	h. Sort soil samples according to one or more physical characteristics such as texture, ability to absorb water, particle size, and colour. i. Communicate procedures and results of investigations related to the testing of water absorption of soils using drawings, demonstrations, and oral and written descriptions. j. Propose answers to initial questions related to soil composition based on the results of personal investigations.
ES3.2 Analyze the interdependence between soil and living things, including the importance of soil for individuals, society, and all components of the environment. ***[CP, DM]***	a. Suggest ways in which individuals and communities value and use soil, including the importance of Mother Earth for First Nations and Métis peoples. b. Examine the interdependence between animals and soils (e.g., insects and grubs live in soil, soil provides shelter for some animals, and earthworms aerate soil). c. Examine the interdependence between plants and soils (e.g., soils provide nutrients for plant growth, plant leaves die and fall onto the ground, and plant roots spread throughout soil). d. Relate the characteristics (e.g., composition, colour, texture, and ability to absorb water) of soils to their uses (e.g., agriculture, berms, pottery, earth shelters, road building, habitats, landscaping, and purifying water). e. Observe the effects of moving water on soils in different environments (e.g., beneath an eavestrough downspout, along a stream bank, down a slope, and under a sprinkler). f. Collaboratively design and safely carry out procedures to determine the effects of moving water on different types of soils. g. Propose practices that individuals and communities can take to reduce the effects of erosion on a small scale (e.g., vegetable garden and flower pot) and a large scale (e.g., agricultural field, sports field, river bank, and road ditch). h. Suggest sustainable practices (e.g., composting and fertilizing) that can affect soils positively and reduce or prevent harmful effects such as compaction and contamination of soils. i. Research careers that involve an understanding of soil.

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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 better 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 three follow.

Arts Education

The conceptual focus for Grade 3 Arts Education is "Environment". This focus includes investigations of how works of art relate to natural and constructed environments. Connections between arts education and science may include:

- Creating dance phrases or dramatic representations which demonstrate the variety of ways that individuals and communities value and use soil.
- Creating sketches, drawings, sculptures, and other appropriate representations of 2-D shapes and 3-D objects found within natural and human-built structures.
- Investigating how artists rely on their experiences within the local environment and other natural surroundings as a foundation for their artistic expressions.

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 three 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 textbooks 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 enjoyment.
- Students should present the results of their science inquiries using a variety of text forms, including expository, informational, and procedural texts (e.g., describe the operation of a toy or game whose function depends on magnetic forces), descriptive texts (e.g., describe what the world might look like if there were no plants), and persuasive texts (e.g., defend a position related to the use or protection of plants in the community).
- 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". Specific examples of the connection between these areas of study at grade three include:

- Examining differences between ceremonial and recreational use of tobacco within First Nations and Métis cultures.
- Comparing how harmful substances affect the health of people and plants.
- Developing a plan to practice safe behaviours when using tools and materials in the classroom.

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 three include:

- Estimating and using linear measurements to compare plant growth and to measure materials needed for constructing a structure.
- Using charts, lists, bar graphs, and tables to record, organize, and represent first-hand data related to plant growth, structures, and soil absorption.
- Examining how plants, soil, and structures change over time.

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. An example of this connection in grade three is:

- Investigating how humans position and move themselves to create strong, balanced structures suitable for applying specific manipulative skills in various games or activities.

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 three include:

- Exploring the influence of individual and communal beliefs, past and present, on land-use practices.
- Examining practical applications of technologies and materials humans have developed and/or used to construct structures.

Glossary

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

Biodiversity is a measure of the amount of variation of life forms within a given ecosystem.

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

A **frame** structure consists of structural components fastened together to support the structure.

A **hypothesis** is a testable, proposed explanation of observable phenomena.

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 that facilitate prediction.

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

A **shell** structure consists of an outside layer that holds the entire structure together without the support of an interior frame.

A **solid** structure, also called a mass structure, usually is made from one solid piece of a strong material with little or no space inside.

STSE, which stands for 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.

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

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Suggested Reading

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Feedback Form

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

Grade 3 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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