Prince Edward Island

CANADA

Education, Early Learning and Culture
English Programs

# Prince Edward Island Science Curriculum

CURRICULUM

# Science

## Grade 8 (Draft)

**Revised 2016**
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# Introduction

## Foreword

The pan-Canadian *Common Framework of Science Learning Outcomes K to 12* (1997) will assist in standardizing science education across the country. The Prince Edward Island Department of Education and Early Childhood Development commits to align, where possible and appropriate, the scope and sequence of science education in Prince Edward Island with the scope and sequence outlined in the *Common Framework of Science Learning Outcomes K to 12*. New provincial science curriculum is also supported by the *Foundation for the Atlantic Canada Science Curriculum* (1998).

## Purpose

The purpose of this curriculum is to outline the provincial requirements for Grade 8 Science. This guide provides the specific curriculum outcomes that Grade 8 students are expected to achieve in science by the end of the year. Achievement indicators and elaborations are included to provide the breadth and depth of what students should know and be able to do in order to achieve the outcomes. This renewed curriculum reflects current science education research, updated technology, and recently developed resources, and is responsive to changing demographics within the province.

## Focus and Context

The focus of Grade 8 Science is to introduce students to a balance of life science, physical science, and Earth and space science. The concepts and terminology associated with Grade 8 Science will be delivered through the contexts of Water Systems on Earth, Optics, Fluids, and Cells, Tissues, Organs and Systems. Inquiry investigations and problem-solving situations create powerful learning opportunities for students. They increase students' understanding of scientific and technological concepts and help students connect ideas about their world. The Grade 8 Science program supports an interactive learning environment that encourages students to make sense of experiences through a combination of "hands-on" and "minds-on" activities.

## Aim

The aim of science education in the Prince Edward Island is to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry,  problemsolving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyse, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

# Scientific Literacy

## Vision

The Prince Edward Island science curriculum is guided by the vision that all students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge that students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them.

## Goals

Consistent with views expressed in a variety of national and international science education documents, the following goals for Canadian science education have been established:

- encourage students at all grade levels to develop a critical sense of wonder and curiosity about scientific and technological endeavours
- enable students to use science and technology to acquire new knowledge and solve problems, so that they may improve the quality of their own lives and the lives of others
- prepare students to address critically science-related societal, economic, ethical, and environmental issues
- provide students with a foundation in science that creates opportunities for them to pursue progressively higher levels of study, prepares them for science-related occupations, and engages them in science-related hobbies appropriate to their interests and abilities
- develop in students, of varying aptitudes and interests, a knowledge of the wide variety of careers related to science and technology

While teachers play the most significant role in helping students achieve scientific literacy, they need support from the rest of the educational system if the challenge is to be met. Science must be an important component of the curriculum at all grade levels and must be explored in an enjoyable environment that students find interesting and intrinsically rewarding. The designation of science into various categories should be discouraged at the primary and elementary levels. At the high school level students will be introduced to the traditional sciences. These divisions are arbitrary and do not reflect current scientific practice. At all stages of science education the connections within and across the sciences, as well as the connections of science to technology, society and the environment should be stressed.

To achieve scientific literacy for all students (K–12), the science curriculum is expected to:

- address the three basic scientific fields of study—life, physical, and Earth and space science. From K–10, students will be exposed to all fields. At the high school level students may opt to take specific sciences. However, in all cases attempts should be made to develop the connections among the basic sciences
- demonstrate that science is open to inquiry and controversy; promote student understanding of how we came to know what we know and how we test and revise our thinking
- utilize a wide variety of print and non-print resources developed in an interesting and interactive style.
- involve instructional strategies and materials which allow all learners to experience both challenge and success
- incorporate assessment approaches that are aligned and correlated with the instructional program
- engage students in inquiry, problem solving, and decisionmaking situations and contexts that give meaning and relevance to the science curriculum. These include the processes of science such as predicting and formulating hypotheses, higher level skills such as critical thinking and evaluating, and manipulative skills such as the use of laboratory equipment
- give students the opportunities to construct important ideas of science, which are then developed in depth, through inquiry and investigation
- be presented in connection with students' own experiences and interests by frequently using hands-on experiences that are integral to the instructional sequence
- demonstrate connections across the curriculum

Student achievement in science and in other school subjects such as social studies, English language arts, technology, etc. is enhanced by coordination between and among the science program and other programs. Furthermore, such coordination can maximize use of time in a crowded school schedule.

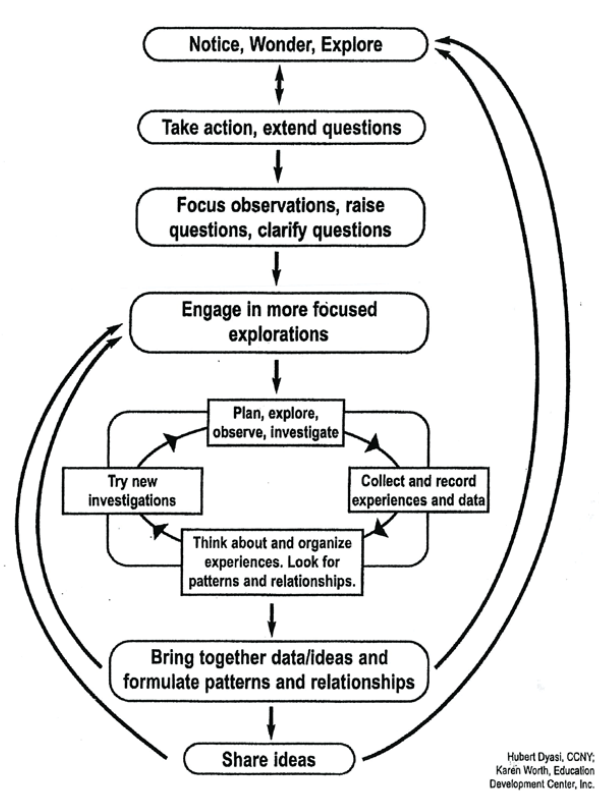
## The Three Processes of Scientific Literacy

A science education which strives for scientific literacy must engage students in asking and answering meaningful questions. Some of these questions will be posed by the teacher, while others will be generated by the students. These questions are of three basic types: “Why…?” “How…?” and “Should…?”. There are three processes used to answer these questions. Scientific inquiry addresses “why” questions. “How” questions are answered by engaging in the problem solving process, and “should” questions are answered by engaging in decision making.

**Scientific Inquiry**

The first of the three processes, scientific inquiry, is a way of learning about the universe. It involves the posing of questions and the search for explanations of phenomena. Although there is no such thing as a “scientific method,” students require certain skills to participate in the activity of science. There is general agreement that skills such as questioning, observing, inferring, predicting, measuring, hypothesising, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging in science. These skills are often represented as a cycle which involves the posing of questions, the generation of possible explanations, and the collection of evidence to determine which of these explanations is most useful in accounting for the phenomena under investigation. Teachers should engage students in scientific inquiry activities to develop these skills.

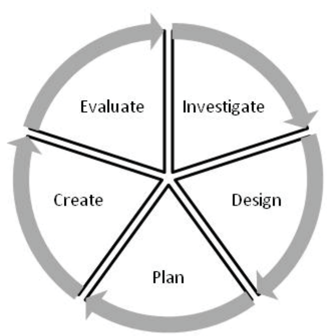
**Young Children’s Inquiry**




**Problem Solving**

The second process, problem solving, seeks solutions to human problems. It is also often represented as a cycle. In this case the cycle represents the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimum solution to a given problem. The skills involved in this cycle facilitate a process which has different aims and different procedures from the inquiry process. Students should be given ample opportunity in the curriculum to propose, perform, and evaluate solutions to problem solving or technological tasks or questions.

**Problem Solving Process**



**Decision Making**

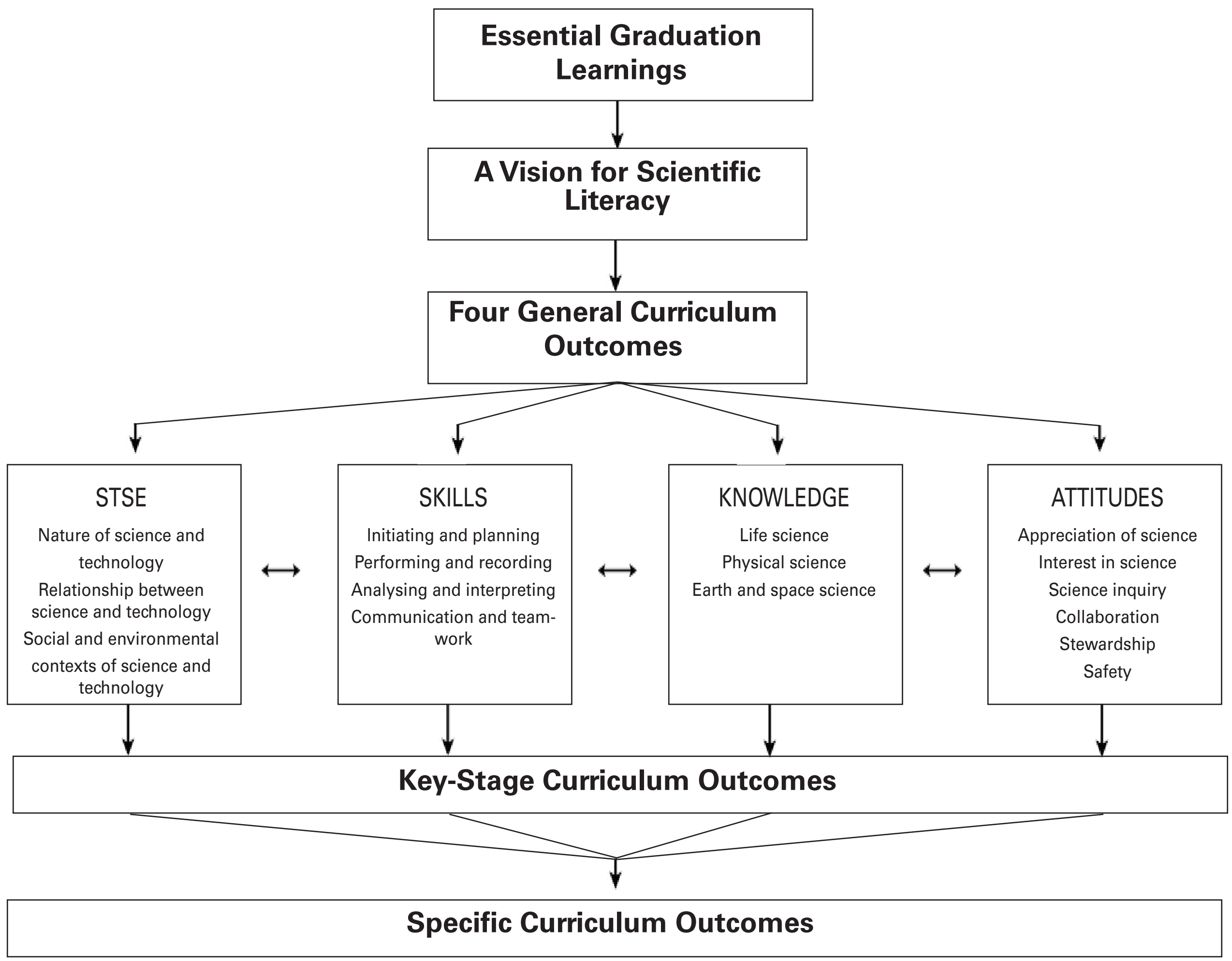
The third process is decision making. It is the determination of what we, as global citizens, should do in a particular context or in response to a given situation. Increasingly, the types of problems that we deal with, both individually and collectively, require an understanding of the processes and products of science and technology. The actual process of decision making involves the identification of the problem or situation, generation of possible solutions or courses of action, evaluation of the alternatives, and a thoughtful decision based on the information available. Students should be actively involved in decision making situations as they progress through the science curriculum. Decision making situations not only are important in their own right, they also often provide a relevant context for engaging in scientific inquiry and/or problem solving.

| **Process Involved in Answering the Question:** | **Scientific inquiry** | **Technological problem solving** | **Decision making** |
|---|---|---|---|
| Question: | Why does my coffee cool so quickly?<br>(Science question) | How can I make a container to keep my coffee hot?<br>(Technology question) | Should we use styrofoam cups or ceramic mugs for our meeting?<br>(STSE question) |
| Response: | Heat energy is transferred by conduction, convection, and radiation. | A styrofoam cup will keep liquids warm for a long time. | Personal health, the environment, cost, and availability must be considered along with science and technology information |
| Problems Arise from: | Curiosity about events and phenomena in the natural world | Coping with everyday life, practices, and human needs | Different views or perspectives based on different or the same information |
| Types of Questions: | What do we know?<br>How do we know? | How can we do it?<br>Will it work? | What alternatives or consequences are there?<br>Which choice is best at this time? |
| Solutions Result in: | Knowledge about the events and phenomena in the natural world | An effective and efficient way to accomplish a task | A defensible decision in the particular circumstances |

# Curriculum Outcomes Framework

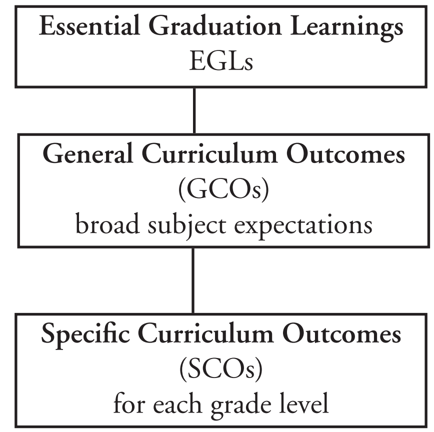
## Conceptual Map

The conceptual map below provides the blueprint of the Prince Edward Island science outcomes framework and is the basis from which general and key-stage outcomes have been developed. At all times when making use of this framework, educators must keep in mind that the outcomes are intended to develop scientific literacy in students. The outcomes in the following section are taken from the Pan-Canadian framework document Common Framework of Science Learning Outcomes K–12.



## Essential Graduated Learning

The CTE curricular program design and components are supportive of the framework incorporated in the *Atlantic Canada Technology Education Foundation Document*.




Essential Graduation Learnings (EGLs) serve as a framework for the curriculum development process and are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the EGLs will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries if they are to be ready to meet the shifting and ongoing demands of life, work, and learning today and in the future. EGLs are cross-curricular, and curriculum in all subject areas is focused on enabling students to achieve these learnings.

Graduates from the public schools of Prince Edward Island will demonstrate knowledge, skills, and attitudes expressed as EGLs, and will be expected to:
respond with critical awareness to various forms of the arts and be able to express themselves through the arts; assess social, cultural, economic, and environmental interdependence in a local and global context; use the listening, viewing, speaking, reading, and writing modes of language(s), and mathematical and scientific concepts and symbols to think, learn, and communicate effectively; continue to learn and to pursue active, healthy lifestyles; use the strategies and processes needed to solve a wide variety of problems, including those requiring language, and mathematical and scientific concepts; use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

**Essential Graduation Learnings**

- Aesthetic Expression
- Citizenship
- Communication
- Personal Development
- Problem Solving
- Technology Competency

## General Curriculum Outcomes

The general curriculum outcomes (GCO) form the basis of the outcomes framework. They constitute a starting point for the development of all subsequent work. The also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered as interrelated and mutually supportive.

**General Curriculum Outcome 1:**
**Science, technology, society, and the environment (STSE)**—Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

**General Curriculum Outcome 2:**
**Skills and processes**—Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

**General Curriculum Outcome 3:**
**Knowledge**—Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

**General Curriculum Outcome 4:**
**Attitudes**—Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

## Description of the General Curriculum Outcomes

**GCO 1: Science, technology, society, and the environment (STSE)**

This general curriculum outcome is the driving force of the curriculum outcomes framework. Many keystage curriculum outcomes presented in this document flow directly or indirectly from the STSE domain. The outcome statement focusses on three major dimensions:

- the nature of science and technology
- the relationships between science and technology
- the social and environmental contexts of science and technology

*Nature of science and technology*

Science provides a base used for predicting, interpreting, and explaining natural and technological phenomena. It is one way of knowing nature, based on curiosity, imagination, intuition, exploration, observation, replication, interpretation of evidence, and consensus making over this evidence. Science-based ideas are continually being tested, modified, and improved as new ideas supersede existing ideas. There is no set procedure for conducting a scientific investigation. Rather, science is driven by a combination of theories, knowledge, experimentation, and processes anchored in the physical world.

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*

While there are important relationships between science and technology, there are also important differences. Science and technology differ in purpose and in process. Where the focus of science is on the development and verification of knowledge; in technology, the focus is on the development of solutions. 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.

By understanding the relationships between science and technology, students learn to appreciate how science and technology interact, how they develop in a social context, how they are used to improve people's lives, and how they have implications for the students themselves, for others, for the economy, and for the environment.

*Social and environmental contexts of science and technology*

The history of science highlights the ways in which culture has influenced the questions of science, and how science in turn has influenced culture. Growth in STSE understandings may involve the following elements:

- increasing complexity of scientific understanding - from simple to abstract ideas
- applications in local and global contexts
- consideration of variables and perspectives - from simple to complex
- critical judgement - from simple right and wrong assessments to complex evaluations
- decision making - from guided decisions based on limited knowledge, to independent decisions based on extensive research and personal judgement.

## GCO 2: Skills and processes

This GCO 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 GCO. The listing of these skills is not intended to imply a linear sequence or to identify a single set of skills required in each science investigation. Every investigation and application of science has unique features that determine the particular mix and sequence of skills involved.

As students advance from grade to grade, the skills they have developed are applied in increasingly demanding contexts. Growth in skills may involve each of the following skill elements:

- range of application—from a limited range to a broad range of applications
- complexity of application—from simple, direct applications to applications that involve abstract ideas and complex interpretations and judgements
- precision of measures and manipulations—from coarse measures and manipulations to those that are precise
- use of current and appropriate technologies and tools—from working with a few simple tools to working with a broad array of specialized and precise tools
- degree of independence and structure—from working under teacher guidance or in a structured situation to working independently and without guidance
- awareness and control—from following a predetermined plan to an approach involving awareness, understanding, and control, such as selecting skills and strategies that are most appropriate to the task at hand and making use of metacognition and strategic thinking
- ability to work collaboratively— from working as an individual to working as part of a team

### *Initiating and planning*

These are the skills 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.

### *Analysing and interpreting*

These are the skills of examining information and evidence, of processing and presenting data so that it can be interpreted, and of interpreting, evaluating, and applying the results.

### *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 society and in learning.

## GCO 3: Knowledge

This general curriculum outcome 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 GCO is framed using the widely accepted science disciplines - life science, physical science, Earth and space science.

### *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, biodiversity, 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 global and universal perspectives to students' knowledge. Earth, our home planet, exhibits form, structure, and patterns of change, as does our surrounding solar system and the physical universe beyond. Earth and space science includes fields of study such as geology, meteorology, and astronomy.

## GCO 4: Attitudes

This general curriculum outcome 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. Attitudes are not acquired in the same way as skills and knowledge. They cannot be observed at any particular moment, but are evidenced by regular, unpromoted displays over time. Attitude development is a lifelong process that involves the home, the school, the community, and society at large. This GCO identifies six categories in which science education can contribute to the development of scientific literacy.

***Appreciation of science***

Students will be encouraged to critically and contextually appreciate the role and contributions of science and technology in their lives and to their community's culture; and 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.

***Scientific inquiry***

Students will be encouraged to develop critical beliefs concerning the need for

- open-mindedness and flexibility,
- critical-mindedness and respect for evidence,
- initiative and perseverance,
- creativity and inventiveness

in the development of scientific knowledge.

***Colloboration***

Students will be encouraged to develop attitudes that support collaborative activity. This will develop their sense of interpersonal responsibilities, an openness to diversity, respect for multiple perspectives, and an appreciation of the efforts and contributions of others.

***Safety***

Students engaged in science and technology activities will be expected to demonstrate a positive attitude toward safety and doing no harm to themselves or others.

***Stewardship***

Students will be encouraged to develop responsibility in the application of science and technology in relation to society and the natural environment. They should be involved in activities that encourage responsible action toward living things and the environment, and to consider issues related to sustainability from a variety of perspectives.

## Specific Curriculum Outcomes

The learning expected of students in Prince Edward Island is defined by specific curriculum outcomes (SCOs) for each area of study within each grade. As Prince Edward Island students achieve the grade and subject-specific outcomes identified in curricula, they will deepen their understanding of each area of study as a living field of knowledge. All specific curriculum outcomes within a grade and subject-area of study are compulsory.

Specific Curriculum Outcomes state the intended outcomes of instruction, and identify what students are expected to know and be able to do within a particular grade and subject-area of study. SCOs provide the goals or targets of instruction in terms of measurable or observable student performance. SCOs provide a focus for instruction and provide a basis for the assessment of student achievement. SCOs are observable, assessable, and supported by achievement indicators that help to define the breadth and depth of the outcome. The outcome of learning described in each SCO provides the basis for selecting learning and teaching activities and assessment procedures. SCOs contribute to the achievement of the key-stage curriculum outcomes. Together, the SCOs provide a continuum of learning from entry through grade 12. In short, SCOs describe the intended outcomes of instruction in performance terms without restricting the means of achieving them.

## Science K-10: At a Glance

The following chart outlines the K-10 science topics organized by processes and skills, life science, physical science, and Earth and space science. Note that these four organizers are for the purposes of identifying prescribed learning outcomes; they are not intended to suggest a linear delivery of course material.

| | Processes and Skills of Science | Life Science | Physical Science | Earth and Space Science |
|---|---|---|---|---|
| **Kindergarten** | • Observing<br>• Communicating (Sharing) | • Exploring the World Using our Senses | | |
| **Grade 1** | • Communicating (Recording)<br>• Classifying | • Needs and Characteristics of Living Things | • Exploring Objects and Materials With Our Senses | • Daily and Seasonal Changes |
| **Grade 2** | • Interpreting Observations<br>• Making Inferences | • Animal Growth and Changes | • Properties of Liquids and Solids<br>• Relative Position and Motion | • Air and Water in the Environment |
| **Grade 3** | • Questioning<br>• Measuring and Reporting | • Plant Growth and Changes | • Invisible Forces<br>• Materials and Structures | • Exploring Soils |
| **Grade 4** | • Interpreting Data<br>• Predicting | • Habitats and Communities | • Sound<br>• Light | • Rocks, Minerals and Erosion |
| **Grade 5** | • Designing Experiments<br>• Fair Testing | • Meeting Basic Needs and Maintaining a Healthy Body | • Properties and Changes of Materials<br>• Forces and Simple Machines | • Weather |
| **Grade 6** | • Controlling Variables<br>• Scientific Problem Solving | • Diversity of Life | • Electricity | • Space<br>• Flight |

| | **Processes and Skills of Science** | **Life Science** | **Physical Science** | **Earth and Space Science** |
|---|---|---|---|---|
| **Grade 7** | • Hypothesizing<br>• Developing Models | • Interactions within Ecosystems | • Mixtures and Solutions<br>• Heat | • Earth's Crust |
| **Grade 8** | • Safety<br>• Scientific method<br>• Representing and interpreting scientific information<br>• Scientific literacy<br>• Ethical behaviour and cooperative skills<br>• Application of scientific principles<br>• Science-related technology | • Cells, Tissues, Organs and Systems | • Optics<br>• Fluids | • Water Systems on Earth |
| **Grade 9** | | • Reproduction | • Atoms and Elements<br>• Electricity | • Space Exploration |
| **Grade 10** | | • Sustainability of Ecosystems | • Chemical Reactions<br>• Motion | • Weather |

## Key-Stage Curriculum Outcomes

**Science, Technology, Society, and the Environment (STSE)**
Students will develop an understanding of the nature of science and technology, ofthe relationships between science and technology, and of the social and environmental contexts of science and technology.

*By the end of grade 3 (STSE/knowledge), students will be expected to*

- investigate objects and events in their immediate environment, and use appropriate language to develop understanding and to communicate results
- demonstrate and describe ways of using materials and tools to help answer science questions and to solve practical problems
- describe how science and technology affect their lives and those of people and other living things in their community
- undertake personal actions to care for the immediate environment and contribute to responsible group decisions

*By the end of grade 6, students will have achieved the outcomes for entry–grade 3 and will also be expected to*

- demonstrate that science and technology use specific processes to investigate the natural and constructed world or to seek solutions to practical problems
- demonstrate that science and technology develop over time
- describe ways that science and technology work together in investigating questions and problems and in meeting specific needs
- describe applications of science and technologythat have developed in response to human and environmental needs
- describe positive and negative effects that result from applications of science and technology in their own lives, the lives of others, and the environment

*By the end of grade 9, students will have achieved the outcomes for entry–grade 6 and will also be expected to*

- describe various processes used in science and technology that enable people to understand natural phenomena and develop technological solutions
- describe the development of science and technology over time
- explain how science and technology interact with and advance one another
- illustrate how the needs of individuals, society, and the environment influence and are influenced by scientific and technological endeavours
- analyse social issues related to the applications and limitations of science and technology, and explain decisions in terms of advantages and disadvantages for sustainability, considering a few perspectives

*By the end of grade 12, students will have achieved the outcomes for entry–grade 9 and will also be expected to*

- describe and explain disciplinary and interdisciplinary processes used to enable us to understand natural phenomena and develop technological solutions
- distinguish between science and technology in terms of their respective goals, products, and values and describe the development of scientific theories and technologies over time
- analyse and explain how science and technology interact with and advance one another
- analyse how individuals, society, and the environment are interdependent with scientific and technological endeavours
- evaluate social issues related to the applications and limitations of science and technology, and explain decisions in terms of advantages and disadvantages for sustainability, considering a variety of perspectives

**Skills**

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

*By the end of grade 3 (STSE/knowledge), students will be expected to*

- ask questions about objects and events in the immediate environment and develop ideas about how those questions might be answered
- observe and explore materials and events in the immediate environment and record the results
- identify patterns and order in objects and events studied
- work with others and share and communicate ideas about their explorations

*By the end of grade 6, students will have achieved the outcomes for entry–grade 3 and will also be expected to*

- ask questions about objects and events in the local environment and develop plans to investigate those questions
- observe and investigate their local environment and record the results
- interpret findings from investigations using appropriate methods
- work collaboratively to carry out science-related activities and communicate ideas, procedures, and results

*By the end of grade 9, students will have achieved the outcomes for entry–grade 6 and will also be expected to*

- ask questions about relationships between and among observable variables and plan investigations to address those questions
- conduct investigations into relationships between and among observations, and gather and record qualitative and quantitative data
- analyse qualitative and quantitative data and develop and assess possible explanations
- work collaboratively on problems and use appropriate language and formats to communicate ideas, procedures, and results

*By the end of grade 12, students will have achieved the outcomes for entry–grade 9 and will also be expected to*

- ask questions about observed relationships and plan investigations of questions, ideas, problems, and issues
- conduct investigations into relationships between and among observable variables, and use a broad range of tools and techniques to gather and record data and information
- analyse data and apply mathematical and conceptual models to develop and assess possible explanations
- work as a member of a team in addressing problems, and apply the skills and conventions of science in communicating information and ideas and in assessing results

## Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

*By the end of grade 3 (STSE/knowledge), students will be expected to*

- For grade 3, STSE and knowledge outcomes are combined in the STSE section.

*By the end of grade 6, students will have achieved the outcomes for entry–grade 3 and will also be expected to*

- describe and compare characteristics and properties of living things, objects, and materials
- describe and predict causes, effects, and patterns related to change in living and non-living things
- describe interactions within natural systems and the elements required to maintain these systems
- describe forces, motion, and energy and relate them to phenomena in their observable environment

*By the end of grade 9, students will have achieved the outcomes for entry–grade 6 and will also be expected to*

Life Science

- explain and compare processes that are responsible for the maintenance of an organism's life
- explain processes responsible for the continuity and diversity of life
- describe interactions and explain dynamic equilibrium within ecological systems

Physical Science

- describe the properties and components of matter and explain interactions between those components
- describe sources and properties of energy, and explain energy transfers and transformations
- recognize that many phenomena are caused by forces and explore various situations involving forces

Earth and Space Science

- explain how Earth provides both a habitat for life and resource for society
- explain patterns of change and their effects on Earth
- describe the nature and components of the solar system

*By the end of grade 12, students will have achieved the outcomes for entry–grade 9 and will also be expected to*

Life Science

- compare and contrast the reproduction and development of representative organisms
- determine how cells use matter and energy to maintain organization necessary for life
- demonstrate an understanding of the structure and function of genetic material
- analyse the patterns and products of evolution
- compare and contrast mechanisms used by organisms to maintain homeostasis
- evaluate relationships that affect the biodiversity and sustainability of life within the biosphere

Chemistry

- identify and explain the diversity of organic compounds and their implications in the environment
- demonstrate an understanding of the characteristics and interactions of acids and bases
- illustrate and explain the various forces that hold structures together at the molecular level, and relate the properties of matter to its structure
- use the redox theory in a variety of contexts related to electrochemistry
- demonstrate an understanding of solutions and stoichiometry in a variety of contexts
- predict and explain energy transfers in chemical reactions

Physics

- analyse and describe relationships between force and motion
- analyse interactions within systems, using the laws of conservation of energy and momentum
- predict and explain interactions between waves and with matter, using the characteristics of waves
- explain the fundamental forces of nature, using the characteristics of gravitational, electric, and magnetic fields
- analyse and describe different means of energy transmission and transformation

Earth and Space Science

- demonstrate an understanding of the nature and diversity of energy sources and matter in the universe
- describe and predict the nature and effects of changes to terrestrial systems
- demonstrate an understanding of the relationships among systems responsible for changes to the Earth's surface
- describe the nature of space and its components and the history of the observation of space

## Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

*By the end of grade 3 (STSE/knowledge), students will be expected to*

- recognise the role and contribution of science in their understanding of the world
- show interest in and curiosity about objects and events within the immediate environment
- willingly observe, question, and explore
- consider their observations and their own ideas when drawing a conclusion
- appreciate the importance of accuracy
- be open-minded in their explorations
- work with others in exploring and investigating
- be sensitive to the needs of other people, other living things, and the local environment
- show concern for their own safety and that of others in carrying out activities and using materials

*By the end of grade 6, students will have achieved the outcomes for entry–grade 3 and will also be expected to*

- appreciate the role and contribution of science and technology in their understanding of the world
- realize that the applications of science and technology can have both intended and unintended effects
- recognize that women and men of any cultural background can contribute equally to science
- show interest and curiosity about objects and events within different environments
- willingly observe, question, explore, and investigate
- show interest in the activities of individuals working in scientific and technological fields
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions
- appreciate the importance of accuracy and honesty
- demonstrate perseverance and a desire to understand
- work collaboratively while exploring and investigating
- be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment
- show concern for their own safety and that of others in planning and carrying out activities and in choosing and using materials
- become aware of potential dangers

*By the end of grade 9, students will have achieved the outcomes for entry–grade 6 and will also be expected to*

- value accuracy, precision, and honesty
- persist in seeking answers to difficult questions and solutions to difficult problems
- work collaboratively in carrying out investigations as well as in generating and evaluating ideas
- be sensitive and responsible in maintaining abalance between the needs of humans and a sustainable environment
- project, beyond the personal, consequences of proposed actions
- show concern for safety in planning, carrying out, and reviewing activities
- become aware of the consequences of their actionsappreciate the role and contribution of science and technology in our understanding of the world
- appreciate that the applications of science and technology can have advantages and disadvantages
- appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds
- show accontinuing curiosity and interest in a broad scope of science-related fields and issues
- confidently pursue further investigations and readings
- consider many career possibilities in science- and technology-related fields
- consider observations and ideas from a variety of sources during investigations and before drawing conclusions

*By the end of grade 12, students will have achieved the outcomes for entry–grade 9 and will also be expected to*

- value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not
- appreciate that the applications of science and technology can raise ethical dilemmas
- value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds
- show a continuing and more informed curiosity and interest in science and science-related issues
- acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research
- consider further studies and careers in science and technology-related fields
- confidently evaluate evidence and consider alternative perspectives, ideas, and explanations
- use factual information and rational explanations when analysing and evaluating
- value the processes for drawing conclusions
- work collaboratively in planning and carrying out investigations, as well as generating and evaluating ideas
- have a sense of personal and shared responsibility for maintaining a sustainable environment
- project the personal, social, and environmental consequences of a proposed action
- want to take action for maintaining a sustainable environment
- show concern for safety and accept the need for rules and regulations
- be aware of the direct and indirect consequences of their actions

## Achievement Indicators

Achievement indicators help to define the breadth and depth of the SCO and are representative of what teachers may observe in the classroom. Achievement indicators, taken together as a set, define the specific level of attitudes demonstrated, skills applied, or knowledge acquired by the student in relation to the corresponding learning outcome. Indicators are examples of ways that students might be asked to demonstrate achievement of an outcome. The set of indicators is not a mandatory checklist, prioritized list of instructional activities, or prescribed assessment items. When teachers are planning for instruction, they must be aware of the set of indicators to understand the breadth and depth of the outcome. Based on their resulting understanding of the outcome, teachers may add to the existing indicators to support the intent of the outcome and to be responsive to their students' interests, lives, and prior learning. It is important to note that, if additional indicators are developed or if given indicators are substituted with alternate indicators, they must be reflective of and consistent with the breadth and depth that is defined by the given indicators. Teachers determine which indicators are most relevant at a particular time (e.g., developmental stage, time of the year, relevant circumstance) by analysing the needs and interests of the student – what s/he already knows, understands, and is able to do. Indicators help to identify the level and types of knowledge intended by the outcome. Lists of achievement indicators will begin with the phrase, "Students who have achieved this outcome should be able to…"

The complete set of indicators is an example of how students might be asked to demonstrate achievement of an outcome. The set of indicators provided for an outcome:

- provides the intent (depth and breadth) of the outcome
- tells the story, or creates a picture, of the outcome
- defines the level and types of knowledge intended by the outcome
- is not a checklist or prioritized list of instructional activities or prescribed assessment item

## Blooms Taxonomy

Prince Edward Island specific curriculum outcomes require that students develop a combination of factual, conceptual, procedural, and metacognitive knowledge. Bloom's influential learning taxonomy of knowledge and cognitive process dimensions has been revised and expanded since it was first developed in 1956. The most recent revision process involved some of Bloom's former colleagues and representatives of three groups including "cognitive psychologists, curriculum theorists and instructional researchers, and testing and assessment specialists" (Anderson & Krathwohl, 2001, p. xxviii). The revised taxonomy recognizes the different types of knowledge (the knowledge dimension) and the processes that students use as they learn (the cognitive process dimension).

| **The Cognitive Dimension** | **The Knowledge Dimension** | | | |
|---|---|---|---|---|
| | **Factual Knowledge** | **Conceptual** | **Procedural** | **Metacognitive** |
| **Remembering** | | | | |
| **Understanding** | | | | |
| **Applying** | | | | |
| **Analysing** | | | | |
| **Evaluating** | | | | |
| **Creating** | | | | |

As Wiggins and McTighe (2005) observe in Understanding by Design,"… in the best designs, form follows function. In other words, all the methods and materials we use are shaped by a clear conception of the vision of desired results" (p. 14). The vision or visualization of the desired results (e.g., outcomes) is a key to developing a deep understanding of the intent of each outcome. For example, when writing an outcome, it is important to determine the type of knowledge required by the outcome (e.g., factual, conceptual, procedural, metacognitive, or a combination).

As teachers reflect deeply and collaborate with each other to identify the types of knowledge required by the outcomes, they will be better able to visualize what the achievement of each outcome will look, sound, and feel like in the classroom. Clear visualization of the desired results (e.g., evidence of achievement of outcomes) assists teachers in planning learning experiences that engage students in higher level thinking and learning.

When determining the intent of curriculum outcomes and indicators, teachers need to look at the nouns to determine what is being learned, and the verbs to determine the cognitive process dimension. Note that some verbs fit into more than on dimension of the cognitive process. Several educational researches provide examples of verbs related to each cognitive process dimension.

## Table of Specifications

| Units | Level 1 | Level 2 | Level 3 | % of Curriculum |
|---|---|---|---|---|
| Water Systems | | ESS1 | ESS2, ESS3 | 25% |
| Fluids | PS2, PS4 | | PS1, PS3 | 25% |
| Optics | PS5, PS7 | PS6 | | 25% |
| Cells, Tissues, Organs, and Systems | LS1 | LS2, LS3 | | 25% |
| | 38% | 31% | 31% | 100% |

# Principles of Teaching and Learning Science

The central goal of science education is scientific literacy. All activities that fall under the umbrella of instruction (teaching and learning) should therefore be aimed at that central goal. An effective approach to science education places the instruction in the context of a contemporary societal or environmental situation, question, or problem. The desire to investigate the situation, answer the question, or solve the problem creates in the students a meaningful context in which to address the skills, concepts, and understandings of the course.

## Explanations, Evidence, and Models in Science

Science is a way of understanding the natural world using 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 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. Scientists spend considerable time and effort building and testing models to further understanding of the natural world.

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.

## Investigative Activities

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.

While investigative activities are not unique to science, they are more commonly associated with science programs than with any other area of the curriculum. Investigative activities include a variety of activities ranging from the traditional experiment done in a science laboratory to a quick field trip to the school yard. All such activities are characterized by active student involvement in attempting to find answers to questions about the natural or constructed world. Many activities involve the use of scientific and technological tools and equipment; others simply involve observation using the senses.

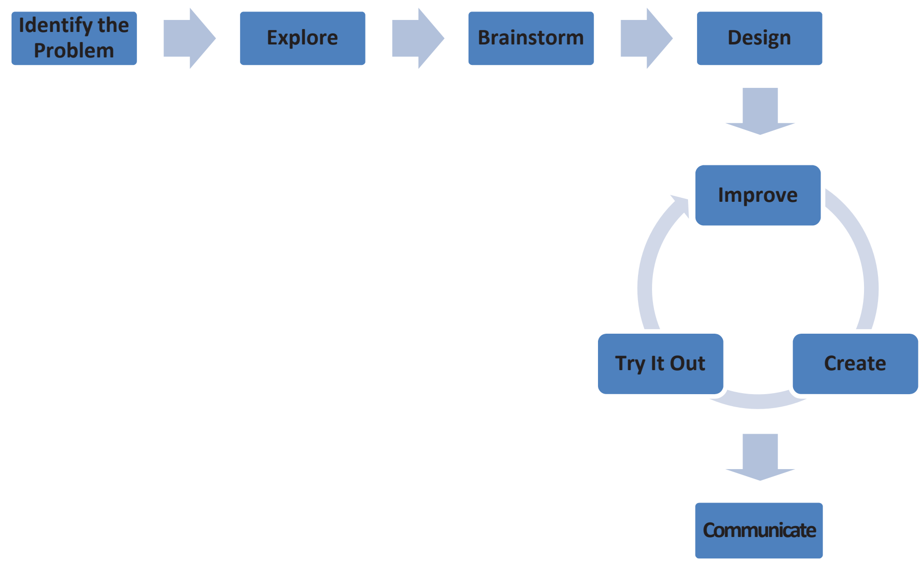
A strong science program includes a variety of individual, small, and large group classroom and field experiences for students. Most importantly, these experience needs to go beyond conducting confirmatory "cook-book" experiments. Similarly, computer simulations and teacher demonstrations are valuable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

Assessment and evaluation of student performance must reflect the nature of the 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.

The investigation is a special instructional format that provides students with the opportunity to do science, not just learn science. Without activities of this sort it is extremely difficult, if not impossible, for students to develop an understanding of the nature of science, to develop the cognitive, scientific, and technical skills associated with doing science, or to construct the important ideas of science.

## Design Process

The design process is a problem solving strategy used to develop possible solutions to solve a problem. The goal for students is to define problems, specifying criteria and constraints for solutions, as well as anticipating potential impacts on society and the environment. Upon careful exploration and research, students brainstorm possible solutions to the problem. Students will next design and create their model/prototypes. After, they will test out their designs, analyse the results, modify their designs accordingly, and then re-test and modify their designs again. Students may go through this cycle numerous times before reaching the optimal result. Students should communicate their results, regardless of the form, such as a poster, drawing, prototype, presentation, or report.




1) Identify the Problem: Describe the challenge to be solved, including limits and constraints.
2) Explore: Do background research to collect information. What have others done? Visit the library. Use computer databases. Ask questions.
3) Brainstorm: What are some solutions?
4) Design: Use your knowledge and creativity to come up with many solutions. Choose one idea and draw or make a model of it.
5) Create: Make your solution. Construct your prototype.
6) Try It Out: Test your solution.
7) Improve: Evaluate how the solution worked and think of how to modify or improve your design to make it better.
8) Communicate: Share your results. This may be presented in many forms, such as a poster, drawing, prototype, presentation, or report.

Reference:

Next Generation Science Standards, June, 2013. http://www.nextgenscience.org/sites/ngss/files/MS%20ETS%20topics%20combined%20 6.12.13.pdf

## Project Based Learning

Project Based Learning (PBL) is a teaching and learning methodology in which students engage in a rigorous, extended process of inquiry focused on complex, authentic questions and problems as they achieve the knowledge, skills, and attitudes defined by the curriculum outcomes. A set of learning experiences and tasks guide students in inquiry toward answering a central question, solving a problem or meeting a challenge, as opposed to several activities tied together under a theme, concept, time period, culture, or geographic area (e.g. the Renaissance, the ocean, WWII, Canada). Throughout the project, students work as independently from the teacher as possible, and have some degree of "voice and choice".

PBL is unlike traditional projects in the sense that it is informed by the curriculum and *drives* the instruction and learning, as opposed to involving students in a "fun activity" or "making something". It is often focused on creating physical artifacts but must involve other intellectually challenging tasks and products focused on research, reading, writing, discussion, investigation, and oral presentation. Through PBL, students can develop and demonstrate in-depth understanding of academic knowledge and skills while enhancing habits of mind, along with collaboration, critical thinking, and communication skills. PBLs can be interdisciplinary in nature and allow for curriculum integration from different subject areas within one project. This learning experience ends with a high-quality product or performance created by the student(s) and presented to a public audience.

Two important components of PBL are the creation of a driving question and the collaboration with a Subject Matter Expert (SME).

**The Driving Question**

A well-crafted *driving question* is essential to all effective PBLs. It is this question that will form the basis of explicit links with the curriculum, create the focus of the project for the students, and encourage their process of inquiry and investigation. All driving questions should be provocative, challenging, open-ended, and complex and must be linked to the core of what students are to learn as determined by the provincially authorized curriculum. Sample driving questions might include:

- Who are the heroes of our community?
- When is war justified?
- What effect does population growth have on our society?
- Is watching TV beneficial or harmful to teenagers?
- How can we create a piece of media to demonstrate diversity in our school?

Students may work in collaborative teams or individually to investigate, research, and refine knowledge and skills to adequately answer the driving question. Because the driving question is open-ended, students are able to reach a variety of potential conclusions in countless ways, while still building in-depth knowledge and skills. This creates the independent nature of the project and also the feeling of "voice and choice" for the students. The teacher then assumes more of a facilitator/coach role, assisting and guiding during an investigation and providing direct instruction when necessary.

**Subject Matter Expert (SME)**
A well crafted PBL also includes the role of a *Subject Matter Expert*, or *SME*. These individuals/groups play a key role in PBL as they bring first-hand authentic knowledge and experience from the specific content field to the classroom. They may be sought out by the student(s) during their investigation or prearranged by the teacher depending on the project. These experts provide additional support and information to the students related to the topics and help demonstrate to the students that the work they are completing is authentic and "real-world". The involvement of these experts allows educators to expand the classroom walls and make strong connections and links with surrounding communities.

At the conclusion of the PBL, students are required to present their findings to a public audience. Their peers in the classroom may act as the dress rehearsal for this presentation and provide valuable feedback to refine the presentation. However, in order to "raise the stakes" for the students' final presentation, students should present their findings to members of the community, experts in the field (including the involved SME), parents, or school administration in addition to presenting to their classroom peers.

Adapted from *PBL Starter Kit*, (2009) The Buck Institute for Education. (www.bie.org)

## Resources

One of the characteristics of the science curriculum that will help all students become scientifically literate is that it should utilize a wide variety of print and non-print resources that have been developed in an interesting and interactive style. Teachers should consider the following in the selection of resources:
- the use of hands-on activities is an essential learning strategy in all science programs
- even with the advent of new media, print materials remain a dominant type of resource for science teaching and learning
- computer software and online resources can offer simulations and models of real-life situations that permit the investigation of phenomena that are not available because of cost, safety, or accessibility
- resources used in all activities should be appropriate to the grade level

## Education for Sustainable Development

Education for sustainable development (ESD) involves incorporating the key themes of sustainable development–such as poverty alleviation, human rights, health, environmental protection, and climate change–into the education system. ESD is a complex and evolving concept and requires learning about these key themes from a social, cultural, environmental, and economic perspective, and exploring how those factors are interrelated and interdependent.

With this in mind, it is important that all teachers, including CTE teachers, attempt to incorporate these key themes in their subject areas. One tool that can be used is the searchable on-line database *Resources for Rethinking*, found at [**http://r4r.ca/en**]. It provides teachers with access to materials that integrate ecological, social, and economic spheres through active, relevant, interdisciplinary learning.

## Technology

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. 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. Technology should enhance, but not replace, essential hands-on science activities.

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

**Data Collection and Analysis**

- Data loggers (e.g., temperature probes, motion detectors) permit students to collect and analyze data in real-time.
- 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.
- 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**

- Students can use word-processing and presentation tools to share the results of their investigations with others.
- The Internet can be a means of networking with scientists, teachers, and other students by gathering information and data, posting data and findings, and comparing results with students in different locations.

## Safety

Safety in the classroom is of paramount importance. 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 teacher's rules or school regulations. 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. Teachers must also follow the guidelines outlined in the Prince Edward Island *Science Safety Resource Manual*. 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 personal safety knowledge and certifications
- Be aware of national, provincial, 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
- Creat safety checklists for in-class activities and field studies

**Prevent**
- Assess and mitigate hazards
- Review procedures for accident provention 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 styudents and visitors use appropriate protective devices

## Science and Literacy

Aside from developing students' scientific literacy, the outcomes undertaken by students in the science curriculum build on, reinforce, and enhance certain aspects of the language arts and mathematics curricula. Fostering students' communication skills is an important part of the teachers' role in the science classroom. Students need to be able to use oral communication, reading, writing, and media literacy skills to gain new learning in science and to communicate their understanding of what they have learned.

Students' understanding is revealed through both oral and written communication. Writing in science employs special forms and therefore requires specific and direct learning opportunities, but it is not necessary for all science learning to involve a written communication component. To develop their oral communication skills, students need numerous opportunities to listen to information and talk about a range of subjects in science and technology. When reading science texts, students use a different set of skills than they do when reading fiction. They need to understand vocabulary and terminology that are unique to science, and must be able to interpret symbols, charts, and diagrams. To help students construct meaning, it is essential that science teachers model and teach the strategies that support learning to read, write, and communicate in this subject area.

The Department of Education and Early Childhood Development has materials to support literacy instruction across the curriculum. Helpful advice for integrating literacy instruction in science and technology may be found in the document *Cross-Curriculuar Reading Tools.*

# Assessment

## Introduction

This section contains information about student assessment, measurement of student achievement, and evaluation.

*Assessment* techniques are used to gather information for evaluation.
Information gathered through assessment helps teachers determine students' strengths and needs in their achievement of the curriculum outcomes, and guides future instructional approaches. Practices should accept the needs of diverse learners in classrooms and should accept and appreciate learners' linguistic and cultural diversity.

Teachers are encouraged to be flexible in assessing the learning success of all students, and to seek diverse ways in which students might demonstrate what they know and are able to do. Assessment criteria and the methods of demonstrating learning successes may vary from student to student depending on their strengths, interests, and learning styles.

*Evaluation* involves the weighing of the assessment information against a standard in order to make an evaluation or judgment about student achievement. Assessment informs the evaluation process.

## Assessment

Assessment should provide students with a variety of ways to demonstrate what they know and are able to do with many different types of text over time. It is the journey of their learning. Teachers collect, interpret, and synthesize information from a variety of student learning activities to gather information about student progress in relation to the achievement of learning outcomes.

Students must recognize each learning activity as worthwhile and relevant, and understand the expectations for each. Information provided through assessment activities allows teachers to give descriptive feedback to students to support and monitor future learning, and allows for necessary adjustments to instruction. Assessment feedback can also be incorporated through peer-and self-assessment activities.

## Purposes of Assessment

According to research, assessment has three interrelated purposes:

- assessment *for* learning to guide and inform instruction
- assessment *as* learning to involve students in self-assessment and setting of goals for their own learning
- assessment *of* learning to make judgments about student performance in relation to curriculum outcomes

Other research indicates that assessment *as* learning should be viewed as part of assessment *for* learning, because both processes enhance future student learning. In all circumstances, teachers must clarify the purpose of assessment and then select the method that best serves the purpose in the particular context.

The interpretation and use of information gathered for its intended purpose is the most important part of assessment. Even though each of the three purposes of assessment (*for, as, of*) requires a different role for teachers, and different planning, the information gathered through any one purpose is beneficial and contributes to an overall picture of an individual student's achievement.

## Assessment *for* Learning

Assessment *for* learning involves frequent interactive assessments designed to make student understanding visible so as to enable teachers to identify learning needs and adjust teaching accordingly. It is teacher-driven, and involves an ongoing process of learning and teaching.

- integrates strategies with instructional planning;
- requires the collection of data from a range of assessments to find out as much as possible about what students know and can do, and in order to plan for future instruction, to learn what student needs still must be addressed;
- uses curriculum outcomes as reference points, along with exemplars and achievement standards that differentiate quality;
- provides descriptive, specific, and instructive feedback to students and parents regarding the next stage of learning;
- actively engages students in their own learning as they assess themselves and understand how to improve performance;
- allows for judgments about students' progress for reporting purposes;
- provides information on student performance that can be shared with parents/guardians, school and district staff, and
- other educational professionals for the purposes of curriculum development.

This type of assessment provides ways to engage and encourage students to acquire the skills of thoughtful self-assessment and to promote their own achievement. Student achievement is compared to established criteria rather than to the performance of other students.

## Assessment *as* Learning

Assessment *as* learning actively involves students' reflection on their learning, and monitoring of their own progress. Student-driven, and supported with teacher guidance, it focuses on the role of the student as the critical connector between assessment and learning— thereby developing and supporting metacognition in students.

Assessment *as* learning is ongoing and varied in the classroom.  This assessment

- integrates strategies with instructional planning;
- focuses on students as they monitor what they are learning and use what they discover to make adjustments, adaptations, or changes in their thinking so as to achieve deeper understanding;
- supports students in critically analysing their learning as it relates to learning outcomes;
- prompts students to consider how they can continue to improve their learning;
- enables students to use collected information to make adaptations to their learning processes and to develop new understandings.

The goal in assessment *as* learning is for students, with teacher support and guidance, to acquire the skills needed to be metacognitively aware of their increasing independence as they take responsibility for learning and constructing meaning.  Through self-assessment, students think about what they have learned and what they have not yet learned, and decide how to best improve their achievement.

## Assessment *of* Learning

Assessment *of* learning involves strategies designed to confirm what students know, demonstrate whether or not they have met curriculum outcomes or the goals of their individual learning plans, or certify proficiency and make decisions about students' future learning needs. Assessment *of* learning occurs at the end of a learning experience that contributes directly to reported results.

Traditionally, teachers relied on this type of assessment to make judgments about student performance by measuring learning after the fact and then reporting it to others.  However, used in conjunction with assessment *for* and assessment *as* learning (previously outlined), assessment *of* learning is strengthened.

Assessment *of* learning

- confirms what students know and can do;
- occurs at the end of a learning experience, using a variety of tools;
- provides opportunities to report to parents/guardians, school and district staff, and other educational professionals evidence to date of student achievement relative to learning outcomes, for the purpose of curriculum development;

- may be either criterion-referenced (based on specific curriculum outcomes) or norm-referenced (comparing student achievement to that of others);
- provides a foundation for discussions on student placement or promotion.

Because the consequences of assessment *of* learning are often far-reaching and affect students seriously, teachers have the responsibility to report student learning accurately and fairly, based on evidence obtained from a variety of contexts and applications.

## Designing Effective Assessment

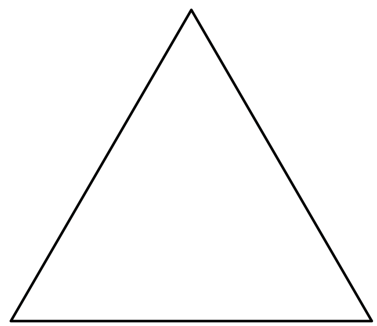
Effective assessment improves the quality of learning and teaching. It can help teachers to monitor and focus their instruction, and help students to become self-reflective and to feel in control of their own learning. When students are given opportunities to demonstrate what they know and what they can do with what they already know, optimal performance can be realized.

Teachers must collect evidence of student learning through a variety of methods. Valuable information about students can be gained through conversations, observations, and products. A balance among these three sources ensures reliable and valid assessment of student learning.

- Conversations may either be informal or structured in the form of a conference, and can provide insight into student learning that might not be apparent through observation or from products. Student journals and reflections provide a written form of conversation with the teacher.
- Observing a student while he/she is engaged in a learning activity allows a teacher insight into this process at various points throughout the activity. Observation is effective in assessing achievement of many of the speaking and listening outcomes.
- Products are work samples completed by a student. Samples can be in the form of written texts, or visual or oral products.

**Effective assessment strategies**

- are explicit and are communicated to students and parents at the beginning of the school term (and at other appropriate points throughout the school year) so that students know expectations and criteria to be used to determine the level of achievement;
- must be valid in that they measure what they intend to measure;
- must be reliable in that they consistently achieve the same results when used again, or similar results with a similar group of students;
- involve students in the co-construction, interpretation, and reporting of assessment by incorporating their interests (students can select texts or investigate issues of personal interest);
- reflect where the students are in terms of learning a process or strategy, and help to determine what kind of support or instruction will follow;




- allow for relevant, descriptive, and supportive feedback that gives students clear directions for improvement;
- engage students in metacognitive self-assessment and goal setting that can increase their success as learners;
- are fair in terms of the students' background or circumstances and provide all students with the opportunity to demonstrate the extent and depth of their learning;
- accommodate the diverse needs of students with exceptionalities, including students with individual learning plans;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- are transparent, pre-planned, and integrated with instruction as a component of the curriculum;
- are appropriate for the learning activities used, the purposes of instruction, and the needs and experiences of the students;
- are comprehensive and enable all students to have diverse and multiple opportunities to demonstrate their learning consistently, independently, and in a range of contexts in everyday instruction;
- include samples of students' work that provide evidence of their achievement;
- are varied in nature, administered over a period of time, and designed to provide opportunities for students to demonstrate the full range of their learning.

# Grade 8 Science Specific Curriculum Outcomes

| **Earth and Space Science - Water Systems on Earth** (September - Mid November) | 25% |
|---|---|
| ESS1 Analyse the global distribution of water and its impacts on local environments. | |
| ESS2 Use the design process to demonstrate how water movement shapes our landscape. | |
| ESS3 Critique human impact on water systems in the environment. | |

| **Physical Science - Fluids** (February - Mid April) | 25% |
|---|---|
| PS1 Design an investigation to demonstrate an understanding of fluid viscosity. | |
| PS2 Compare the density of various substances qualitatively and quantatively. | |
| PS3 Create a prototype of an object that floats to analyse the effects of forces on objects in fluids. | |
| PS4 Explain how the transfer of fluids is used to apply a force or to control a motion in technological devices and in the natural world. | |

| **Physical Science - Optics** (Mid November - January) | 25% |
|---|---|
| PS5 Examine the properties and behaviour of visible light. | |
| PS6 Analyse different types of electromagnetic radiation and its impact on their daily lives. | |
| PS7 Explain how human vision works, including ways of correcting or extending human vision. | |

| **Life Science - Cells, Tissues, Organs and Systems** (Mid April - June) | 25% |
|---|---|
| LS1 Identify and describe the structure and functions of cells within living things. | |
| LS2 Analyse the relationship and interdependence among cells, tissues, organs, and organ systems. | |
| LS3 Demonstrate an understanding of factors that affect the healthy functioning of the human body. | |

# Science 8SCIA

## Water Systems on Earth

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**ESS1 Analyse the global distribution of water and its impact on local environments.** |

| 7SCIA | 8SCIA | SCI421A |
|---|---|---|
| Interactions within Ecosystems<br>Students explain how different parts of an ecosystem interact and affect each other. | **ESS1 Analyse the global distribution of water and its impact on local environments.** | Sustainability of Ecosystems<br>Students analyse the impact of external factors on an ecosystem. |

### Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Describe how water circulates between the land, the ocean, and the atmosphere (water cycle).
- Identify how water is used on PEI (e.g., domestic, industrial, agricultural, fisheries, recreational).
- Identify factors that affect glaciers and polar icecaps, and describe their consequent effects on the environment.
- Interpret graphical information on the availability of drinking water.
- Compare and contrast the characteristics of salt and fresh water (e.g., density, freezing point).
- Research water availability in different regions around the world, and explain how it impacts the local environment, economy, and culture.
- Propose a plan of action to reduce personal water consumption to help address water sustainability issues.

## Elaboration

**Focus question**: Where does water come from?

To begin this unit, teachers should use graphics or an interactive activity to demonstrate the water distribution on Earth. The purpose of this activity is to highlight the ratio of available fresh water to the Earth's total water supply. Teachers should then describe, in general terms, the distribution of drinking water in Prince Edward Island (groundwater), Canada (abundance of freshwater), and the world (areas of abundance and scarcity). Teachers could have students engage in a think-pair-share in which they explain how water availability could affect a particular region's (e.g., Ethiopia, P.E.I., Mexico City) environment, economy, and culture.

Teachers should also review the water cycle to ensure that students can identify the various components of the cycle, and understand how freshwater is cycled between the land, the ocean, and the atmosphere. Note that the interactions of the components are much more complex than indicated in a diagram of the water cycle.

A qualitative comparison of salt water to fresh water could lead to a discussion on the effects of glaciers and polar ice caps melting into the oceans (e.g., sea level rise, changes in ocean currents). Students should be encouraged to identify new questions that arise from their study of salt and fresh water, glaciers, and polar ice caps.

**Literacy connection** (**RAFT Writing**): RAFT writing is an after reading strategy in which students project themselves into unique roles and look at content from various perspectives. This type of writing shold be creative and informative.

R - Role (Role of the writer [experienced water drop])
A - Audience (to whom or what the RAFT is being written [new water drop])
F - Format (the form the writing will take - letter, song, poem, newspaper article, etc. [travel guide])
T - Topic (the subject focus of the writing [journey through the water cycle])

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**ESS2 Use the design process to demonstrate how water movement shapes our landscape.** |

| 7SCIA | 8SCIA | SCI421A |
|---|---|---|
| Earth's Crust<br>Students explain how the Earth's crust undergoes gradual and sudden changes over time. | **ESS2 Use the design process to demonstrate how water movement shapes our landscape.** | Weather Dynamics<br>Students describe and explain heat transfer effects on water currents and weather systems. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Explain how waves and tides are generated and how they interact with shorelines.
- Describe how ocean currents can impact regional climates (e.g., Gulf Stream moderating effects, Labrador Current).
- Research the processes of erosion and deposition that result from wave action and water flow, and describe their impact on PEI.
- Collaborate to plan and conduct a simulation that demonstrates how temperature differences cause water currents.
- Critique the design and function of technologies designed to minimize damage caused by waves and tides (e.g., piers, breakwaters, levees).
- Design, construct, evaluate, and present a prototype of a device or system to prevent erosion caused by water.

## Elaboration

**Focus question**: How do water systems, climate, and landscape affect each other?

To establish a context for the topic, students may be asked if they have ever seen or experienced exceptional events involving waves, currents, or tides. Pictures or videos of extraordinary local events could be viewed. Students should collaborate to create a set of procedures that will permit them to simulate and experience the formation of water currents. Students can investigate wave structure by generating waves in a basin, sink or large baking pan. Tides should be described as the gravitational forces among the Earth, the Moon, and the Sun.

Students should investigate the relationship between waves and shoreline formation. Pictures, videos, or a class trip to a variety of shorelines can stimulate student observations and inferences on how and why shoreline features are similar or different. Students should have opportunities to investigate and critique technological attempts to prevent or reduce damage to coastal areas due to wave action and tides.

The high heat capacity of water allows oceans to store and transport large amounts of heat. Students should understand how ocean temperatures can noticeably affect the climate of coastal areas such as Prince Edward Island. Teachers could have students study El Nino and La Nina as examples of global weather phenomena related to ocean currents.

**Literacy connection** (**Cause-and-Fffect Text Pattern**): Science text is often written in a cause-effect order. It explains events that have occurred (cause) and what happens as a result of these events (effect). As they read this section, students should consider the cause of water movements and their effects on the landscape and climate.

# Science

8SCIA

Water Systems on Earth

| Learning Contexts | |
|---|---|
| | Scientific Inquiry |
| | Technological Problem Solving |
| ✓ | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**ESS3 Critique human impact on water systems in the environment.** |

| 7SCIA | 8SCIA | SCI421A |
|---|---|---|
| Interactions within Ecosystems<br>Students investigate how human activities impact local ecosystems. | **ESS3 Critique human impact on water systems in the environment.** | Sustainability of Ecosystems<br>Students propose a course of action on social issues taking into account human and environmental needs. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Describe factors that affect productivity and species distribution in marine and freshwater environments (e.g., temperature, nutrients, pollutants, salinity, turbidity).
- Provide examples of problems related to water systems that cannot be resolved using scientific and technological knowledge alone (e.g., pollution, overfishing, freshwater scarcity).
- Provide examples of how individuals and institutions contribute to the sustainability of water systems.
- Apply the concept of systems to show how changes in one component of a body of water cause changes in other components in that system.

## Elaboration

**Focus question**: How do human activities affect the bodies of water on Earth?

The abiotic factors that create ocean currents and influence environments also have an impact on types of organisms that inhabit our waters. Students can investigate how the above factors, as well as salinity and ocean currents, affect productivity and species distribution in marine and freshwater environments.

Teachers should also incorporate a discussion of sustainable development into this topic. Students can use the context of the Confederation Bridge to examine and discuss what impacts human technologies (other examples include oil rigs, hydroelectric dams, factory trawlers) have on ocean and freshwater environments and the fisheries. Students should identify and explore problems related to water systems that are not always resolved using science and technology.

Problems and issues that are often encountered and debated, such as which types of fisheries we should sustain and what effect development has on the environment (for example, oil/gas drilling, industrial pollution, the effect of icecap melting on ocean currents), may help to illustrate that decisions and actions by groups are not always completely based on scientific or technological knowledge. Students should develop an understanding that environmental risks are often balanced by economical and societal needs. A class debate of these topics could help build students' critical thinking skills and promote education for sustainable development.

**Literacy connection** (**Critical Literacy**): As they read text samples of human impact on water systems, ask students if the information is objective or identifies a bias. What factors need to be considered? Students should use critical literacy skills when researching a major issue regarding human impact on water systems. Students could write a position paper or formal letter.

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS1 Design an investigation to demonstrate an understanding of fluid viscosity.** |

| 7SCIA | 8SCIA | |
|---|---|---|
| Heat<br>Students use observation and experimentation to describe the effect of heat on different forms of matter. | **PS1 Design an investigation to demonstrate an understanding of fluid viscosity.** | |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Use scientific equipment safely, effectively, and accurately for collecting and analysing data in viscosity investigations.
- Explain, using the particle theory of matter, which factors can affect viscosity (e.g., temperature, concentration, particle size, and attractive forces).
- Relate how the properties of viscosity apply to daily life.
- Conduct a fair test to identify which factors can modify the viscosity of a liquid.
- Conduct an experiment to compare the viscosity of various fluids and identify the major variables.

## Elaboration

**Focus question**: How does a fluid's viscosity affect its flow rate?

Teachers should ask students to provide examples of fluids in everyday life (teachers may have to provide examples of gases as fluids). This could be done through a brainstorm and categorize activity. A brief review of the particle theory of matter, states of matter, and changes of state may also be appropriate.

Students should be challenged to design a method for testing the viscosity of several liquids and identifying the major variables in the test. The investigation should be extended to identify how temperature or concentration can modify the viscosity of the liquids. Some types of viscous liquids that can be discussed and investigated may include molasses, corn syrup, vinegar, dishwashing liquid, shampoo, water, pop, and cooking oil.

Providing opportunities for hands-on experiences that demonstrate the viscosities of a variety of liquids gives the students concrete learning experiences upon which other concepts related to viscosity, such as the particle theory of matter, can be addressed. It also helps students connect the properties of viscosity to everyday applications (e.g., motor oil labels, cooking, lava flowing from a volcano).

**Literacy connection** (**Asking Questions**): Questions asked early give the reader a purpose for reading. Asking questions and searching for answers ensure that we are monitoring comprehension and interacting with the text to construct meaning. Good questions spring from background knowledge. When students generate their own questions, not only do they remember the information better, they are more interested in reading. The "Say Something" strategy helps students attend to their reading. This strategy interrupts a student's reading, giving him or her a chance to think about what is being read.  Students get into small groups and take turns reading aloud. As they read, they occassionally pause to "say something" about what was read. They make a prediction, ask a question, clarify confusion, comment on what is happening next, or connect what is in the text to something they know. The reading partners offer a response to what was said, then a different student continues the reading until the next time they pause to say something.

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS2 Compare the density of various substances qualitatively and quantatively.** |

| 7SCIA | 8SCIA | |
|---|---|---|
| Mixtures and Solutions<br>Students explore the particle theory of matter as it relates to states of matter. | **PS2 Compare the density of various substances qualitatively and quantatively.** | |

### Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Explain the difference among mass, volume, and density.
  Calculate the density of various substances.
- Explain, using the particle theory of matter, differences in the density of solids, liquids, and gases.
- Collaborate to design an experiment, and identify major variables, in order to investigate floating, sinking, and density.
- Describe practical applications that have developed over time that are based on differing densities (e.g., hot-air balloons, wooden boats, Galileo thermometer, oil/water separators).
- Predict how temperature will affect the density of a substance.
- Conduct an experiment using the water displacement method to determine the density of various regular and irregular shaped objects.

## Elaboration

**Focus question**: How do the properties of fluids affect fluid behaviour?

A KWL chart (what I **K**now, what I **W**ant to know, and what I have **L**earned) could be used by students prior to investigating floating, sinking, and density to activate prior knowledge, form questions, and summarize key information. Students should be given the opportunity to come up with a working definition of density by predicting whether a variety of similarly sized objects will sink or float in water and then test their predictions. This experience will help gain an understanding of relationships among mass, volume, and density. Students should have the opportunity to mathematically determine the density of regularly shaped objects and experimentally determine the density of irregularly shaped objects (using an overflow can).

Students can also do a variety of activities to experience and describe the effect that temperature change has on the volume and density of an object. These experiments should develop the concept that density is a property of matter and can be explained using the particle theory of matter. Note that water is one of the few substances that is less dense in its solid state than its liquid state (due to its molecular structure). Therefore, avoid using water as an example when explaining density through the particle theory of matter.

Students should discuss everyday applications dealing with density and how these applications have evolved over time.

**Literacy connection** (**Making Predictions**): P.O.E. (Predict/Observe/Explain) is a strategy that works best with demonstrations that allow for immediate observations. Students write their prediction of what will happen regarding what they think they will see and why they think this. Carry out the demonstration. Students then write down their observation and then add to or edit their explanation to take into account their observations. After all students have noted their observations, then they should discuss them as a group.

# Science
*8SCIA*

*Fluids*

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| ✓ | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS3 Create a prototype of an object that floats to analyse the effects of forces on objects in fluids.** |

| 5SCIA | 8SCIA | PHY521A |
|---|---|---|
| Forces and Simple Machines<br>Students use devices such as rubber bands and spring scales to measure force. | **PS3 Create a prototype of an object that floats to analyse the effects of forces on objects in fluids.** | Dynamics<br>Students use Newton's laws to describe and determine forces acting on objects. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Explain the concept of force (push or pull on an object) and provide examples of contact and non-contact forces.
- Differentiate between mass and weight.
- Illustrate, using force diagrams, the movement of objects in fluids in terms of positive, negative, and neutral buoyancy.
- Collaborate to design, construct, evaluate, and improve upon a prototype of an object that floats and can carry the greatest amount of cargo.

## Elaboration

**Focus question**: Explain the forces that determine whether an object will float or sink.

Teachers should provide students with examples of balanced and unbalanced forces through positive, negative, and neutral buoyancy. Teachers may have to spend some time differentiating between mass and weight as the two terms are often misused in everyday language. Students can use spring scales and balances to weigh various masses in water to observe that the mass remains constant but the weight appears to change. The apparent change in weight can be used to introduce the concept of buoyancy. The story of the origin of Archimedes Principle can be related and demonstrated as the next step in the study of forces and displacement of fluid as related to average density and buoyancy.

Students should apply their knowledge of buoyancy and density by creating a model boat from a material that is more dense than water (e.g., modelling clay, aluminum foil). Working in small groups, students could be challenged to see which team's boat can hold the most mass (pennies, marbles, etc.) without sinking, while explaining the rationale behind their design.

Students should be provided with opportunities to conduct experiments and identify major variables related to relationships among force, area, pressure, and temperature.

**Literacy connection** (**Reading a Diagram**): Diagrams help students understand what is written in the text. As they read, encourage students to move back and forth between the text and the force diagrams to help them understand each idea.

# Science
8SCIA

## Fluids

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| ✓ | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS4 Explain how the transfer of fluids is used to apply a force or to control a motion in technological devices and in the natural world.** |

| 7SCIA | 8SCIA | 9SCIA |
|---|---|---|
| Heat<br>Students illustrate the underlying scientific principles of technologies designed to address a specific need. | **PS4 Explain how the transfer of fluids is used to apply a force or to control a motion in technological devices and in the natural world.** | Atoms and Elements<br>Students provide examples of scientific knowledge that have resulted in the development of technologies. |

### Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Explain qualitatively the relationship among pressure, volume, and temperature when fluids are compressed or heated.
- Describe the science underlying hydraulic and pneumatic technologies.
- Explain how animals in nature (e.g., fish, whales, insects) and constructed devices (e.g., submarines, airplanes, heart pumps, aerosol cans) manipulate the properties of fluids.
- Describe real life situations where scientists and engineers use their knowledge and understanding of fluids to solve challenges.
- Collaborate to construct a device that uses the transfer of fluids to apply a force or to control a motion (e.g., construct a model hydraulic lift, water-spraying toy, model airbag, submersible that can sink and float, hovercraft, etc.).

## Elaboration

**Focus question**: How does the flow of fluids affect our lives?

An investigation of hydraulic and pneumatic systems (e.g., car hoist, hairdresser's chair, jackhammer) can be used to help students better understand the relationship among force, area, and pressure. Water-filled balloons, plastic bottles, and syringes allow for a kinesthetic appreciation of hydraulics.

Teachers could assign teams of students to analyse and describe how fluids are used in technological devices (e.g., car brakes, farm machinery, water towers, dams) and in the natural world (e.g., archerfish, whales, jumping spiders). They could then collaborate to create a device that uses fluids to apply a force or control a motion to meet a specified challenge.

**Literacy connection** (**Summarizing**): After reading, good readers summarize by thinking about the most important details. Students could ask themselves, "What are the key ideas about forces in fluids? How can this information help us build our prototype?"

# Science
*8SCIA*

*Optics*

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS5 Examine the properties and behaviour of visible light.** |

| 4SCIA | 8SCIA | PHY521A |
|---|---|---|
| Light<br>Students will use mirrors, flashlights, lenses and other materials to investigate various properties of light. | **PS5 Examine the properties and behaviour of visible light.** | Waves<br>Students apply the law of reflection and the law of refraction to predict wave behaviour. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Demonstrate waves, wavelength, frequency, and amplitude, with corresponding explanations.
- Select appropriate methods and tools to demonstrate rectilinear propagation and the visible spectrum (e.g., pinhole camera to demonstrate how light travels in a straight line, prism to demonstrate spectrum of colour).
- Determine how light interacts with transparent, translucent, and opaque materials.
- Identify how reflection is used in everyday life (e.g., plane mirrors, sun dogs, magician's tricks, the ability to see the moon and other non-luminous bodies).
- Use experimentation to derive the law of reflection by estimating and measuring the angles of incidence and angles of reflection of visible light.
- State a conclusion, based on experimental data and evidence, on how light is refracted when passing from one medium to another (e.g., water, glass, plastic, oil).

## Elaboration

**Focus question**: What is light made of and how does it travel from one place to another?

Questions about sources of light, what light is, how it travels, and how fast it travels will set the stage for exploratory activities about light. A word wall may help students distinguish among the terms involved with optics and waves (wavelength, frequency, amplitude, reflection, refraction, etc.). Teachers could also ask students to generate a list of technologies that manipulate visible light (e.g., microscope, telescope, fibre optics, cameras, prescription lenses).

Wherever possible, students should have the opportunity to investigate the nature and properties of light throughout the course of this unit. Students can use a variety of materials and other media to investigate and explore the reflecting and refracting properties of light. Activities could include experiments with pinhole cameras, periscopes, shadows, prisms, or telescopes.

Experiences with flat, convex and concave mirrors should be made available to students to illustrate the different effects and uses of these types of reflection. Collaborative student challenges and other problem-solving activities permit students to derive and use the laws of reflection in a given context. Ray diagrams may be used, although emphasis should be on the uses of mirrors and not on predicting image characteristics using ray diagrams.

Demonstrations, analogies, and experiments should be used to investigate properties, and applications of refraction and dispersion. Ray diagrams may be used, although emphasis should be on the uses of lenses and not on predicting image characteristics using ray diagrams.

**Literacy connection** (**Interactive Word Wall**): An interactive word wall is an organized collection of words displayed in a classroom, arranged to illustrate relationships and organize learning. Word walls provide reference support for students during reading and writing activities. Word walls should include terms and concepts aligned with the curriculum, visual supports, and student generated material. Students should be provided with opportunities to interact with the word wall such as creating a concept map, summary sentence, short story, or poem.

| Learning Contexts | |
|---|---|
| | Scientific Inquiry |
| | Technological Problem Solving |
| ✓ | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS6 Analyse different types of electromagnetic radiation and its impact on their daily lives.** |

| | 8SCIA | PHY521A |
|---|---|---|
| | **PS6 Analyse different types of electromagnetic radiation and its impact on their daily lives.** | Waves<br>Students compare the properties of electromagnetic radiation and describe how they are produced and transmitted. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Describe and compare different types of electromagnetic radiation, including infrared, visible light, ultraviolet, X-rays, microwaves, and radio waves.
- Provide examples of technologies that use different types of electromagnetic radiation (e.g., cellular phones, X-ray machines, radios, microwave ovens, UV tanning beds, GPS, wireless computing devices, thermographic cameras) and how they relate to their daily lives.
- 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.

## Elaboration

**Focus question**: What are some everyday devices that use electromagnetic radiation?

Teachers should ensure that students recognize the relationship between wavelength and the colours we see. This discussion can then be extended to the wavelengths (and frequencies) of other waves in the electromagnetic spectrum (microwaves, ultraviolet waves, radio waves, etc.). Teachers should ensure that students realize that all of this electromagnetic radiation is continuously present; we just aren't able to see it.

Teachers should have students research and present the various uses of electromagnetic radiation in their daily lives and identify benefits and problems related to particular kinds of electromagnetic radiation. Microwave ovens, X-ray machines, cellular phones, and the nuclear industry are some examples of technologies that can be explored. Students should understand that, generally, exposure to high frequency, short wavelength electromagnetic waves (e.g., X rays) have higher energy and are more dangerous than exposure to low frequency, long wavelength electromagnetic waves (e.g., radio waves).

**Literacy connection** (**Conducting Scientific Research**): Teachers should provide students with some suggestions on conducting scientific research such as:

- Ask questions about the world around them.
- Identify a research topic or develop a research question.
- Identify sources of information.
- Evaluate the sources of information.
- Record and organize the information.
- Make a conclusion.
- Evaluate their research.
- Communicate their conclusions.

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| ✓ | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**PS7 Explain how human vision works, including ways of correcting or extending human vision.** |

| 4SCIA | 8SCIA | BIO801A/621A |
|---|---|---|
| Light<br>Students will construct optical devices that perform specific functions. | **PS7 Explain how human vision works, including ways of correcting or extending human vision.** | Nervous System<br>Students describe how the human eye works as part of the nervous system. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Demonstrate an understanding of how light interacts with concave and convex lenses.
- Explain how the human eye sees objects and detects colours.
- Research the technological development of microscopes, telescopes, and other optical devices; describe how these developments enabled scientific research.
- Identify similarities and differences between the human eye and other optical devices.
- Identify new questions and problems that arise from what was learned about human vision and lenses (e.g., How do contact lenses work?).

## Elaboration

**Focus question**: How can we apply the properties of light to design devices that help us see better and see more?

Teachers should ensure that students understand the evolution of practical applications for convex and concave lenses (e.g., corrective lenses, refracting telescopes, microscopes) and how these devices enabled scientific research. Students can then work together to build a device that can enhance or correct human vision.

Students should be able to identify the main parts of the human eye and explain how objects and colours are seen by the eye. They could then compare the function and design of the human eye to other animal eyes and to cameras. An extension of this knowledge could be to research a common vision defect and explain methods of correcting or limiting it.

Questions for students to explore and investigate may include, “How do contact lenses work?”, “Do all humans see colour the same way?”, “What are some common defects in human vision?”, “Why can cats see so well at night?”, “How do telescopes/microscopes work?”

**Literacy connection** (**Comparisons**): As students read this section, ask them to compare the human eye to other optical devices. Comparing their similarities and differences will help them better understand the functioning of the human eye and other optical devices. A semantic feature analysis is a matrix that helps students look at similarities and differences among related concepts. Words related to a category are written across the top of the matrix and features or properties shared by some of the words in the column are listed down the left side of the matrix.

# Science 8SCIA

## Cells, Tissues, Organs, and Systems

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...* <br> **LS1 Identify and describe the structure and function of cells within living things.** |

| 5SCIA | 8SCIA | BIO521A |
|---|---|---|
| Maintaining a Healthy Body<br>Students propose questions about how our body works and what its components are. | **LS1 Explain the role of cells within living things.** | Matter and Energy for Life<br>Students explain the cell theory and describe cell organelles visible with the light and electron microscopes. |

### Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Understand that all living things (e.g., algae, trees, whales) are composed of cells.
- Illustrate and explain that the cell is a living system that exhibits the characteristics of life.
- Identify and describe the structure and function of cell organelles (e.g., cell membrane, cell wall, cytoplasm, chloroplast, vacuole, mitochondria, nucleus).
- Use a microscope to observe and draw the similarities and differences between the structure of plant and animal cells.
- Construct a 3D model of plant and animal cells.

## Elaboration

**Focus question**: What do all living things have in common?

This is intended as a basic introduction to cell theory. Students should understand that the cell is the basic building block of life. Students should understand that all cells divide for growth and reproduction, but the processes of mitosis and meiosis are not to be taught in Grade 8 science.

Students should be provided with an opportunity to use a light microscope safely and effectively to examine samples of plant and animal cells. Students should be able to differentiate between cell walls and cell membranes in given samples and to identify the nucleus, cytoplasm, vacuoles, and chloroplasts. It is important to note that students should not harvest live human cells in this activity and that they follow appropriate safety guidelines as outlined in the *Science Safety Resource Manual*. Students often believe that cells are two-dimensional as they sometimes appear under the microscope. Teachers can dispel this misconception and help students develop their concept of cells by having them create their own three-dimensional models of plant and animal cells.

**Literacy connection** (**Models and Diagrams**): Teachers should lead students in a discussion of the strengths and limitations of using models or diagrams in science. These graphic organizers attempt to simplify complex relationships. Students should understand that in an effort to simplify, some models (e.g., plant and animal cells) can lead to an incomplete representation or oversimplification of natural processes.

# Science 8SCIA

*Cells, Tissues, Organs, and Systems*

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| | STSE Decision Making |

| Specific Curriculum Outcome |
|---|
| *Students will be expected to...*<br>**LS2 Analyse the relationship and interdependence among cells, tissues, organs, and organ systems.** |

| 5SCIA | 8SCIA | BIO521A |
|---|---|---|
| Maintaining a Healthy Body<br>Students build models of major internal organs and systems to see how they function. | **LS2 Analyse the relationship and interdependence among cells, tissues, organs, and organ systems.** | Maintaining Dynamic Equilibrium<br>Students explain how different plant and animal systems help maintain homeostasis. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Distinguish among cells, tissues, organs, and organ systems based on structure and function.
- Relate the needs and functions of various cells and organs to the needs and functions of the human organism as a whole.
- Identify and describe, in general terms, the main components and roles of the human organ systems (digestive, circulatory, respiratory, excretory, and nervous systems).
- Explain how organ systems work together to obtain and transport nutrients, remove wastes, and exchange gases.

## Elaboration

**Focus question**: How do cells work together?

The concept of systems (separate parts that work together as a whole) should be explored in this section. Teachers should help students develop an understanding and appreciation of the interdependence and interconnectedness of cells, tissues, organs, and organ systems. Students should be able to relate the cell's needs for respiration, energy use, and waste removal with that of the human body. The shape and function of specialized human cells should be discussed and viewed through pictures or a microscope.

Students should study the different body systems but not in minute detail. It is important to address this section holistically and not dwell on terminology and the memorization of anatomical details. They should understand the role of the main organ systems in getting oxygen and food to cells and getting rid of the wastes produced. Students should understand the interdependence of body systems as part of an integrated whole.

**Literacy connection** (**Scientific Terminology**): Students should be given a variety of learning activity opportunities in to introduce the use of scientifically appropriate language. For example, students could write a paragraph or story, using scientific terms, to describe the interdependence among cells, tissues, organs, and organ systems.

| Learning Contexts | |
|---|---|
| ✓ | Scientific Inquiry |
| | Technological Problem Solving |
| ✓ | STSE Decision Making |

| **Specific Curriculum Outcome** |
|---|
| *Students will be expected to...* |
| **LS3 Demonstrate an understanding of factors that affect the healthy functioning of the human body.** |

| 5SCIA | 8SCIA | BIO521A |
|---|---|---|
| Maintaining a Healthy Body<br>Students design experiments to measure the affect of various factors on body systems. | **LS3 Demonstrate an understanding of factors that affect the healthy functioning of the human body.** | Maintaining Dynamic Equilibrium<br>Students explain the importance of nutrition and fitness to the maintenance of homeostasis. |

## Achievement Indicators

*Students who have achieved this outcome should be able to...*

- Recognize that cells in multicellular organisms must reproduce to form and repair tissue.
- Describe how lifestyle choices (e.g., nutrition, exercise, smoking, drugs, and alcohol) and technologies (e.g., dialysis, pacemaker, organ transplant) can affect human health.
- Design, plan, and carry out an experiment on changes in body functions in response to changing conditions (e.g., factors that affect reaction time, changes in heart rate, respiration rate, or body temperature in response to exercise, change in metabolism in response to lower temperature).
- Predict the impact of the failure or removal of one or more organs on the healthy functioning of the human body.

## Elaboration

**Focus question**: How do lifestyle choices affect the health of body systems?

Teachers should identify misconceptions that students may have on the effects of diet, nutrition, exercise, and stress on the health of the human system. Teachers could have students collaborate, investigate, and explore how certain practices and lifestyles positively or negatively affect the function and performance of several body systems. Conflicting evidence on health product claims, conventional versus alternative medicine, and the use of controversial treatments should be explored to illustrate the fact that scientific knowledge is tentative and subject to review.

**Literacy connection** (**Making Connections**) To gain deeper meaning from their reading, students should practise making connections between what they are reading and what they have read before, from what they know about similar topics, and from their own life experiences. Use a double-entry journal, a two-column graphic organizer where the left-hand column is used to record important, factual information, and the right-hand column is used to make connections to the text by recording personal responses.