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Saskatchewan Curriculum

Science

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Introduction

Science is a Required Area of Study in Saskatchewan's Core Curriculum. The provincial requirement for Grade 6 Science is 150 minutes of instruction per week (Saskatchewan Learning, 2007).

The purpose of this curriculum is to outline the provincial requirements for Grade 6 Science. This curriculum provides the intended learning outcomes that Grade 6 students are expected to achieve in science 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 in order 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
- Grade 6 Science outcomes and indicators
- sample assessment and evaluation criteria related to outcomes in science
- connections with other areas of study
- a glossary.

Using this Curriculum

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.

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

Critical characteristics of an outcome include the following:

- 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 in order to achieve an outcome. Indicators represent the breadth and the 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 but those teacher-developed indicators must be reflective of and consistent with the breadth and depth that is 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 say that students are to compare the sources of thrust of various constructed flying devices including the propeller, jet engine, and solid or liquid-fuelled rocket. This means that, although other sources of thrust can be explored and described, it is mandatory that the propeller, jet engine, and solid or liquid-fuelled rocket be included.

- 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 a bird spreading wings or an airplane employing flaps" as examples of different methods for altering drag in flying devices. This statement provides teachers and students with possible methods to consider, while not excluding other methods.
- Finally, the term "e.g.," offers specific examples of what a term, concept, or strategy might look like. For example, an indicator might include the phrase "e.g., medicine wheel, Mayan calendar, Stonehenge, and pyramids" to refer to ways in which different cultures have recorded and used their understandings of astronomical phenomena to solve practical problems.

Although the outcomes and indicators in the science curriculum are organized by units, teachers may organize their instruction using interdisciplinary or transdisciplinary themes. There is no requirement for teachers 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 various 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* (Saskatchewan Learning, 2007).

The Broad Areas of Learning and Cross-curricular Competencies connect the specificity of the areas of study and the day-to-day work of teachers with the broader philosophy of Core Curriculum and the Goals of Education for Saskatchewan.

Broad Areas of Learning

There are three Broad Areas of Learning that 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.

Developing Lifelong Learners

Developing lifelong learners is related to the following Goals of Education:
- *Basic Skills*
- *Lifelong Learning*
- *Self Concept Development*
- *Positive Lifestyle.*

Students engaged in constructing and applying science knowledge naturally build a positive disposition towards learning. Throughout their study of science, students bring a natural 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.

Developing a Sense of Self and Community

Developing a sense of self and community is related to the following Goals of Education:
- *Understanding & Relating to Others*
- *Self Concept Development*
- *Positive Lifestyle*
- *Spiritual Development.*

Students develop and strengthen their personal identity as they explore connections between their own understanding of the natural and constructed world and 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.

Developing Engaged Citizens

Developing engaged citizens is related to the following Goals of Education:
- *Understanding & Relating to Others*
- *Positive Lifestyle*
- *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

K-12 Goals for Developing Thinking:
- *thinking and learning contextually*
- *thinking and learning creatively*
- *thinking and learning critically.*

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 is already known by themselves and others. By thinking contextually, creatively, and critically, students develop deeper understanding of various phenomena in the natural and constructed world.

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, of social and cultural expectations, and of 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.*

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.

K-12 Goals for Developing Social Responsibility:
- *using moral reasoning processes*
- *engaging in communitarian thinking and dialogue*
- *taking social action.*

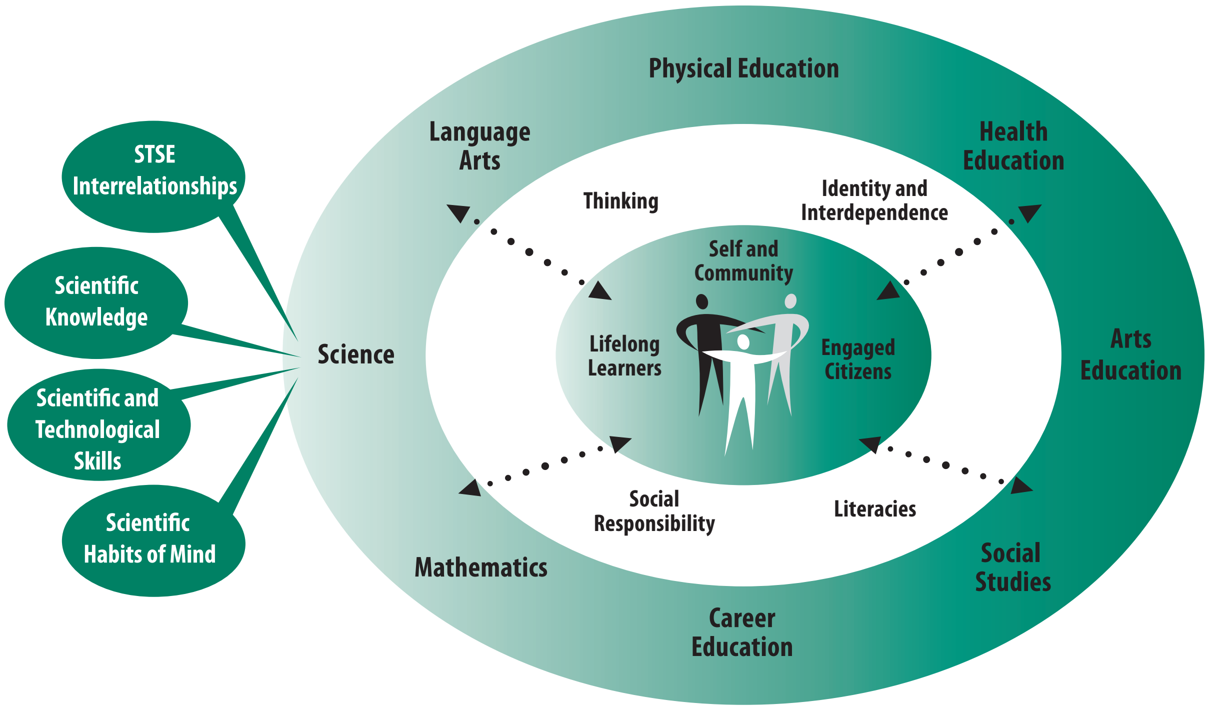
Aim and Goals

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, their careers, and their 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, in physical science, in earth and space science, and in Indigenous Knowledge of nature; and 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, interdisciplinary, and transdisciplinary 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.

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

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

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)

- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

(NRC, 1996, pp. 145, 148)

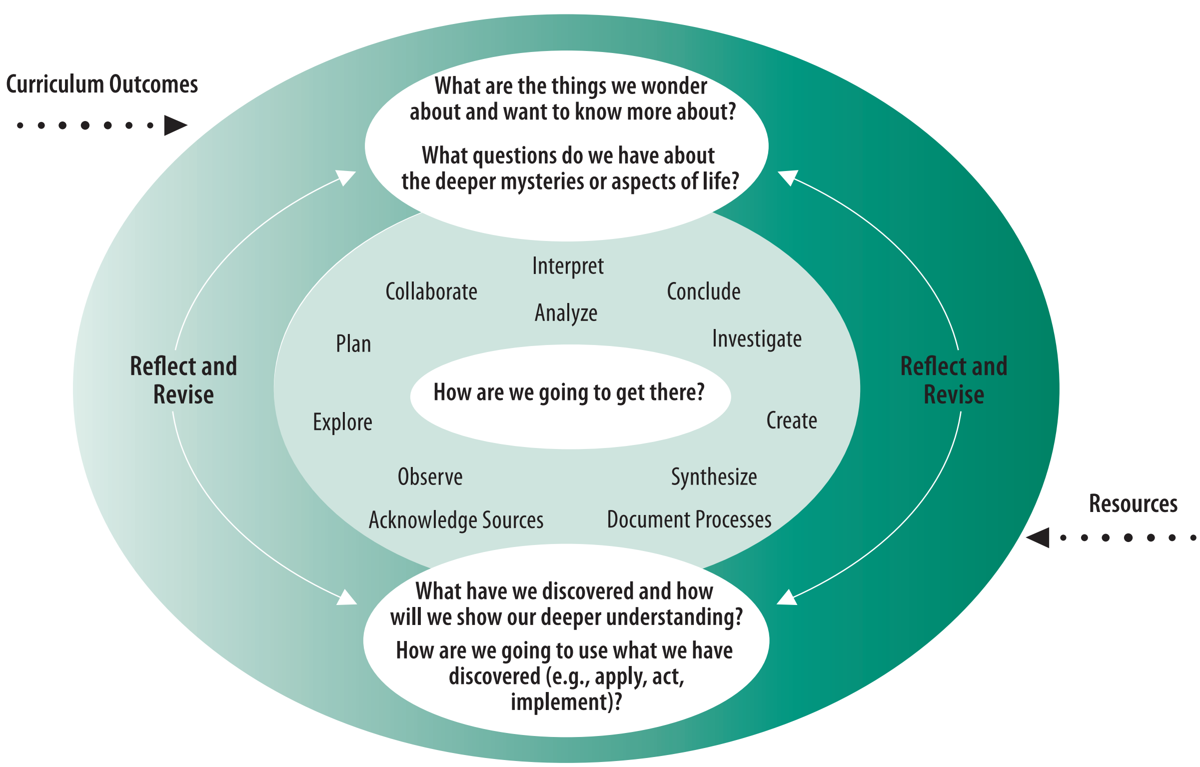
Students do not come to understand inquiry simply by learning words such as "hypothesis" and "inference" or by memorizing procedures such as "the steps of the scientific method".

(NRC, 2000, p. 14)

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

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



Inquiry focuses on the development of questions to initiate and guide the learning process. These questions are formulated by teachers and students 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.

Creating Questions for Inquiry in Science

In science, teachers and students can use the four learning contexts as curriculum entry points to begin their inquiry; however, the process may evolve into transdisciplinary learning opportunities, as reflective of the holistic nature of our lives and interdependent global environment.

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)

It is essential to develop questions that are evoked by student interests and have 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 transdisciplinary 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, and help students connect what they are learning to their experiences and life beyond school.

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)

Questions give students some 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. They also invite and encourage students to pose their own questions for deeper understanding.

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

An Effective Science Education Program

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

- foundations of scientific literacy
- learning contexts
- nature of scientific discourse
- modelling in science
- laboratory work
- safety
- technology in science
- science challenges.

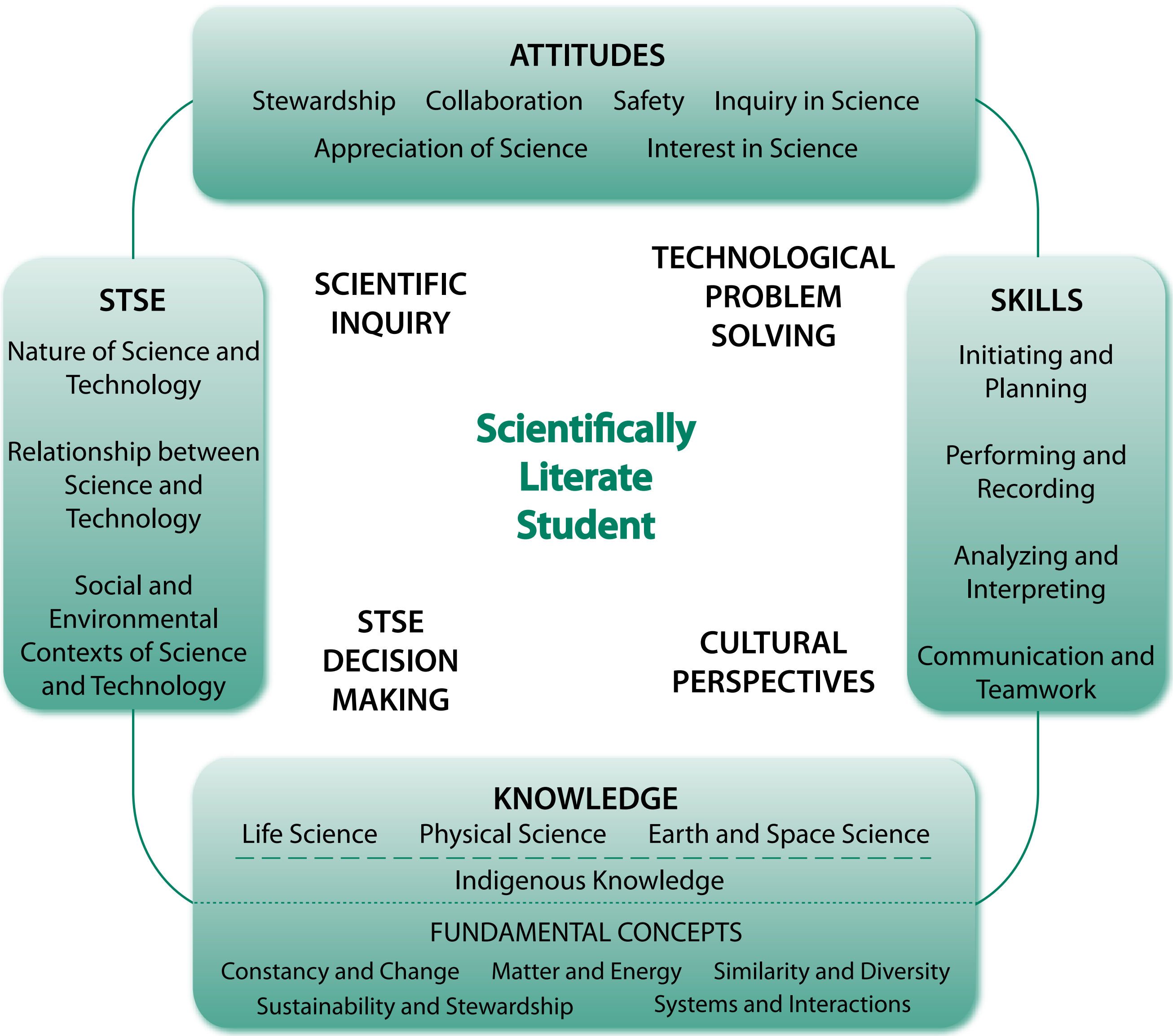
All science outcomes and indicators emphasize one or more foundations of scientific literacy; these represent the "what" of the curriculum. The learning contexts represent different processes for engaging students in achieving curricular outcomes; they are the "how" of the curriculum. The four units of study at each grade serve as 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 laboratory work. During their investigations, students must follow safe practices in the laboratory, as well as in regard to living things.

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

To achieve the vision of scientific literacy outlined in this curriculum, students must increasingly 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, to initiate investigations, to communicate findings, and to complete projects that demonstrate learning. Teachers and students may also choose to engage in science challenge activities as a means of achieving learning outcome

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). 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 context in which it is developed. This foundation statement should be considered 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 are continually being tested, modified, and improved as new ideas supersede existing ideas. Technology, like science, is a creative human activity, but is concerned with solving practical problems that arise from human/social needs, particularly the need to adapt to the environment and to fuel a nation's economy. New products and processes are produced by research and development through the processes of inquiry and design.

Relationships between Science and Technology

Historically, the development of technology has been strongly linked to the development of science, with each making contributions to the other. While there are important relationships and interdependencies, there are also important differences. 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 us explain, interpret, and predict; the test of technology is that it works – it enables 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 can be used to show that cultural and intellectual traditions have influenced the focus and methodologies of science, and that science, in turn, has influenced the wider world of ideas. Today, societal and environmental needs and issues often drive research agendas. As technological solutions have emerged from previous research, many of the new technologies have given rise to complex social and environmental issues which are increasingly 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. The conservation laws of mass and energy, momentum, and charge are addressed in physical science.

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 such fields of study as 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 better 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).

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 in order 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 are also 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 can contribute to the development of scientific literacy.

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.

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 to be aware of the limits of science and technology as well as 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 that facilitate prediction.
- The **technological problem solving** learning context reflects an emphasis on designing and building to solve practical human problems similar to the way an engineer would.
- The **STSE decision making** learning context reflects the need to engage citizens in thinking about human and world issues through a scientific lens in order to inform and empower decision making by individuals, communities, and society.
- The **cultural perspectives** learning context reflects a humanistic perspective that views teaching and learning as cultural transmission and acquisition (Aikenhead, 2006).

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

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.

A choice of learning approaches can also 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 [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 multifaceted 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.

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.
(National Research Council, 1996, p. 23)

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 is typically 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.

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)

> *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)*

STSE Decision Making [DM]

Scientific knowledge can be related to understanding the relationships among science, technology, society, and the environment. Students must also consider values or ethics, however, 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.

> *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)*

Cultural Perspectives [CP]

Students should recognize and respect that all cultures develop knowledge systems to describe and explain nature. Two knowledge systems which are 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 are, in part, conveyed through the other three learning contexts, and when addressing the nature of science. Cultural perspectives on science can also 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 technologies they have created to solve human problems

- recognizing that 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 to Indigenous knowledge.

Explanations, Evidence, and Models in 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 *laws*, *theories*, and *hypotheses* 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:

- 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

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

evidence that the theory is unable to adequately explain. 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 in order 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 are constantly building and testing their own models of understanding of 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 in order to investigate or understand different aspects of the phenomena.

Laboratory Work

Laboratory work is often at the centre of scientific research; as such, it should also be an integral component of school science. 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. Laboratory experiences should be designed so that all students – including students with academic and physical challenges – are able to authentically participate in and benefit from those experiences.

Laboratory activities help students develop scientific and technological skills and processes including:

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

Laboratory investigations also help students understand the nature of science, specifically that theories and laws must be consistent with observations. Similarly, student-centered laboratory investigations help to 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.

> *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)*

A strong science program includes a variety of individual, small, and large group laboratory experiences for students. Most importantly, the laboratory experience needs to go beyond conducting confirmatory "cook-book" experiments. Similarly, computer simulations and teacher demonstrations are valuable but should not serve as substitutions for hands-on student laboratory activities.

Assessment and evaluation of student performance must reflect the nature of the laboratory experience by addressing scientific and technological skills. As such, the results of student investigations and experiments do not always need to be written up using formal laboratory reports. Teachers may consider alternative formats such as narrative lab reports for some experiments. The narrative lab report enables students to tell the story of their process and findings in a less structured format than a typical lab report.

In a narrative lab report, students answer four questions:

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

The answers are written in an essay format rather than using the structured headings of Purpose, Procedure, Hypothesis, Data, Analysis, and Conclusion that are typically associated with a formal lab report. For some investigations, teachers may decide it is sufficient for students to write a paragraph describing the significance of their findings.

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. To create a safe classroom requires that a teacher be informed, aware, and proactive and that the students listen, think, and respond appropriately.

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

Safe practice in the laboratory is the joint responsibility of the teacher and students. The teacher's responsibility is to provide a safe environment and to ensure the 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.

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 your 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, visitors, and yourself 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. It is important that students 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).

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. 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 the Saskatchewan Ministry of Advanced Education, Employment and Labour.

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.

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 which 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 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.
  - Databases and spreadsheets can facilitate the analysis and display of student-collected data or data obtained from scientists.

- **Visualization and Imaging**
  - 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.
  - 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.

- **Communication and Collaboration**
  - 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).

Science Challenges

Science challenges, which may include science fairs, science leagues, Science Olympics, Olympiads, or talent searches, should be considered as instructional methods suitable for students to undertake in any unit, across units, or in conjunction with other subject areas. Teachers may incorporate science challenge activities as an integral component of the science program or treat them similar to other extracurricular activities such as school sports and clubs. If science challenges are undertaken as a classroom activity, teachers should consider these guidelines, adapted from the NSTA position statement *Science Competitions* (1999):

- Student and staff participation should be voluntary and open to all students.
- Emphasis should be placed on the learning experience rather than the competition.
- Science competitions should supplement and enhance other learning and support student achievement of curriculum outcomes.
- Projects and presentations should be the work of the student, with proper credit given to others for their contributions.
- Science competitions should foster partnerships among students, the school, and the science community.

Science challenge activities may be conducted solely at the school level, or with the intent of preparing students for competition in one of the regional science fairs, perhaps as a step towards the Canada Wide Science Fair. Although students may be motivated by prizes, awards, and the possibility of scholarships, teachers should emphasize that the importance of doing a science fair project includes attaining new experiences and skills that go beyond science, technology, or engineering. Students learn to present their ideas to an authentic public that may consist of parents, teachers, and the top scientists in a given field.

Science fair projects typically consist of:

- An experiment, which is an original scientific experiment with a specific, original hypothesis. Students should control all important variables and demonstrate appropriate data collection and analysis techniques.
- A study, which involves the collection of data to reveal a pattern or correlation. Studies can include cause and effect relationships and theoretical investigations of the data.

Studies are often carried out using surveys given to human subjects.

- An innovation, which deals with the creation and development of a new device, model, or technique in a technological field. These innovations may have commercial applications or be of benefit to humans.

Youth Science Foundation Canada (www.ysf.ca) provides further information regarding science fairs in Canada.

Outcomes and Indicators

Life Science – Diversity of Living Things (DL)
DL6.1 Recognize, describe, and appreciate the diversity of living things in local and other ecosystems, and explore related careers.
DL6.2 Examine how humans organize understanding of the diversity of living things.
DL6.3 Analyze the characteristics and behaviours of vertebrates (i.e., mammals, birds, reptiles, amphibians, and fish) and invertebrates.
DL6.4 Examine and describe structures and behaviours that help: • individual living organisms survive in their environments in the short term • species of living organisms adapt to their environments in the long term.
DL6.5 Assess effects of micro-organisms on past and present society, and contributions of science and technology to human understanding of micro-organisms.

Physical Science – Understanding Electricity (EL)
EL6.1 Assess personal, societal, economic, and environmental impacts of electricity use in Saskatchewan and propose actions to reduce those impacts.
EL6.2 Investigate the characteristics and applications of static electric charges, conductors, insulators, switches, and electromagnetism.
EL6.3 Explain and model the properties of simple series and parallel circuits.

Physical Science – Principles of Flight (FL)
FL6.1 Examine connections between human fascination with flight and technologies and careers based on the scientific principles of flight.
FL6.2 Investigate how the forces of thrust, drag, lift, and gravity act on living things and constructed devices that fly through the air.
FL6.3 Design a working prototype of a flying object that meets specified performance criteria.

Earth and Space Science – Our Solar System (SS)
SS6.1 Research and represent the physical characteristics of the major components of the solar system, including the sun, planets, moons, asteroids, and comets.
SS6.2 Assess the efficacy of various methods of representing and interpreting astronomical phenomena, including phases, eclipses, and seasons.
SS6.3 Evaluate past, current, and possible future contributions of space exploration programs, including space probes and human spaceflight, which support living and working in the inner solar system.

Life Science: Diversity of Living Things (DL)

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

Outcomes	Indicators
DL6.1 Recognize, describe, and appreciate the diversity of living things in local and other ecosystems, and explore related careers. ***[CP, SI]***	a. State the characteristics that define all living things (e.g., are made up of one or more cells, require energy for life processes, respond to stimuli in their environment, and have the ability to reproduce). b. Observe and document the diversity of living things in their local habitat through journaling, a nature walk, sketching, drawing, photographing, video recording, or other means. c. Show respect for other people, living things, and the environment when observing ecosystems. d. Document the diversity of living things in different terrestrial and aquatic habitats (e.g., grasslands, forests, tundra, deserts, rivers, ponds, and oceans) using print, video, and/or online resources. e. Analyze how First Nations and Métis art and storytelling highlight movement and/or behaviour of living things and reflect a worldview that values all living things. f. Identify examples of science and technology-related careers and workplaces which require an understanding of the diversity of living things (e.g., naturalist, zoo keeper, palaeontologist, and wildlife biologist).
DL6.2 Examine how humans organize understanding of the diversity of living things. ***[CP, SI]***	a. Construct and use a classification system to organize living things into groups and subgroups according to student-developed criteria. b. Consider personal observations and ideas as well as those of others (including differing worldviews) when constructing classification systems by asking questions, sharing stories, and responding to classmates' classification systems. c. Demonstrate how different classification systems can be used to classify the same set of objects and explain how humans develop and refine classification systems to meet specific needs. d. Explore local First Nations and Métis methods of organizing understanding of living things (e.g., two-leggeds, four-leggeds, winged-ones, swimmers, trees, and grasses) and the criteria underlying that understanding (e.g., where animals are found, how animals move, and the uses of plants).

Outcomes	Indicators
DL6.2 continued	e. Describe how aspects of First Nations and Métis worldviews (e.g., holistic, interconnectedness, valuing of place-based knowledge) shape their systems of organizing understanding of living things. f. Illustrate the diversity of living things on Earth by constructing a visual representation (e.g., poster, mobile, slide show, and web page) showing examples from each kingdom of the five kingdom taxonomic model: monera, protists, fungi, plants, and animals. g. Use appropriate scientific terminology to communicate ideas about the diversity of living things (e.g., biotic, abiotic, kingdom, phylum, monera, protist, fungi, plant, animal, vertebrate, and invertebrate). h. Critique the use of biological classification systems to aid scientific understanding of living things rather than relying on common, local, or personally chosen names.
DL6.3 Analyze the characteristics and behaviours of vertebrates (i.e., mammals, birds, reptiles, amphibians, and fish) and invertebrates. ***[SI]***	a. Identify characteristics of vertebrates and invertebrates and classify animals as vertebrates or invertebrates from drawings, videos, pictures, lists, and/or personal observations. b. Compare and represent characteristics and behaviours (e.g., body shape, body description, method of respiration, method of reproduction, method of movement, and method of feeding) of student-selected examples of vertebrates. c. Compare and represent characteristics and behaviours (e.g., body shape, body description, method of respiration, method of reproduction, method of movement, and method of feeding) of student-selected examples of invertebrates (e.g., arthropods, annelids, cnidarids, echinoderms, molluscs, and nematodes). d. Propose questions for inquiry that arise from personal investigations of characteristics and behaviours of animals. e. Suggest reasons why current biological classification systems for living things are based on structural (internal) characteristics rather than solely on physical appearance or behaviour.

Outcomes

DL6.4 Examine and describe structures and behaviours that help:
- ***individual living organisms survive in their environments in the short term***
- ***species of living organisms adapt to their environments in the long term.***

[CP, DM, SI]

Indicators

a. Propose questions to investigate related to the structures and behaviours that help organisms survive in their environments (e.g., "What advantage are different beaks for birds?", "Why do owls turn their heads to look sideways?", "Why do rabbits change colour at different times of the year?", "Why do caribou migrate?", "Why do ground squirrels hibernate?").
b. Show interest and curiosity in learning about organisms' adaptations to different environments by journaling, participating in a nature walk, or sharing science-related information about adaptations (gathered from print or video resources or personal experience) with classmates.
c. Describe examples of structures and behaviours, including seasonal changes, which help living things survive in their environments during the lifetime of the organism.
d. Describe examples of adaptations to structures and behaviours (e.g., flippers, webbed feet, night-time vision, wide wings, camouflage colouring, migration, and hibernation) that have enabled living things to adapt to their environments in the long term.
e. Explain how scientists use fossils and the fossil record as a source of information to identify changes or diversity in species over long periods of time.
f. Suggest reasons why specific species of organisms have or might become endangered or extinct.
g. Gather information from a variety of sources (e.g., Elder, traditional knowledge keeper, naturalist, textbook, non-fiction book, museum display, encyclopaedia, and website) to answer student-generated questions about the structural and behavioural adaptations of organisms.
h. Compare closely-related animals that live in different parts of the world and propose explanations for any differences in their structures and behaviours.
i. Research the advantages of particular structures or behaviours of organisms that suit different environments (e.g., how different bird beaks are best suited to obtain different types of food, how different types of foot structure are best suited for different environments).
j. Suggest reasons to explain how results of similar and repeated studies of the adaptations of organisms may vary and suggest possible explanations for variations (e.g., independent studies may reveal different responses by polar bears to temperature changes or pollution).

Outcomes	Indicators
DL6.5 Assess effects of micro-organisms on past and present society, and contributions of science and technology to human understanding of micro-organisms. ***[CP, DM, SI]***	a. Choose and correctly use appropriate tools (e.g., magnifying glasses, optical microscopes, and video microscopes) to study living organisms that cannot be seen with the naked eye. b. Observe and represent, using words and diagrams, characteristics of micro-organisms obtained from student- or teacher-collected water samples (e.g., bottled water, tap water, rain barrel, pond, creek, slough, and river water). c. Explain how micro-organisms meet their basic needs, including moving around and obtaining food, water, and oxygen. d. Design and conduct an investigation of the factors that influence how quickly micro-organisms break down organic matter (e.g., build a composter in a 2L plastic bottle and vary conditions such as the amount of water, soil, light, and combinations of waste products). e. Compare cultural (including First Nations and Métis), historical, and scientific understandings and explanations of disease, including the contributions of scientists such as John Snow and Louis Pasteur to the germ theory. f. Critique representations or depictions of micro-organisms in a variety of texts (e.g., science fiction, cartoons, movies, music, and poetry). g. Discuss positive and negative impacts of micro-organisms for humans (e.g., food production and spoilage, fermentation, pasteurization, water and sewage treatment, human digestion, composting, disease spread and prevention, and biological warfare).

Physical Science: Understanding Electricity (EL)

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

Outcomes	Indicators
EL6.1 Assess personal, societal, economic, and environmental impacts of electricity use in Saskatchewan and propose actions to reduce those impacts. ***[CP, DM]***	a. Provide examples of the types of energy sources used to provide heat and light to homes in the past and describe ways in which electricity-based technologies have changed the way people work, live, and interact with the environment in Saskatchewan. b. Describe how electrical energy is generated from hydroelectric, coal, natural gas, nuclear, geothermal, biomass, solar, and wind sources and categorize these resources as renewable or non-renewable.

Outcomes	Indicators
EL6.1 continued	c. Locate and categorize by type the large-scale electrical energy generation facilities in Saskatchewan and explain how electrical energy is transmitted from those facilities to locations throughout the province. d. Identify factors that affect electrical energy consumption at home, school, and in the workplace and propose methods of decreasing electrical energy consumption that can help to conserve natural resources and protect the environment. e. Explain potential dangers of electricity at home, school, and the workplace and suggest ways individuals can minimize those dangers. f. Research employers and careers related to electrical energy generation, distribution, and conservation in Saskatchewan.
EL6.2 Investigate the characteristics and applications of static electric charges, conductors, insulators, switches, and electromagnetism. ***[SI]***	a. Conduct investigations to determine the attraction and repulsion of electrostatically charged materials and represent the results of those investigations using drawings, sketches, tables, charts, and/or other representations. b. Describe how results of similar and repeated investigations into the characteristics of static electric charges (e.g., the rubbing together of different substances) may vary and suggest possible explanations for identified variations. c. Identify natural and man-made applications of static electric charge and discharge (e.g., lightning, photocopiers, laser printers, air filters, and electrostatic paint sprayers). d. Pose questions related to the physical properties of conductors, insulators, simple circuits, and electromagnets (e.g., "How can we determine if an unknown material is a conductor or an insulator?", "How does a switch work in a simple electric circuit?", "What materials work best to create an electromagnet?"). e. Make predictions, based on observed patterns of events, related to the physical properties of conductors, insulators, simple circuits, and electromagnets and conduct investigations to test those predictions. f. Identify appropriate tools, instruments, and materials (e.g., bulbs, batteries, and wires) to use when investigating the properties of conductors, insulators, simple circuits, and electromagnets and use those tools and apparatus in a manner that ensures personal safety and the safety of others.

Outcomes	Indicators
EL6.2 continued	g. Test the conductivity of a variety of solids and liquids, following a given set of procedures, to identify which materials are conductors and which are insulators, and draw conclusions about the types of materials that work best as conductors and which work best as insulators. h. Explain the role of switches in electrical circuits. i. Describe the operation of an electromagnet and contrast magnets and electromagnets. j. Plan a set of steps to carry out a fair test of a science-related idea related to electromagnets, such as how to increase the strength of an electromagnet. k. Use evidence gathered through research and observation to answer questions related to the physical properties of conductors, insulators, simple circuits, and electromagnets. l. Describe the operation of common technologies based on properties of static electricity, current electricity, or electro-magnetism.
EL6.3 Explain and model the properties of simple series and parallel circuits. ***[SI, TPS]***	a. State the required characteristics of a simple electric circuit (e.g., a source of electrical energy, a closed path to conduct electrical energy, and a load to convert the electrical energy into another form of energy). b. Compare a variety of electrical pathways by constructing simple circuits. c. Contrast a closed circuit, open circuit, and short circuit. d. Propose questions to investigate, and practical problems to solve, related to simple series and parallel circuits (e.g., "What happens when a light bulb is removed from a series or parallel circuit?", "How can I create a simple circuit using only a battery, light bulb, and one wire?", "How are light circuits in a house wired?"). e. Construct and test various combinations of simple electric circuits to determine similarities and differences between series and parallel circuits. f. Draw electrical circuit diagrams to represent simple series and parallel circuits using appropriate symbols (e.g., battery, conductor, light bulb, motor, and switch). g. Construct simple circuits to demonstrate how electrical energy can be controlled to produce light, heat, sound, motion, and magnetic effects. h. Design, construct, and troubleshoot an electrical circuit that meets one or more student-specified criteria.

Physical Science: Principles of Flight (FL)

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

Outcomes	Indicators
FL6.1 Examine connections between human fascination with flight and technologies and careers based on the scientific principles of flight. ***[CP, DM, SI]***	a. Observe and describe physical characteristics and adaptations that enable birds (e.g., ravens, hawks, loons, geese, hummingbirds, sandpipers, cranes, and sparrows), insects (e.g., mosquitoes, dragonflies, grasshoppers, bees, wasps, and butterflies), and bats to fly. b. Show how First Nations and Métis art and storytelling highlight understanding of and respect for birds. c. Examine the role of inspiration and aesthetic design in the development of flying devices (e.g., initial attempts at trying to fly were based on observations of birds). d. Research technological problems that had to be overcome to develop devices that fly (e.g., balloons, kites, gliders, airplanes, helicopters, and rockets) and explain how various creative solutions to those problems have resulted in the development of flying devices with different designs. e. Discuss historical and current contributions of individuals, including Canadians, who have contributed to scientific understanding and technological developments related to flight. f. Describe examples of traditional and modern technologies developed by First Nations, Métis, and other cultures that are based on principles of flight (e.g., atlatl, bow and arrow, slingshot, catapult, boomerang, and trebuchet). g. Explain how inventions based on principles of flight have changed the way people work, live, and interact with the environment locally, nationally, and globally (e.g., bush planes in northern Saskatchewan, scheduled airline travel, supply of cargo to remote communities and mine sites, and transoceanic air travel). h. Describe career opportunities in Canada related to the science and technology of flight.

Outcomes	Indicators
FL6.2 Investigate how the forces of thrust, drag, lift, and gravity act on living things and constructed devices that fly through the air. ***[SI]***	a. Diagram how the forces of thrust, drag, lift, and gravity act on living things or devices that fly through the air. b. Use scientific terminology appropriately (e.g., thrust, drag, lift, and gravity) when communicating ideas about the principles of flight. c. Generate questions related to the principles of flight and rephrase those questions in a testable form (e.g., rephrase a question such as "Why can some gliders travel farther than others?" to "What effect does wing shape have on the distance a glider can travel?"). d. Describe the role of lift in overcoming gravity and enabling devices or living things to fly. e. Determine how lift is affected by the shape of a surface by planning and carrying out steps to investigate the effect of wing shape on lift. f. Describe and represent methods for altering drag in flying devices, such as a bird spreading wings or an airplane employing flaps. g. Provide examples of how science and technology have been used to solve problems related to drag in devices that fly. h. Compare the sources of thrust of various constructed flying devices including the propeller, jet engine, and solid or liquid-fuelled rocket.
FL6.3 Design a working prototype of a flying object that meets specified performance criteria. ***[TPS]***	a. Assess the characteristics of flying objects (e.g., balloon, kite, glider, airplane, helicopter, and rocket). b. Construct a prototype of a flying object that meets student-specified performance and aesthetic criteria. c. Work collaboratively with classmates to define criteria for judging the performance and aesthetics of a prototype of a flying object. d. Select and carefully use appropriate tools in manipulating materials and in building prototypes. e. Work collaboratively to collect relevant observations and data to evaluate the performance of a prototype of an object that will fly. f. Demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems (e.g., explain why it is important to change one variable while keeping others constant in designing and testing prototypes of flying objects).

Outcomes	Indicators
FL6.3 continued	g. Analyze personally collected data and suggest improvements to a prototype design. h. Communicate procedures and results of prototype design, construction, testing, and evaluation in a technical design report. i. Identify new questions or problems about flight that arise through the prototype design process. j. Propose designs for futuristic flying devices that meet a particular student-identified need.

Earth and Space Science: Our Solar System (SS)

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

Outcomes	Indicators
SS6.1 Research and represent the physical characteristics of the major components of the solar system, including the sun, planets, moons, asteroids, and comets. ***[CP, SI]***	a. Use a variety of sources and technologies to gather and compile pertinent information about the physical characteristics of the major components of the solar system. b. Analyze historical and current technological developments that have enabled human observation of the major components of the solar system. c. Construct a timeline of Canadian and worldwide research efforts related to understanding the major components of the solar system. d. Evaluate the validity and usefulness of different sources of information about the physical characteristics of the solar system. e. Use star charts and astronomy guides to investigate the night sky, including constellations, and record observations using notes in point form, data tables, simple diagrams, and/or charts. f. Describe objects in the heavens, as indicated through First Nations and Métis art and stories or by Elders or traditional knowledge keepers. g. Create scale-distance and/or scale-size models to represent the major components of the solar system. h. Evaluate the usefulness and accuracy of scale-distance and scale-size models of the major components of the solar system. i. Explain how evidence is continually questioned in order to validate scientific knowledge about the solar system.

Outcomes	Indicators
SS6.2 Assess the efficacy of various methods of representing and interpreting astronomical phenomena, including phases, eclipses, and seasons. ***[CP, SI]***	a. Examine how people of different cultures, including First Nations, have recorded (e.g., medicine wheel, Mayan calendar, Stonehenge, pyramids) and used understandings of astronomical phenomena (e.g., positions of the stars and/or planets) to solve practical problems such as the appropriate time to plant and harvest crops, to support navigation on land and water, or to foretell significant events through stories and legends. b. Examine ways in which humans have represented understanding of or interest in astronomical phenomena through music, dance, drama, visual art, or stories. c. Demonstrate the importance of selecting appropriate processes for investigating scientific questions and solving technological problems by explaining why astronomy is considered a part of science but astrology is not. d. Propose personal explanations for the causes of seasons, phases, and eclipses. e. Demonstrate how Earth's rotation causes the day and night cycle and how Earth's 23.5° tilt and revolution around the sun causes the yearly cycle of seasons. f. Propose explanations for how the yearly cycle of seasons might differ if Earth's axis were not tilted. g. Consider alternate models of seasons and explanations for those models (e.g., the six-season model of the Woodland Cree, the rainy and dry seasons of some tropical and subtropical regions). h. Model the relative positions of the sun, Earth, and moon to demonstrate moon phases and lunar and solar eclipses. i. Propose questions related to astronomical phenomena to investigate using models and simulations, such as "Do other planets exhibit phases?", "How would seasons on Earth differ if Earth were not tilted?", "How would patterns of eclipses change if the sun, Earth, or moon were different diameters or positioned at different locations?".

Outcomes	Indicators
SS6.3 Evaluate past, current, and possible future contributions of space exploration programs including space probes and human spaceflight, which support living and working in the inner solar system. ***[DM, TPS]***	a. Construct a timeline of Canadian and worldwide space exploration programs related to living and working in space, including collaborative efforts among countries. b. Investigate how astronauts are able to meet their basic needs (e.g., food, water, shelter, and waste elimination) while living and working in space. c. Research the various work roles and worldwide locations required to support human spaceflight programs. d. Describe instances where scientific ideas and discoveries have led to new inventions and applications (e.g., lunar buggy, space shuttle, Canadarm, Dextre, and the International Space Station) that support human exploration of space and which have extended scientific knowledge related to living and working in space. e. Identify potential personal, societal, technological, and environmental barriers to living and working in space. f. Design a model of a habitable space vehicle that can travel to and return from a student-selected location in the inner solar system. g. Investigate the work being done in preparation for future space travel and make predictions about future achievements related to living and working in space.

Assessment and Evaluation of Student Learning

Assessment and evaluation require thoughtful planning and implementation to support the learning process and to 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 to make informed decisions about the teaching and learning process. Reporting of student achievement must be in relation to curriculum outcomes.

There are three interrelated purposes of assessment. 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 their learning, and information to parents in support of learning.

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

- supports students in critically analyzing learning related to curricular outcomes
- is student-driven with teacher guidance
- occurs throughout the learning process.

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

- provides 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).

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

Arts Education

The conceptual focus for Grade 6 Arts Education is "Identity". This focus includes investigations of how identity is influenced by factors such as cultural heritage and personal interests. Connections between arts education and science may include:

- Represent moon phases and solar and lunar eclipses using models, interpretive dance, or a dramatic representation.
- Create sketches, drawings, and other appropriate representations to document observations of the natural and constructed world by drawing electrical circuit diagrams, observing and describing physical characteristics and adaptations of birds, and constructing representations of the

major components of the solar system.
- Examine ways in which others have represented their scientific understanding through music, dance, drama, or art by critiquing representations or depictions of micro-organisms and astronomical phenomena.
- Examine ways that First Nations and Métis art and storytelling highlight movement and behaviour of living things, and understanding of and respect for birds and other living things that fly.

Career Education

Areas of study such as science can serve to provide the context for student explorations of connections between learning and work pathways and their connections to community. Two specific examples of these connections between science and career education at grade six include:
- Investigate science and technology-related careers and workplaces that require an understanding of diversity of life, electricity, flight, and/or space exploration.
- Use the results of their investigations into science and technology-related careers to support their construction of a personal life and work plan in career education.

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 an opportunity to learn and apply science knowledge. Some specific examples of connections between ELA and science at grade six 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 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 development of a prototype of a flying object), descriptive texts (e.g., write a journal of a nature walk), and persuasive texts (e.g., explain potential dangers of electricity at home, at school, and in the workplace).
- Students should reflect on and critique their choices of grade appropriate strategies for communicating their science learning.

Health Education

Connections can often be found between the topics in health education and science, even though students may conduct their inquiries into these topics from different disciplinary "worlds". A specific example of the connection between these areas of study at grade six is:
- Investigation of the effects of micro-organisms in science can help students understand the transmission of infectious disease in health education.

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 six include:
- Collect, organize, and display data when constructing prototypes of flying devices.
- Construct and analyze tables of values and graphs when compiling information about the major components of the solar system and constructing scale models of the major components of the solar system.
- Determine angle measure when investigating the relationship between the tilt of the Earth's axis and the yearly cycle of seasons.
- Demonstrate understanding of polygons when examining the shapes of historical and modern flying devices.

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; by contrast, the analysis of human movement can contribute to a deeper understanding of the underlying scientific principles. Two specific examples of connections between these areas of study at grade six include:

- Student investigations of human adaptations to their environments in the long term can contribute to an understanding of the effects of inactivity on body composition among humans today.
- Investigate how the forces of thrust, drag, lift, and gravity act on living things and constructed devices that fly through the air in science. Students can apply their understanding of these forces by demonstrating skill-related components of fitness such as power, speed, and balance, by examining the forces that act on balls and objects that fly through the air, and by explaining the effects of different forces on skill performance.

Social Studies

The content of social studies and science can often 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 six include:

- Explore parallels between inquiries into social and cultural diversity and the diversity of living things.
- Examine the ways in which people of different cultures and peoples of earlier times relied on astronomical phenomena in science is related to student exploration of how people orient themselves within time and place in the natural environment.
- Student investigations of how flight has changed the way people work, live, and interact with the environment and investigations of the personal, societal, economic, and environmental impacts of electricity are both related to student explorations of the factors that contribute to the quality of life in social studies.

Glossary

Adaptations are physical characteristics or behaviours that help living things survive in different environments.

An **asteroid** is a medium-size rocky object orbiting the sun that is smaller than a planet but larger than a meteoroid.

Aquatic habitats are water-based habitats such as rivers, ponds, streams, lakes, and oceans.

Astronomy is the study of objects that originate outside Earth's atmosphere.

Attraction of electrostatically charged materials occurs when the charges of each material are opposite.

Behavioural adaptations are changes in an organism's behaviour over many generations to respond to changes in the environment.

A **circuit** is a complete pathway for the flow of electrical energy and includes a source of electrical energy, a conductor to carry electric energy, and a load to use the electric energy.

A **classification system** is a way of grouping things based on similarities.

A **comet** is a medium-sized icy object that orbits the sun in a fixed but very long orbit.

Conductivity is a measure of a material's ability to conduct an electric current.

Conductors are materials that allow electric energy to easily flow through them.

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

Current electricity is the flow of electrical energy through a material.

A **dependent variable** is something that can be measured and whose value may change as a result of an experiment.

Drag is a mechanical aerodynamic force that opposes the motion of an object through a liquid or a gas.

An **eclipse** occurs when one celestial object moves into the shadow of another celestial object.

An **ecosystem** consists of all the biotic factors such as plants, animals, and micro-organisms functioning together with abiotic factors of a particular environment.

Electric energy is the energy carried by charged particles in a conductor.

An **electromagnet** is a temporary magnet produced by the flow of electrical energy in a conductor.

A **fair test** is an experiment that has been planned and controlled so that only one variable is changed at a time.

A **force** is a push or pull that causes an object to change its speed or direction.

The **fossil record** is made up of all the fossils of species that have lived on Earth.

Gravity is the force of attraction between two objects that have mass.

Hydroelectric energy is a renewable energy resource derived from falling or flowing water.

An **independent variable** is something that can be changed by an experimenter to cause an effect.

Insulators are materials that do not allow electrical energy to easily flow through them.

Invertebrates are animals without backbones.

A **kingdom** is a taxonomic rank of living things in biological classification systems.

Lift is a mechanical aerodynamic force produced by the motion of an object through a liquid or gas.

A **lunar eclipse** occurs when the moon passes through some portion of the Earth's shadow.

Micro-organisms are organisms that are too small to be seen with the naked eye.

A **moon** is a natural body that orbits a planet or smaller body.

Non-renewable energy is generated from natural resources such as coal, natural gas, and nuclear fuel, which are not naturally replenished as fast as they are being consumed.

An **organism** is a living thing.

A **parallel circuit** is an electric circuit that provides more than one pathway for electrical energy.

A **phase** is the appearance of the illuminated portion of a body as seen by an observer on another body; the phases of the moon, or lunar phases, refers to the appearance of the moon as seen by an observer on Earth.

A **planet** is a large, spherical body that orbits in a regular pattern around a star.

Renewable energy is generated from natural resources such as sunlight, wind, biomass, and geothermal heat, which are naturally replenished.

Repulsion of electrostatically charged materials occurs when the charges on each material are the same.

Revolution is the movement of one object around another object, such as the yearly revolution of Earth around the sun.

Rotation is the movement of a body on its axis around a centre of rotation, such as the daily rotation of Earth.

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 to maintain a sense of wonder about and responsibility towards the natural and constructed world.

A **series circuit** is an electric circuit that provides a single pathway for electrical energy.

A **short circuit** is a closed circuit that does not have a useful load.

A **solar eclipse** occurs when the moon passes between Earth and the sun and blocks some or all of the sun's light, forming a shadow on Earth.

The **solar system** consists of the sun and those objects that orbit the sun, including planets and their moons, asteroids, comets, meteoroids, and interplanetary dust.

Static electric discharge is the transfer of electric charge from one object to another.

Static electricity is the build-up of electric charge on the surface of an object.

Structural adaptations are changes in an organism's structure over many generations to respond to changes in their environment.

STSE, which stands for Science-Technology-Society and the 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 in order to inform and empower decision making by individuals, communities, and society.

A **switch** is a device that closes or opens a circuit to start or stop the flow of electrical energy.

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

Terrestrial habitats are land-based habitats such as deserts, grasslands, forests, and tundra.

Thrust is a mechanical force created by a propeller, rocket, jet engine, or the beating of a bird's wings.

Vertebrates are animals with backbones.

WHMIS is an acronym that stands for Workplace Hazardous Materials Information Systems.

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Suggested Reading

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

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

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5. Explain which aspects you found to be:

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