Ministry of Education

Saskatchewan Curriculum

Science

8

2009

Science 8
ISBN 978-1-926631-09-7
1. Study and teaching (Middle school) - Saskatchewan - Curricula. 2. Competency-based education - Saskatchewan.
Saskatchewan. Ministry of Education. Curriculum and E-Learning. Science and Technology Unit.
All rights are reserved by the original copyright owners.

Table of Contents

Acknowledgements

The Ministry of Education wishes to acknowledge the professional contributions and advice of the provincial curriculum reference committee members:

Glen Aikenhead, Professor Emeritus
College of Education
University of Saskatchewan

Wayne Clark, Teacher
Good Spirit School Division
Saskatchewan Teachers' Federation

Laura Connors, Teacher
Prairie South School Division
Saskatchewan Teachers' Federation

Aimee Corriveau
Meath Park School
Student

Michala Hegi, Teacher
Regina Roman Catholic School Division
Saskatchewan Teachers' Federation

Ji Xia, Assistant Professor
Faculty of Education
University of Regina

Duane Johnson, Principal
Prairie Valley School Division
Saskatchewan Teachers' Federation

Pattie Lysyk, Teacher
Saskatchewan Rivers School Division
Saskatchewan Teachers' Federation

Brien Maguire, Professor
Computer Science Department
University of Regina

Larry McCallum, Consultant
Greater Saskatoon Catholic School Division
Saskatchewan Teachers' Federation

Janet McVittie, Assistant Professor
College of Education
University of Saskatchewan

Herman Michell, Assistant Professor
Department of Science
First Nations University of Canada

Devona Putland, Teacher
South East Cornerstone School Division
Saskatchewan Teachers' Federation

Josée Roberge-Dyck, Teacher
Christ the Teacher School Division
Saskatchewan Teachers' Federation

Patty Serwotki, Teacher
Living Sky School Division
Saskatchewan Teachers' Federation

Sheryl Siemens, Teacher
Chinook School Division
Saskatchewan Teachers' Federation

Lori Slater, Program Manager
Education and Training Secretariat
Federation of Saskatchewan Indian Nations

Warren Wessel, Associate Professor
Faculty of Education
University of Regina

Ruth Wilson, Teacher
Sun West School Division
Saskatchewan Teachers' Federation

Matthew Zelenski
Meath Park School
Student

The Ministry of Education also wishes to thank many others who contributed to the development of this curriculum:

- former Science Reference Committee members
- First Nations Elders and teachers
- university faculty members
- other educators and reviewers.

Introduction

Science is a Required Area of Study in Saskatchewan's Core Curriculum. The provincial requirement for Grade 8 Science is 150 minutes of instruction per week (Saskatchewan Learning, 2007).

The purpose of this curriculum is to outline the provincial requirements for Grade 8 Science. This curriculum provides the intended learning outcomes that Grade 8 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 8 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 describe the knowledge, skills, and understandings that students are expected to attain by the end of a particular grade.

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

Critical characteristics of an outcome 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 should construct visual representations of the world distribution of water, and the distribution of water in Saskatchewan, including watersheds, lakes, rivers, streams, river systems, wetlands, ground water, saline lakes, and riparian areas. This means that, although other types of water could be considered, it is mandatory to represent the nine types listed.

- 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 pin-hole cameras, single lens reflex cameras, telescopes, microscopes, and periscopes" as examples of different optical devices that can be illustrated using geometric ray diagrams. 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., nutrition, exercise, smoking, drugs, and alcohol" to refer to the types of personal lifestyle choices that students might analyze with respect to the functions and efficiency of the human respiratory, circulatory, digestive, excretory, and nervous systems.

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*

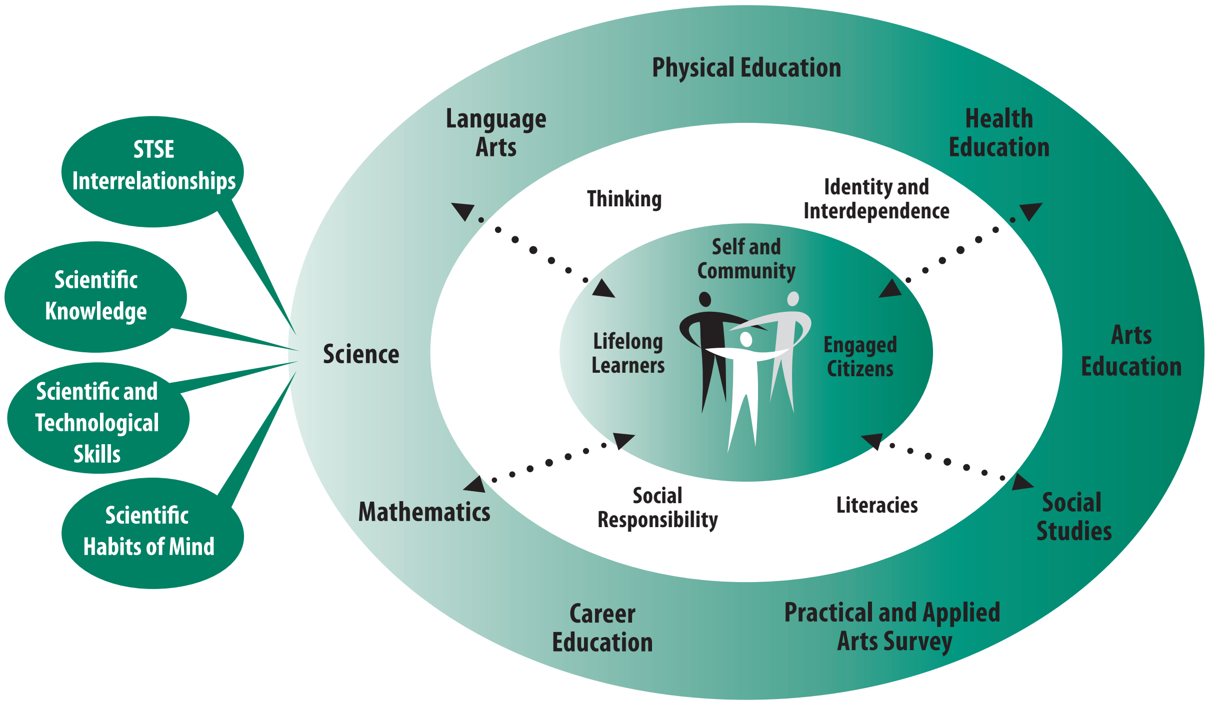
Aim and Goals

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

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)

using evidence.

- 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)

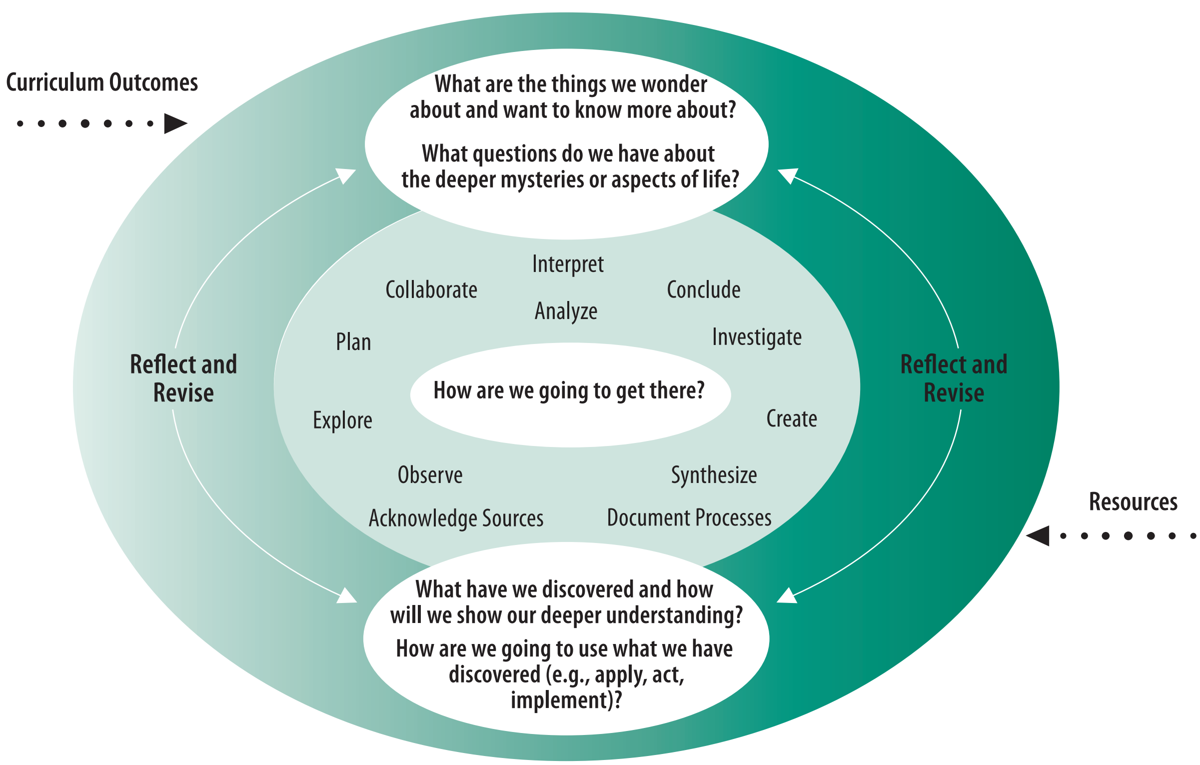
Students do not come to understand inquiry simply by learning words such as "hypothesis" and "inference" or by memorizing procedures such as "the steps of the scientific method".

(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
- explanations, evidence, and modelling in science
- laboratory work
- safety
- technology in science
- science challenges.

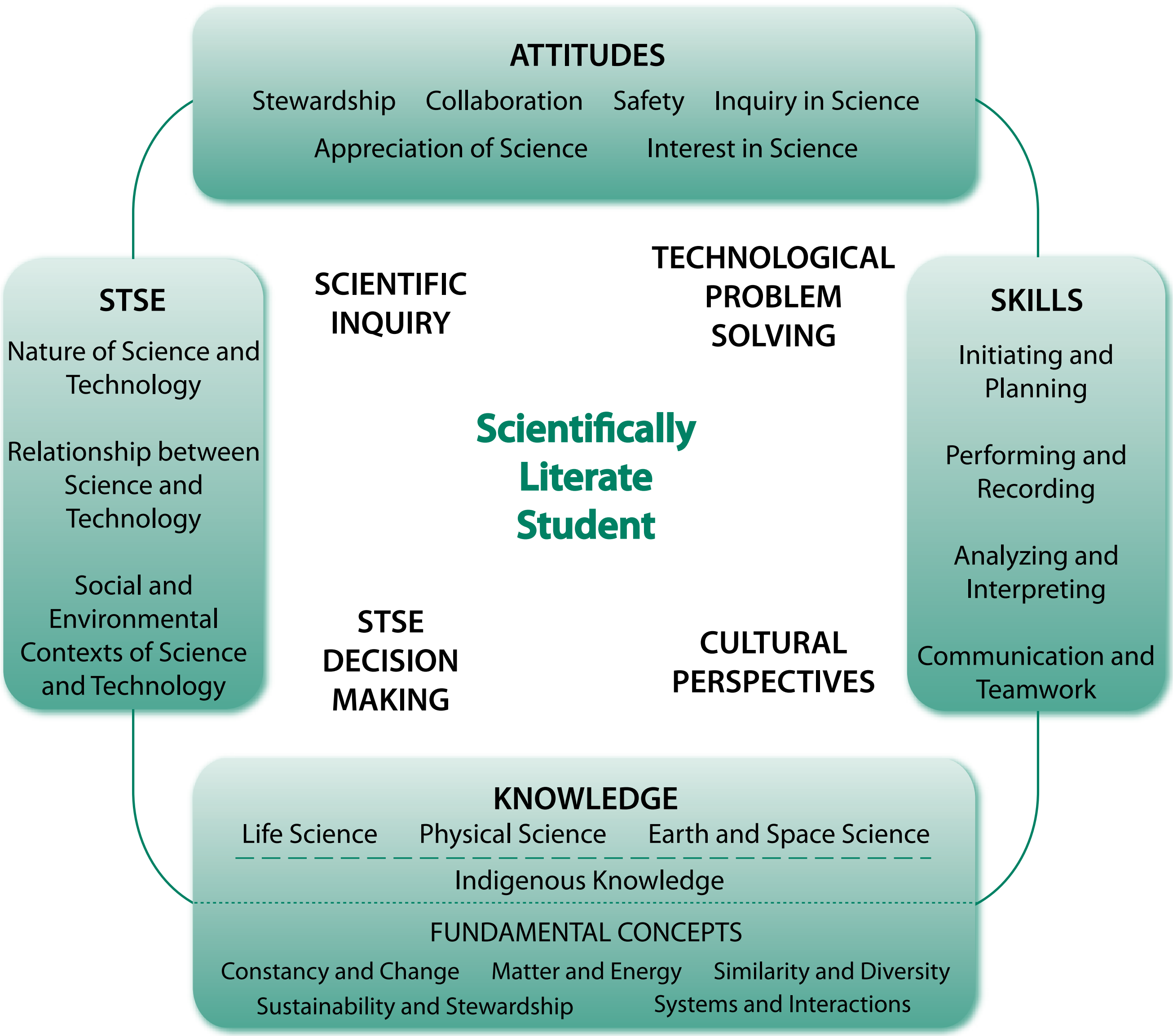
All science outcomes and indicators emphasize one or more foundations of scientific literacy; these represent the "what" of the curriculum. The learning contexts represent different processes for engaging students in achieving curricular outcomes; they are the "how" of the curriculum. The four units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

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.

> *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 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 this 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 solely 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 – Cells, Tissues, Organs, and Systems (CS)
CS8.1 Analyze the characteristics of cells, and compare structural and functional characteristics of plant and animal cells.
CS8.2 Demonstrate proficiency in the use of a compound light microscope to observe plant and animal cells.
CS8.3 Distinguish structural and functional relationships among cells, tissues, organs, and organ systems in humans and how this knowledge is important to various careers.
CS8.4 Analyze how the interdependence of organ systems contributes to the healthy functioning of the human body.

Physical Science – Optics and Vision (OP)
OP8.1 Identify and describe, through experimentation, sources and properties of visible light including: • rectilinear propagation • reflection • refraction.
OP8.2 Explore properties and applications of optics-related technologies, including concave and convex mirrors and lenses.
OP8.3 Compare the nature and properties of human vision with optical devices and vision in other living organisms.
OP8.4 Evaluate the impact of electromagnetic radiation-based technologies on self and community.

Physical Science – Forces, Fluids, and Density (FD)
FD8.1 Investigate and represent the density of solids, liquids, and gases based on the particle theory of matter.
FD8.2 Examine the effects of forces in and on objects in fluids, including the buoyant force.
FD8.3 Investigate and describe physical properties of fluids (liquids and gases), including viscosity and compressibility.
FD8.4 Identify and interpret the scientific principles underlying the functioning of natural and constructed fluid systems.

Earth and Space Science – Water Systems on Earth (WS)
WS8.1 Analyze the impact of natural and human-induced changes to the characteristics and distribution of water in local, regional, and national ecosystems.
WS8.2 Examine how wind, water, and ice have shaped and continue to shape the Canadian landscape.
WS8.3 Analyze natural factors and human practices that affect productivity and species distribution in marine and fresh water environments.

Life Science: Cells, Tissues, Organs, and Systems (CS)

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

Outcomes	Indicators
CS8.1 Analyze the characteristics of cells, and compare structural and functional characteristics of plant and animal cells. ***[SI]***	a. Explain that the cell is a living system that exhibits all the characteristics of life including growth, movement, reaction to stimulus, and reproduction. b. Categorize organisms as single-celled and multi-cellular. c. Observe and describe how single-celled organisms take in food and move. d. Explain how growth and reproduction of living organisms depends on cell division. e. Design and carry out an experiment to demonstrate the function of selectively permeable membranes in cells. f. Model the processes of diffusion and osmosis to demonstrate how gases and water move into and out of plant and animal cells. g. Observe and identify cell structures (e.g., cell wall, cell membrane, vacuole, nucleus, cytoplasm, mitochondria, and chloroplast) and identify which are found in plant cells and which are found in animal cells. h. Explain the function of cell structures (e.g., cell wall, cell membrane, vacuole, nucleus, cytoplasm, mitochondria, and chloroplast), including how each structure contributes to the health of plant and animal cells. i. Use appropriate scientific terminology to communicate plans, ideas, and results related to the study of plant and animal cells. j. Work cooperatively with team members to develop and carry out a plan to construct a representation (e.g., model, drawing, sculpture, or dance) of the structures and functions of plant and animal cells. k. Analyze the strengths and weaknesses of various representations of the structure and function of plant and animal cells.
CS8.2 Demonstrate proficiency in the use of a compound light microscope to observe plant and animal cells. ***[SI]***	a. Identify the parts of a compound light microscope, describe their functions, and describe how to use a compound light microscope correctly and safely. b. Prepare samples of plant and animal cells for viewing by wet mounting and staining when necessary. c. Calculate the magnification of a microscope, and estimate and determine the size of objects viewed through a microscope.

Outcomes	Indicators
CS8.2 continued	d. Use a microscope effectively and accurately to observe differences in structure between plant and animal cells and draw labelled diagrams of what is seen. e. Show concern for self and others by safely planning and carrying out activities involving microscopes, slides, and biological material.
CS8.3 Distinguish structural and functional relationships among cells, tissues, organs, and organ systems in humans and how this knowledge is important to various careers. ***[CP, SI]***	a. Pose questions about the composition of the human body such as "What are humans made of?". b. Research various ideas and theories, past and present, used to explain the composition of the human body (e.g., living organisms were made of air, fire, and water; and body is animated by spirit). c. Analyze why cells and tissues are specialized in multi-cellular organisms. d. Describe the function and provide examples of the four major types of tissue found in humans (i.e., muscle, nerve, epithelial, and connective tissue). e. Construct a representation of the relationships among cells, tissues, organs, and organ systems in humans using examples from the respiratory, circulatory, digestive, excretory, and nervous systems. f. Relate the needs and functions of various cells and organs to the needs and functions of the human organism as a whole. g. Summarize the main points of modern cell theory and identify the contributions of men and women, past and present, to the development of the theory. h. Describe examples of science- and technology-based careers in Saskatchewan that require an understanding of cells and human body systems (e.g., lab and X-ray technicians, doctors, physiotherapists, nutritionists, and public health nurses).
CS8.4 Analyze how the interdependence of organ systems contributes to the healthy functioning of the human body. ***[CP, DM, SI]***	a. Examine First Nations and Métis perspectives on the interdependence and connectedness of human body systems and the sacredness of life. b. Show interest in science-related questions and issues by posing questions and defining practical problems related to the healthy functioning of the human body. c. Describe how various body systems work together to accomplish tasks such as eating, running, and sleeping. d. Provide examples of how the body reacts to internal and external stimuli such as viruses, bacteria, alcohol, drugs, dust, and temperature changes.

Outcomes	Indicators
CS8.4 continued	e. Analyze how organ systems work together to obtain and transport nutrients and oxygen, and to remove wastes from the body. f. Analyze the impact of personal lifestyle choices (e.g., nutrition, exercise, smoking, drugs, and alcohol) on the functions and efficiency of the human respiratory, circulatory, digestive, excretory, and nervous systems. g. Predict the impact of the failure or removal of one or more organs on the healthy functioning of the human body. h. Discuss personal and societal ethical issues related to the use of various technologies (e.g., pacemaker, artificial hip, prosthetic limbs, and artificial heart) that support or replace ailing body systems. i. Select and synthesize information from various sources to illustrate examples of conflicting evidence regarding the ways in which we should maintain our body (e.g., energy drinks, dairy products, vaccinations, and vitamin supplements). j. Design and carry out an experiment, including identifying and controlling major variables, to compare and contrast the heart rate, breathing rate, and/or blood pressure of an individual during various levels of activity. k. Suggest explanations for discrepancies in data related to variations in the heart rate, breathing rate, and/or blood pressure of the same individual during various levels of activity when an experiment is repeated.

Physical Science: Optics and Vision (OP)

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

Outcomes	Indicators
OP8.1 Identify and describe, through experimentation, sources and properties of visible light including: • ***rectilinear propagation*** • ***reflection*** • ***refraction.*** ***[SI]***	a. Classify natural and artificial sources of light as incandescence or fluorescence (including phosphorescent, chemiluminescent, and bioluminescent). b. Demonstrate that light is a form of energy, that light can be separated into a visible spectrum, and that light travels in straight lines in a uniform transparent medium. c. Investigate the properties of shadows, including umbra and penumbra formation, and demonstrate how the existence of shadows provides evidence that light travels in straight lines.

Outcomes	Indicators
OP8.1 continued	d. Select appropriate methods and tools and use them safely when collecting data and information to investigate properties of visible light. e. Estimate and measure angles of incidence and angles of reflection of visible light and determine the quantitative relationship between the angle of incidence and the angle of reflection. f. Investigate characteristics and applications of specular and diffuse reflection, including the absorption of light by surfaces of different colour and made of different materials (e.g., coloured paper, white paper, aluminium foil, mirror, and water). g. Describe applications of the laws of reflection in everyday life (e.g., sun dogs, rear view mirror, magician's tricks, and the ability to see the Moon and other non-luminous bodies). h. Describe qualitatively how visible light is refracted when passing from one substance to a substance of a different refractive index. i. Predict how light will refract when passing into transparent media with different refractive indices (e.g., water, salt water, plastic, glass, and oil) and conduct an experiment to confirm or refute that prediction. j. State a conclusion that explains how evidence gathered supports or refutes a prediction related to the refraction of light through media with different refractive indices.
OP8.2 Explore properties and applications of optics-related technologies, including concave and convex mirrors and lenses. ***[SI, TPS]***	a. Investigate to determine how light interacts with transparent, translucent, and opaque materials. b. Investigate to determine how light interacts with concave and convex mirrors and lenses, including the formation of real and virtual images. c. Predict and verify the effects of changes in lens position on the size and location of images produced by a convex lens and/or mirror. d. Receive, understand, and act on the ideas of others when trying other lenses or mirror combinations to obtain various light patterns. e. Draw geometric ray diagrams to illustrate how light travels within optical devices such as pin-hole cameras, single lens reflex cameras, telescopes, microscopes, and periscopes. f. Use a technological problem-solving process to design and construct a prototype of an optical device to address a student-defined problem based on findings related to an understanding of geometric optics.

Outcomes	Indicators
OP8.2 continued	g. Work collaboratively and safely with others to identify and correct practical problems in the way a prototype of an optical device functions. h. Provide examples of optics-related technologies that have enabled scientific research (e.g., lasers have enabled research in the fields of medicine and electronics; microscopes have enabled research in medicine, forensics, and microbiology; and fibre optics and the endoscope has facilitated medical research).
OP8.3 Compare the nature and properties of human vision with optical devices and vision in other living organisms. ***[CP, SI]***	a. Identify questions to investigate arising from practical problems and issues related to human vision (e.g., "How are contact lenses crafted?", "Do humans see colour the same way?", and "What are some problems associated with human vision?"). b. Illustrate, using a geometrical ray diagram, how the human eye sees objects. c. Compare the functional operation of the human eye to that of a camera or other optical instruments in focusing an image. d. Compare human vision with that of other vertebrates and invertebrates, including the function and design of the eye. e. Explain how the human eye detects colour, and demonstrate that the ability to perceive colour may vary from person to person. f. Explain how colours are produced, using both the additive and subtractive models of colour, and identify applications of the additive and subtractive models of colour in daily life, including the use of traditional dyes. g. Describe the operation of optical technologies that enhance human vision (e.g., contact lenses, glasses, night vision scopes, and snow goggles).
OP8.4 Evaluate the impact of electromagnetic radiation-based technologies on self and community. ***[CP, DM, SI]***	a. Describe the characteristics (i.e., wavelength, frequency, energy transferred, and typical sources) of different types of electromagnetic radiation, including infrared, visible light, ultraviolet, X-rays, microwaves, and radio waves. b. Compare properties of visible light (e.g., relative energy, frequency, wavelength, and human perception) to the properties of other types of electromagnetic radiation, including infrared, ultraviolet, X-rays, microwaves, and radio waves.

Outcomes	Indicators
OP8.4 continued	c. Provide examples of uses of instruments that emit or detect different types of electromagnetic radiation (e.g., cordless phone, cell phone, GPS, wireless computer network, black light, X-ray photographic film, radio, and thermal imaging camera). d. Analyze the design and function of a technology that incorporates electromagnetic radiation (e.g., microwave oven, solar cooker, sun tanning lamp, infrared heat lamp, radio, medical imaging X-ray, blacklight, UV fire detector, night vision goggles, infrared thermography, and radar) on the basis of student-identified criteria such as cost, usefulness, and impact on self, society, and the environment. e. Defend a position on an issue or problem, identified through personal research, related to the impact of electromagnetic radiation-based technologies on self and community. f. Identify new questions and problems that arise from what was learned about electromagnetic radiation (e.g., identify issues such as how and why to protect oneself against various forms of electromagnetic radiation).

Physical Science: Forces, Fluids, and Density (FD)

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

Outcomes	Indicators
FD8.1 Investigate and represent the density of solids, liquids, and gases based on the particle theory of matter. ***[SI, TPS]***	a. Illustrate the relationship between mass, volume, and density of solids, liquids, and gases using the particle theory of matter. b. Design and carry out processes, including the water displacement method, to determine the density of various regularly shaped and irregularly shaped materials. c. Use instruments safely, effectively, and accurately for collecting data about the density of solids, liquids, and gases. d. Measure the mass and volume of a variety of objects, record the data in tabular form, and display the data graphically. e. Value accuracy, precision, and honesty when gathering data about the density of objects. f. Interpolate or extrapolate from student-constructed graphs of density to determine the mass or volume of a substance.

Outcomes	Indicators
FD8.1 continued	g. Calculate the density of various regularly shaped materials using the formula d=m/v and using units of g/mL or g/cm^3. h. Compare the densities of common substances to the density of water and discuss practical applications that are based on differing densities. i. Identify the effects of changes in temperature on the density of solids, liquids, and gases and explain the results using the particle theory of matter. j. Describe situations in daily life where we see evidence that the density of substances changes naturally (e.g., molten lava as it cools, water 'turning over' at 4°C in the fall, air when mirages form) or is intentionally altered (e.g., air in a hot-air balloon, cream when it is churned and cooled).
FD8.2 Examine the effects of forces in and on objects in fluids, including the buoyant force.	a. Identify questions to investigate arising from practical problems and issues involving floating, sinking, and buoyancy (e.g., "What factors affect the amount of cargo a barge can hold?", "Why do some objects float and some objects sink?", and "How can a ship made of steel float in the ocean?"). b. Examine contributions of people from various cultures to understanding the principles of buoyancy, including Archimedes Principle, and the development of watercraft such as canoes and kayaks. c. Explain the concept of force and provide examples of different types of contact and non-contact forces. d. Illustrate, using force diagrams, the movement of objects in fluids in terms of balanced and unbalanced forces acting on the objects. e. Use a spring scale to determine the relationship between mass and weight for various substances. f. Express the quantitative relationship between pressure, force, and area in fluids. g. Conduct a fair test to identify which factors determine whether a given object will float or sink, and discuss reasons why scientists control some variables when conducting a fair test. h. Use a technological problem-solving process to design, construct, and evaluate a prototype of an object that floats and can carry the greatest amount of cargo. i. Explain how buoyancy is controlled in nature (e.g., fish, humans, and sharks) and in constructed devices (e.g., submarines, airplanes, airships, scuba gear, and hot air balloons).

Outcomes	Indicators
FD8.2 continued	j. Compare different fluids to determine how they alter the buoyant force on a given object. k. Explain the operation of technologies whose development is based on scientific understanding of the properties of fluids (e.g., personal flotation devices, float planes, surfboards, gliders, anti-freeze tester, and heart pumps). l. Analyze designs of traditional and contemporary watercraft (e.g., canoe, kayak, lake boat, catamaran, and jet-ski) with respect to the principles of buoyancy.
FD8.3 Investigate and describe physical properties of fluids (liquids and gases), including viscosity and compressibility. ***[SI]***	a. Design and conduct an experiment to compare the viscosity of various fluids (e.g., water, syrup, oil, shampoo, glycerine, honey, ketchup, hand cream, and detergent) and identify variables relevant to the investigation. b. Use appropriate vocabulary related to the study of fluids, including fluid, viscosity, buoyancy, pressure, compressibility, hydraulic, pneumatic, and density. c. Demonstrate knowledge of Workplace Hazardous Materials Information System (WHMIS) standards by using proper techniques for handling and disposing of lab materials and by explaining the WHMIS labelling system. d. Investigate the relationship between the temperature and viscosity of a liquid, controlling the major variables. e. Use a temperature measuring technology, such as a temperature probe, effectively and accurately for collecting data to investigate the relationship between temperature and viscosity of a liquid. f. Identify products in which viscosity is an important property (e.g., paint, hand lotion, motor oil, salad dressing, and condiments) and evaluate different brands of those products using student-developed criteria. g. Predict and investigate the effect of applying external pressure to the behaviour of liquids and gases (e.g., squeezing a balloon, depressing a plunger in a syringe). h. Describe situations in which pressure can be increased or decreased by altering surface area (e.g., snowshoes vs. boots, flat-heeled vs. high-heeled shoes, adaptive hoof shape of the woodland caribou, dual or triple tires on a tractor, and placing a thumb over the end of a garden hose). i. Use the particle theory of matter to explain the differences in compressibility between liquids and gases. j. Explore and explain qualitatively the relationship between pressure, volume, and temperature when liquids and gases are compressed or heated.

Outcomes	Indicators
FD8.3 continued	k. Show concern for safety of self and others when planning, carrying out, and reviewing procedures involving heating and compressing liquids and gases.
FD8.4 Identify and interpret the scientific principles underlying the functioning of natural and constructed fluid systems. ***[CP, SI]***	a. Describe how hydraulic or pneumatic pressure can be used to create a mechanical advantage in a simple mechanical device (e.g., hydraulic jack, air powered tools, hairstylist's chair, and water spraying toy) b. Compare natural (e.g., circulatory and respiratory system) and constructed (e.g., hydraulic and air brakes, oil and gas pipelines, swimming pool circulation system, bicycle and other pumps, Archimedes screw, and automobile lifts) hydraulic and pneumatic fluid systems and identify advantages and disadvantages of each, using student-identified criteria such as cost and impact on society and the environment. c. Use a technological problem-solving process to design, construct, and evaluate a prototype of a device that models the operation of a natural or constructed fluid system. d. Work collaboratively to identify and correct problems in the way a prototype of a natural or constructed fluid system functions. e. Apply given criteria for evaluating evidence and sources of information by testing a prototype of a natural or constructed fluid system in a variety of situations to ensure that the results were not due to chance. f. Describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge related to fluids and fluid systems (e.g., finding relationships between density or pressure and change in temperature provides insights into practical uses for fluids). g. Provide examples of Canadian contributions to the science and technology of fluids (e.g., submersibles, oil rigs and platforms, diving equipment, pumps, tires, and vacuum cleaners).

Earth and Space Science: Water Systems on Earth (WS)

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

Outcomes	Indicators
WS8.1 Analyze the impact of natural and human-induced changes to the characteristics and distribution of water in local, regional, and national ecosystems.	a. Construct visual representations of the world distribution of water, and the distribution of water in Saskatchewan, including watersheds, lakes, rivers, streams, river systems, wetlands, ground water, saline lakes, and riparian areas. b. Compare physical characteristics of surface water features, such as lakes, rivers, streams, wetlands, and riparian areas. c. Examine the significance of water to First Nations and Métis people of Saskatchewan, including water as an essential element of life, transportation, water quality, fishing practices, and treaty rights regarding fishing. d. Apply the concept of systems as a tool for interpreting the structure and interactions of water systems by constructing representations of systems such as the water cycle, watersheds, and continental drainage basins and showing interrelationships between parts of the system. e. Construct a written, visual, or dramatic representation of the water cycle, including showing or explaining how a single particle of water can travel through the cycle over extended periods of time. f. Identify possible personal, societal, economic, and environmental consequences of natural changes and human practices and technologies that pose threats to surface and/or ground water systems in Saskatchewan (e.g., vegetation removal, water and sewage treatment plants, timber harvesting, over-application of fertilizers, agricultural and urban irrigation, impervious ground cover, land alterations, mining, introduction of invasive species, shoreline erosion, fluctuating lake levels, flooding, draining and/or channelling of surface water features, and damming of rivers). g. Research a specific human practice or technology that may pose a threat to surface and/or groundwater systems in Saskatchewan and explain how different groups in society (e.g., landowner, consumer, business owner, recreational user, fisherman, government official, and farmer) may have conflicting needs and desires in relation to the practice or technology and how those decisions or actions of different stakeholders may or may not be addressed by scientific or technological knowledge.

Outcomes	Indicators
WS8.1 continued	h. Evaluate individual and group processes used in planning, problem solving, decision making, and completing a task related to studying threats to water systems, such as accepting various roles in a group, sharing responsibility for carrying out decisions, and seeking consensus before making decisions.
WS8.2 Examine how wind, water, and ice have shaped and continue to shape the Canadian landscape. ***[DM, SI]***	a. Explain how the processes of weathering, erosion, and deposition result from water movement and wave action, including how waves and tides are generated and how they interact with shorelines. b. Plan and conduct a simulation to demonstrate how temperature differences cause water currents. c. Explain the meaning and significance of the forces that shape the landscape to First Nations and Métis people. d. Describe how the interactions of ocean currents, winds, and regional climates shape local, regional, national, and global environments. e. Critique the design and function of technologies designed to minimize damage due to waves and tides (e.g., piers, breakwaters, dune vegetation, and coastline reconfiguration) in oceans and in-land water bodies. f. Create a written, visual, physical, or dramatic representation of the processes that lead to the development of rivers, lakes, continental drainage systems, and ocean basins, including glaciation, continental drift, erosion, and volcanic action. g. Relate factors that affect glacier formation and reduction and their effects on the environment to the formation of glacial landforms in Saskatchewan (e.g., drumlins, moraines, eskers, and kettle lakes). h. Identify factors that affect polar icecap formation and reduction and their effects on the environment, including possible changes to ocean currents and climate patterns. i. Propose new questions and problems for future study that arise from the study of the effects of wind, water, and ice on the landscape (e.g., "How might changes in glaciers affect Saskatchewan water supplies?" "How might icecap melting change Canadian coastlines?").

Outcomes	Indicators
WS8.3 Analyze natural factors and human practices that affect productivity and species distribution in marine and fresh water environments. ***[CP, DM, SI]***	a. Examine the ways in which First Nations and Métis people traditionally valued, depended upon, and cared for aquatic wildlife and plants in Saskatchewan and Canada. b. Identify diverse examples of organisms in a variety of marine and freshwater ecosystems (e.g., wetlands, lakes, rivers, salt marsh, estuary, ocean, and intertidal zone) and explain how biodiversity is an indicator of ecosystem health. c. Identify factors that affect productivity and species distribution in aquatic environments (e.g., temperature, turbidity, sunlight, nutrients, salinity, water depth, currents, overfishing, upwelling, and pollutants). d. Research a student-selected aquatic species, describe the characteristics of its environment, identify factors that could affect its productivity, and suggest methods of ensuring long-term viability of the species. e. Measure factors that provide indicators of water quality, such as temperature, turbidity, dissolved oxygen content, presence of nitrates or phosphates, and macroinvertebrates, from a variety of samples of water. f. Interpret patterns and trends in water quality data, and infer and explain relationships among the variables. g. Identify strengths and weaknesses of different methods of collecting and displaying data about water quality. h. Describe examples of technologies used to assess water quality and how those technologies have changed over time. i. Provide examples of how individuals and public and private Canadian institutions contribute to the sustainable stewardship of water through traditional knowledge and scientific and technological research and endeavours related to aquatic environments (e.g., marine research institutes, universities, federal and provincial government departments, and ecological groups) and identify possible careers related to the study and stewardship of water.

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 eight.

Arts Education

The conceptual focus for Grade 8 Arts Education is "Social Issues". This focus involves students in expressing ideas and perspectives on social issues through the arts. Connections between arts education and science may include:

- Create visual art works inspired by social issues related to cells, tissues, organs, or organ systems (e.g., genetic engineering of plants, organ transplants).
- Create a dance composition demonstrating the interdependence of organ systems and the need to maintain a healthy body.

- Create a drama involving issues related to the impact of electromagnetic radiation-base technologies on self and community.
- Create a dance inspired by the effects of forces in and on fluids, and the physical properties of fluids (liquids and gases).
- Create visual art works and dances that examine how wind, water, and ice have shaped and continue to shape the Canadian landscape.
- Create lyrics for music compositions that comment on the impact of natural and human factors on the earth's water systems.

Career Education

Areas of study such as science can provide the context for student exploration of transferability of present knowledge and skills to career pathways and their connections to community. Two specific examples of these connections between science and career education at grade eight include:

- Investigate science and technology-related occupations and workplaces that require an understanding of human physiology, the physics of light, the density of materials, and the importance of water for all life.
- Use the results of their investigations into science to support the initial 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 eight 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., construct a written, visual, or dramatic representation of the water cycle); descriptive texts (e.g., write a description of the effects of weathering and erosion that are evident in the surrounding environment); and persuasive texts (e.g., support the use of various technologies that support or replace ailing body systems).
- 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, although students may conduct their inquiries into these topics from different disciplinary "worlds". Some specific examples of the connection between these areas of study at grade eight are:

- Analyzing how the interdependence of organ systems contribute to the healthy functioning of the human body and how these contributions relate to the importance of healthy behaviours (like eating, exercising, sleeping) on a person's health and well-being.
- Analyzing the impact of natural and human changes to the distribution and characteristics of water in local and regional ecosystems will include the examination of human practices and activities that pose a threat to the environment and to the health of people.

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 eight include:

- Analyze the effectiveness of data representations related to the healthy functioning of the human body.
- Apply and strengthen their understanding of independent events as they examine the effects of different mediums on optics and vision.

- Develop and apply their proportional reasoning when exploring density, viscosity, and compressibility of fluids.
- Apply their understandings of percents to analyze the impacts of natural and human-induced changes to water systems on Earth.

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 the students' ability to engage in movement that will support their well-being; 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 eight include:

- Students will be describing the function of muscle tissues in science and this understanding will support them as they focus on how to positively affect major muscle groups in physical education.
- Students design and carry out an experiment, to compare and contrast the heart rate, breathing rate, and/or blood pressure of an individual during various levels of activity in science. In physical education, students are to monitor heart rate to draw conclusions about personal achievement of maintaining a level of participation at their target heart zone. They also develop and test, physically, a hypothesis on the effects of various movement activities on the heart rate. Students can strengthen their understanding in both subject areas by integrating these learnings.

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. A specific example of this connection in grade eight is:

- Students investigate the use of water as a resource for human and industrial use and the impact the availability of water has on distribution of human population and the development of industry.

Glossary

The **additive model of colour** describes the adding together of coloured light sources to produce colours.

The **angle of incidence** is the angle between an incident ray of light and the normal.

The **angle of reflection** is the angle between the normal and a reflected ray of light.

Archimedes principle states that the buoyant force acting on an object equals the weight of the fluid displaced by the object.

Balanced forces are equal in strength and opposite in direction and thus do not cause an object to move.

A **cell** is the basic unit of a living organism that exhibits all of the characteristics associated with life.

Cell division is the process by which a cell divides into two or more cells.

A **compound light microscope** is a microscope that has two or more lenses and uses a lamp or mirror to provide light for viewing the object.

Compressibility is the relative volume change of a fluid or solid due to pressure change.

A **concave lens** is a transparent material that is thinner in the middle than at the edges.

A **concave mirror** is a reflective surface that is curved inward.

A **convex lens** is a transparent material that is thicker in the middle than at the edges.

A **convex mirror** is a reflective surface that is curved outward.

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

Density is the amount of mass of a material per unit volume and is measured in kg/m^3, g/cm^3, or g/mL.

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

Deposition is the geological process by which eroded sediments and other materials are dropped or left by water or ice, creating built-up landforms such as deltas and eskers.

Diffuse reflection is the reflection of light from an uneven or granular surface in a broad range of directions.

Diffusion is the movement of particles from an area of higher concentration to an area of lower concentration.

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

Electromagnetic radiation includes all forms of radiated energy (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays).

Erosion is the transport of sediments from one place to another by wind, water, glaciers, or gravity.

Extrapolation means to construct new data points outside the range of a set of data points.

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

A **fluid** is a form of matter than can flow, such as gases or liquids.

Fluorescence is the emission of light from a cold body due to the release of long wavelength energy, such as the coating inside a fluorescent lamp.

A **force** is a push or pull that causes an object to move; forces may be contact (e.g., physical push) or non-contact (e.g., force of gravity).

Frequency is the number of times a wave source or medium vibrates in a given unit of time.

A **geometric ray diagram** uses rays with arrows to represent how light travels.

Glaciers are large moving masses of compressed ice and snow.

Groundwater is water that has seeped into the ground from the surface of Earth.

A **hydraulic system** uses relatively incompressible liquids, such as oil, to transmit force.

Incandescence is the emission of light from a hot body due to its temperature, such as a hot filament within an incandescent lamp.

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

Interpolation means to construct new data points within the range of a set of data points.

Magnification is the ratio between the apparent size of an object as seen through a microscope and the real size of an object.

Mechanical advantage is the factor by which a mechanism multiplies the force put into it.

Opaque materials prevent light from passing through them.

An **organ** is a group of different types of tissues that work together to perform a function.

An **organ system** is comprised of a group of related organs that perform specific functions.

Osmosis is the diffusion of water through a selectively permeable membrane.

The **particle theory of matter** explains the behaviour of solids, liquids, and gases based on the assumption that all matter is made up of tiny moving particles that attract each other and have spaces between them.

A **penumbra** is the region in which only part of a body is in shadow.

A **pneumatic system** uses easily compressible gases, such as air, to transmit force.

Pressure is the amount of force applied over a given area of an object and is measured in Pa, bar, or pounds per square inch (psi).

Productivity is the ability of a water body to support living things.

A **real image** is an image of a source object that can be projected onto a screen.

Rectilinear propagation is the property that light travels in straight lines.

Reflection of light is the change in direction of light when it strikes a surface, such as from air onto a mirror and back into the air.

Refraction of light is the change in direction of light when it passes from one medium into another, such as from air into water.

The **refractive index** of a medium is a measure of how much the speed of light is reduced inside the medium, which causes the light ray to change direction.

Riparian areas are land areas directly influenced by bodies of water such as stream banks, lake borders, and marshes.

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 **selectively permeable membrane** allows some substances, but not others, to pass through.

Specular reflection is the reflection of light from a smooth surface.

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.

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.

The **subtractive model of colour** describes the mixing of paints, dyes, and inks to create colours.

Surface water is water that is on Earth's surface, such as in a stream, lake, river, or reservoir.

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

Tissue is a group of the same type of cells that work together to perform a function.

Translucent materials allow light to pass through them diffusely.

Transparent materials allow light to pass through freely.

An **umbra** is the darkest part of a shadow.

A **virtual image** is an image of a source object that appears to be behind a lens or mirror and can not be projected onto a screen.

Viscosity is the resistance of a fluid (gas or liquid) to flow.

The **visible spectrum** is the portion of the electromagnetic spectrum which can be detected by the human eye and is seen by humans as colours.

A **watershed**, or drainage basin, is an area of land that drains water into a particular stream, river, or lake.

Water quality consists of the physical, chemical, and biological characteristics of water which can be measured using indicators such as temperature, turbidity, pH, colour, dissolved oxygen, hardness, nitrates, biochemical oxygen demand, total suspended solids, and benthic macroinvertebrates.

Wavelength is the distance from one point on a wave to the same point on the next wave (e.g., from crest to crest or from trough to trough).

Weathering is the breaking down of rocks and minerals through mechanical, chemical, and biological processes.

Wetlands are areas with saturated soils and water tolerant plants such as marshes, fens, and peat lands, which serve as transitions between dry land and water bodies.

A **wet mount** is a microscope slide that is made by placing a specimen in a drop of water and covering with a small piece of glass or plastic.

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

References

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

National Science Teachers Association (NSTA). 1999. *NSTA position statement: Science competitions*. Available online at http://www.nsta.org/about/positions/competitions.aspx.

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

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

Saskatchewan Learning. (2007). *Core curriculum: Principles, time allocations, and credit policy*. SK: Author.

Suggested Reading

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Feedback Form

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

Document Title: **Grade 8 Science Curriculum**

1. Please indicate your role in the learning community

☐ parent ☐ teacher ☐ resource teacher

☐ guidance counsellor ☐ school administrator ☐ school board trustee

☐ teacher librarian ☐ school community council member

☐ other ____

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

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

☐ print

☐ online

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

☐ print

☐ online

3. How does this curriculum address the needs of your learning community or organization? Please explain.

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

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

5. Explain which aspects you found to be:

   Most useful:

   Least useful:

7. Additional comments:

7. Optional:

   Name: ______________________________

   School: ______________________________

   Phone: __________________ Fax: __________________

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

Please return the completed feedback form to:

Executive Director
Curriculum and E-Learning Branch
Ministry of Education
2220 College Avenue
Regina SK S4P 4V9
Fax: 306-787-2223