Science 4

Curriculum Guide 2016

Newfoundland
Labrador

Education and Early Childhood Development

Department of Education
Mission Statement

By March 31, 2017, the Department of Education will
have improved provincial early childhood learning and
the K-12 education system to further opportunities for
the people of Newfoundland and Labrador.

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Section One:
Newfoundland and Labrador Curriculum

Introduction

There are multiple factors that impact education including: technological developments, increased emphasis on accountability, and globalization. These factors point to the need to consider carefully the education our children receive.

The Newfoundland and Labrador Department of Education believes that curriculum design with the following characteristics will help teachers address the needs of students served by the provincially prescribed curriculum:

- Curriculum guides must clearly articulate what students are expected to know and be able to do by the time they graduate from high school.
- There must be purposeful assessment of students' performance in relation to the curriculum outcomes.

Outcomes Based Education

The K-12 curriculum in Newfoundland and Labrador is organized by outcomes and is based on *The Atlantic Canada Framework for Essential Graduation Learning in Schools* (1997). This framework consists of Essential Graduation Learnings (EGLs), General Curriculum Outcomes (GCOs), Key Stage Curriculum Outcomes (KSCOs) and Specific Curriculum Outcomes (SCOs).

Essential Graduation Learnings
(common to all subject areas)

General Curriculum Outcomes
(unique to each subject area)

Key Stage Learning Outcomes
(met by end of grades 3,6,9 and 12)

Specific Curriculum Outcomes
(met within each grade level and subject area)
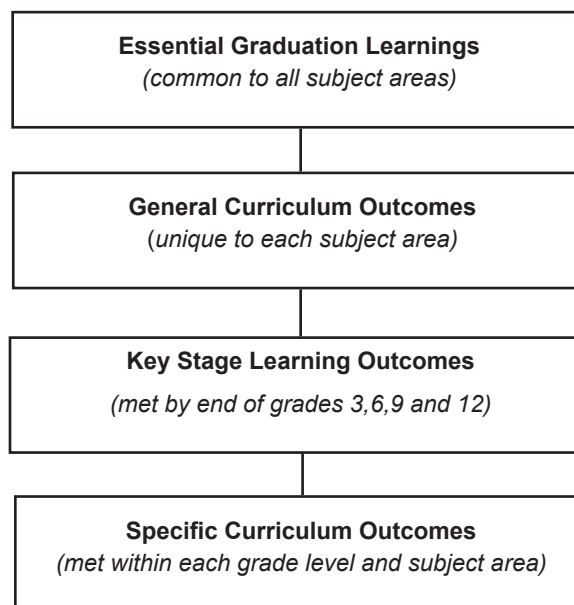
Essential Graduation Learnings

Essential Graduation Learnings (EGLs) provide vision for the development of a coherent and relevant curriculum. The EGLs are statements that offer students clear goals and a powerful rationale for education. The EGLs are delineated by general, key stage, and specific curriculum outcomes.

EGLs describe 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. EGLs describe expectations, not in terms of individual subject areas, 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 areas if they are to be ready to meet the shifting and ongoing demands of life, work, and study.
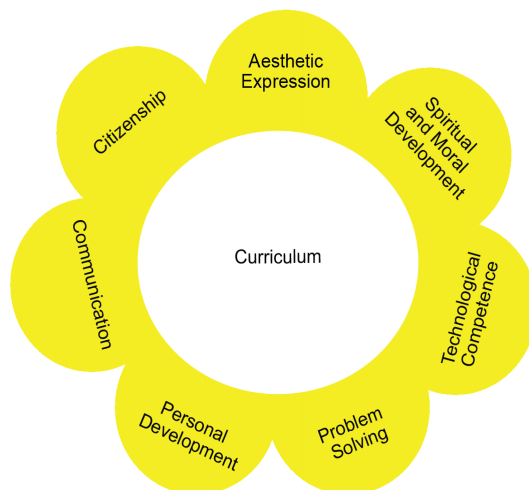
Aesthetic Expression - Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship - Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication - Graduates will be able to think, learn and communicate effectively by using listening, viewing, speaking, reading and writing modes of language(s), and mathematical and scientific concepts and symbols.

Problem Solving - Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, and mathematical and scientific concepts.

Personal Development - Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Spiritual and Moral Development - Graduates will demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical conduct.

Technological Competence - Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Curriculum Outcomes

Curriculum outcomes are statements that articulate what students are expected to know and be able to do in each program area in terms of knowledge, skills, and attitudes.

Curriculum outcomes may be subdivided into General Curriculum Outcomes, Key Stage Curriculum Outcomes, and Specific Curriculum Outcomes.

General Curriculum Outcomes (GCOs)

Each program has a set of GCOs which describe what knowledge, skills, and attitudes students are expected to demonstrate as a result of their cumulative learning experiences within a subject area. GCOs serve as conceptual organizers or frameworks which guide study within a program area. Often, GCOs are further delineated into KSCOs.

Key Stage Curriculum Outcomes (KSCOs)

Key Stage Curriculum Outcomes (KSCOs) summarize what is expected of students at each of the four key stages of Grades Three, Six, Nine, and Twelve.

Specific Curriculum Outcomes (SCOs)

SCOs set out what students are expected to know and be able to do as a result of their learning experiences in a course, at a specific grade level. In some program areas, SCOs are further articulated into delineations. **It is expected that all SCOs will be addressed during the course of study covered by the curriculum guide.**

EGLs to Curriculum Guides
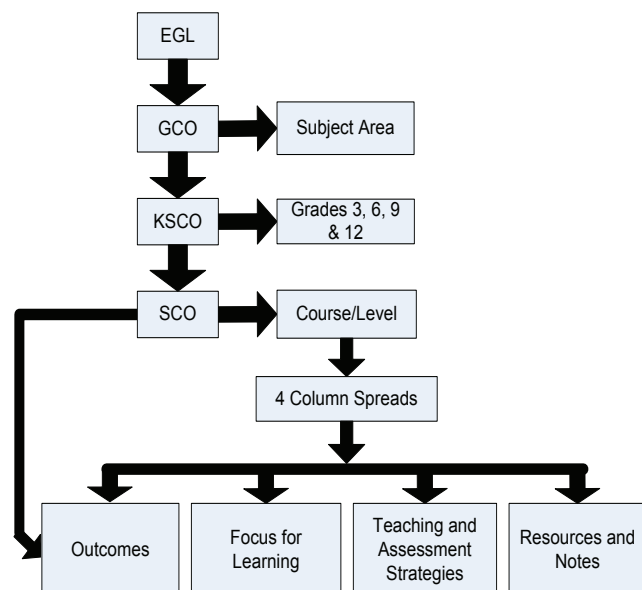
Context for Teaching and Learning

Teachers are responsible to help students achieve outcomes. This responsibility is a constant in a changing world. As programs change over time so does educational context. Factors that make up the educational context in Newfoundland and Labrador today: inclusive education, support for gradual release of responsibility teaching model, focus on literacy and learning skills in all programs, and support for education for sustainable development.

Inclusive Education

Valuing Equity and Diversity

Effective inclusive schools have the following characteristics: supportive environment, positive relationships, feelings of competence, and opportunities to participate. (The Centre for Inclusive Education, 2009)

All students need to see their lives and experiences reflected in their school community. It is important that the curriculum reflect the experiences and values of both genders and that learning resources include and reflect the interests, achievements, and perspectives of all students. An inclusive classroom values the varied experiences, abilities, social, and ethno-cultural backgrounds of all students while creating opportunities for community building. Inclusive policies and practices promote mutual respect, positive interdependencies, and diverse perspectives. Learning resources should include a range of materials that allow students to consider many viewpoints and to celebrate the diverse aspects of the school community.
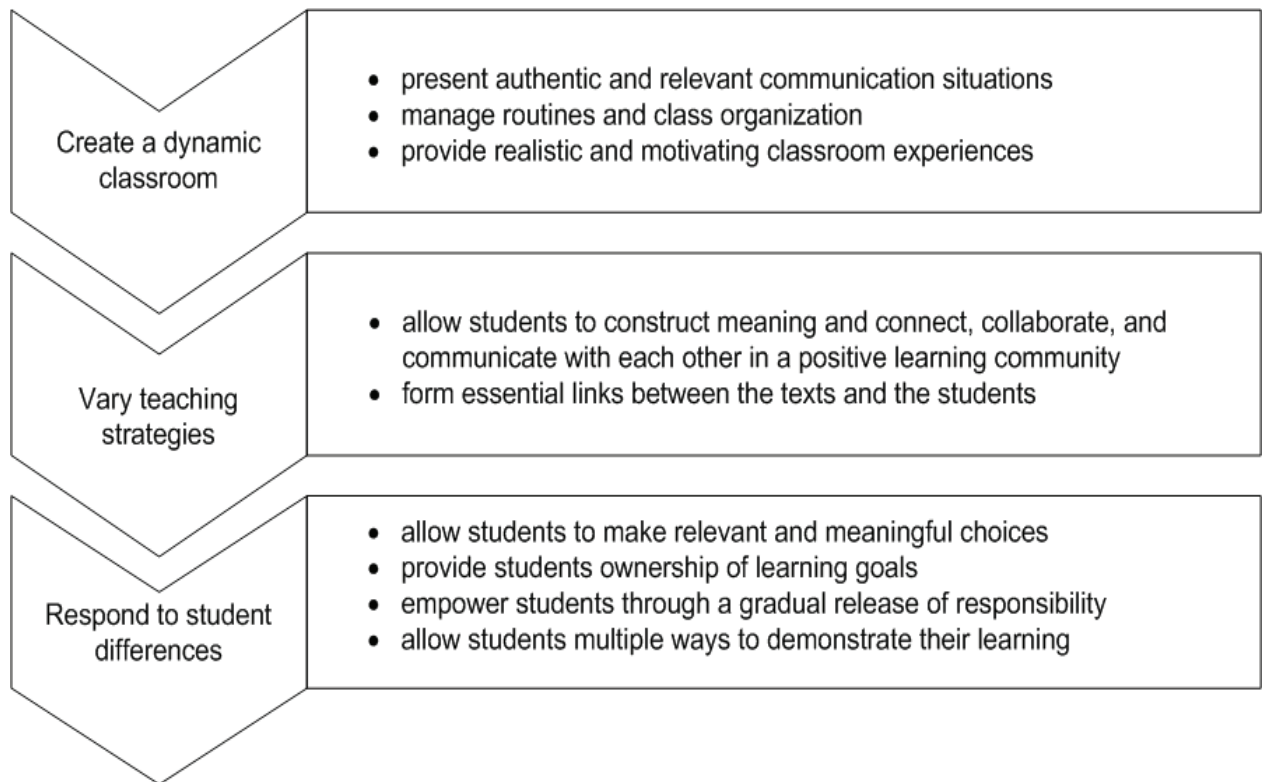
Attend to learning preferences

Recognize students' diverse learning styles

Promote varied and flexible assessment

Inclusive Classrooms

Utilize multiple resources

Provide varied avenues and entry points to learning

Differentiated Instruction

Differentiated instruction is a teaching philosophy based on the premise that teachers should adapt instruction to student differences. Rather than marching students through the curriculum lockstep, teachers should modify their instruction to meet students' varying readiness levels, learning preferences, and interests. Therefore, the teacher proactively plans a variety of ways to 'get it' and express learning.- Carol Ann Tomlinson

Curriculum is designed and implemented to provide learning opportunities for all according to student abilities, needs, and interests. Teachers must be aware of and responsive to the diverse range of learners in their classes. Differentiated instruction is a useful tool in addressing this diversity.

Differentiated instruction responds to different readiness levels, abilities, and learning profiles of students. It involves actively planning so that: the process by which content is delivered, the way the resource is used, and the products students create are in response to the teacher's knowledge of whom he or she is interacting with. Learning environments should be flexible to accommodate various learning preferences of the students. Teachers continually make decisions about selecting teaching strategies and structuring learning activities to provide all students with a safe and supportive place to learn and succeed.

Teachers should...

Create a dynamic classroom
- present authentic and relevant communication situations
- manage routines and class organization
- provide realistic and motivating classroom experiences

Vary teaching strategies
- allow students to construct meaning and connect, collaborate, and communicate with each other in a positive learning community
- form essential links between the texts and the students

Respond to student differences
- allow students to make relevant and meaningful choices
- provide students ownership of learning goals
- empower students through a gradual release of responsibility
- allow students multiple ways to demonstrate their learning

Differentiating the Content

Differentiating content requires teachers to pre-assess students to identify those who require pre-requisite instruction, as well as those who have already mastered the concept and may, therefore, proceed to apply the concepts to problem solving or further use. Another way to differentiate content is to permit students to adjust the pace at which they may progress through the material. Some students may require additional time while others may move through at an increased pace and thus create opportunities for

enrichment or more indepth consideration of a topic of particular interest.

Teachers should consider the following examples of differentiating content:

- meet with small groups to re-teach an idea or skill or to extend the thinking or skills
- present ideas through auditory, visual. and tactile means
- use reading materials such as novels, web sites, and other reference materials at varying reading levels

Differentiating the Process

Differentiating the process involves varying learning activities or strategies to provide appropriate methods for students to explore and make sense of concepts. A teacher might assign all students the same product (e.g., giving a presentation) but the process students use to create the presentation may differ. Some students could work in groups while others meet with the teacher alone. The same assessment criteria can be used for all students.

Teachers should consider flexible groupings of students such as whole class, small group, or individual instruction. Students can be grouped according to their learning styles, readiness levels, interest areas, and the requirements of the content or activity presented. Groups should be formed for specific purposes and be flexible in composition and short-term in duration.

Teachers should consider the following examples of differentiating the process:

- offer hands-on activities for students who need them
- provide activities and resources that encourage students to further explore a topic of particular interest to them
- use activities in which all learners work with the same learning outcomes, but proceed with different levels of support, challenge, or complexity

Differentiating the Product

Differentiating the product involves varying the complexity and type of product that students create to demonstrate learning outcomes. Teachers provide a variety of opportunities for students to demonstrate and show evidence of what they have learned.

Teachers should consider the following examples of differentiating by product:

- encourage students to create their own products as long as the assignments contain required elements
- give students options of how to express their learning (e.g., create an online presentation, write a letter, or develop a mural)

Allowing students to choose how they demonstrate their understanding in ways that are appropriate to their learning needs, readiness, and interests is a powerful way to engage them.

Differentiating the Learning Environment

The learning environment includes the physical and the affective tone or atmosphere in which teaching and learning take place, and can include the noise level in the room, whether student activities are static or mobile, or how the room is furnished and arranged. Classrooms may include tables of different shapes and sizes, space for quiet individual work, and areas for collaboration.

Teachers can divide the classroom into sections, create learning centres, or have students work both independently or in groups. The structure should allow students to move from whole group, to small group, pairs, and individual learning experiences and support a variety of ways to engage in learning. Teachers should be sensitive and alert to ways in which the classroom environment supports their ability to interact with students.

Teachers should consider the following examples of differentiating the learning environment:

- develop routines that allow students to seek help when teachers are with other students and cannot provide immediate attention
- ensure there are places in the room for students to work quietly and without distraction, as well as places that invite student collaboration
- establish clear guidelines for independent work that match individual needs
- provide materials that reflect diversity of student background, interests, and abilities

The physical learning environment must be structured in such a way that all students can gain access to information and develop confidence and competence.

Meeting the Needs of Students With Exceptionalities

All students have individual learning needs. Some students, however, have exceptionalities (defined by the Department of Education) which impact their learning. The majority of students with exceptionalities access the prescribed curriculum. Details of these exceptionalities are available at:

www.gov.nl.ca/edu/k12/studentsupportservices/exceptionalities.html

Supports for these students may include:

- accommodations
- modified prescribed courses
- alternate courses
- alternate programs
- alternate curriculum

For further information, see Service Delivery Model for Students with Exceptionalities at www.cdli.ca/sdm/

Classroom teachers should collaborate with instructional resource teachers to select and develop strategies which target specific learning needs.

Meeting the Needs of Students Who are Highly Able
* includes gifted and talented

Some students begin a course or topic with a vast amount of prior experience and knowledge. They may know a large portion of the material before it is presented to the class or be capable of processing it at a rate much faster than their classmates. All students are expected to move forward from their starting point. Many elements of differentiated instruction are useful in addressing the needs of students who are highly able.

Some strategies which are often effective include:
- the offer of independent study to increase depth of exploration in an area of particular interest
- the use of curriculum compacting to allow for an increased rate of content coverage commensurate with a student's ability or degree of prior knowledge
- the use of similar ability grouping to provide the opportunity for students to work with their intellectual peers and elevate discussion and thinking, or delve deeper into a particular topic
- tiering of instruction to pursue a topic to a greater depth or to make connections between various spheres of knowledge

Highly able students require the opportunity for authentic investigation and become familiar with the tools and practices of the field of study. Authentic audiences and tasks are vital for these learners. Some highly able learners may be identified as gifted and talented in a particular domain. These students may also require supports through the Service Delivery Model for Students with Exceptionalities.

Gradual Release of Responsibility

Teachers must determine when students can work independently and when they require assistance. In an effective learning environment, teachers choose their instructional activities to model and scaffold composition, comprehension and metacognition that is just beyond the students' independence level. In the gradual release of responsibility approach, students move from a high level of teacher support to independent work. If necessary, the teacher increases the level of support when students need assistance. The goal is to empower students with their own learning strategies, and to know how, when, and why to apply them to support their individual growth. Guided practice supports student independence. As a student demonstrates success, the teacher should gradually decrease his or her support.

Gradual Release of Responsibility Model
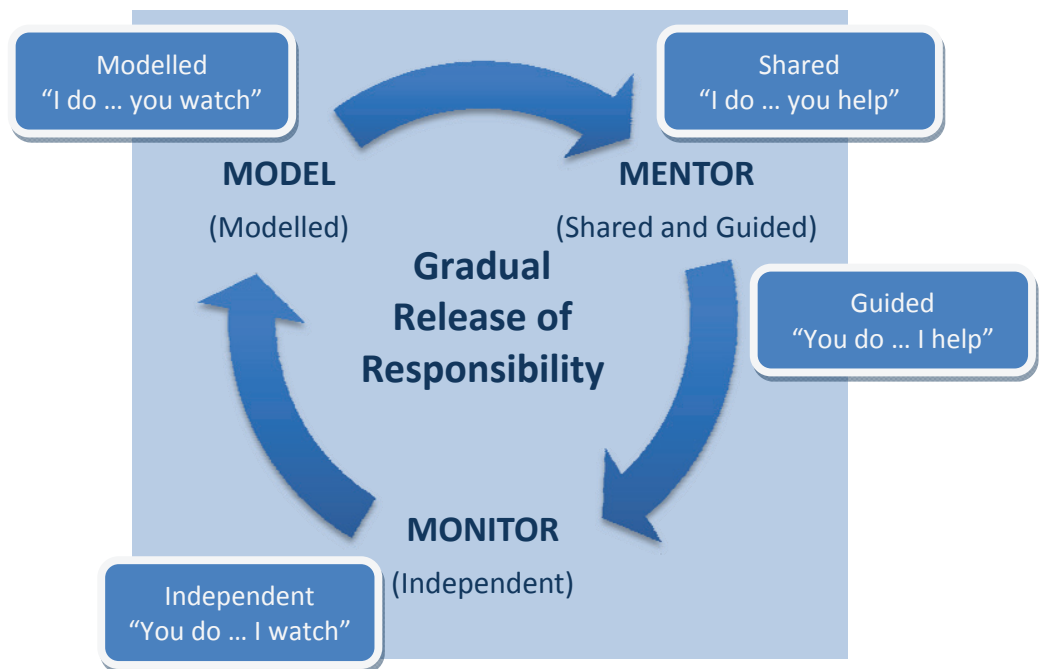
Literacy

UNESCO has proposed an operational definition which states, "Literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society". To be successful, students require a set of interrelated skills, strategies and knowledge in multiple literacies that facilitate their ability to participate fully in a variety of roles and contexts in their lives, in order to explore and interpret the world and communicate meaning. - The Plurality of Literacy and its Implications for Policies and Programmes, 2004, p.13

Literacy is:

- a process of receiving information and making meaning from it
- the ability to identify, understand, interpret, communicate, compute, and create text, images, and sounds

Literacy development is a lifelong learning enterprise beginning at birth that involves many complex concepts and understandings. It is not limited to the ability to read and write; no longer are we exposed only to printed text. It includes the capacity to learn to communicate, read, write, think, explore, and solve problems. Literacy skills are used in paper, digital, and live interactions where people:

- analyze critically and solve problems
- comprehend and communicate meaning
- create a variety of texts
- read and view for enjoyment
- make connections both personally and inter-textually
- participate in the socio-cultural world of the community
- respond personally

These expectations are identified in curriculum documents for specific subject areas as well as in supporting documents, such as *Cross-Curricular Reading Tools* (CAMET).

With modelling, support and practice, students' thinking and understandings are deepened as they work with engaging content and participate in focused conversations.

Reading in the Content Areas

The focus for reading in the content areas is on teaching strategies for understanding content. Teaching strategies for reading comprehension benefits all students, as they develop transferable skills that apply across curriculum areas.

When interacting with different texts, students must read words, view and interpret text features and navigate through information presented in a variety of ways including, but not limited to:

• Books	• Documentaries	• Speeches
• Poems	• Movies	• Podcasts
• Songs	• Music videos	• Plays
• Video games	• Advertisements	• Webpages
• Magazine articles	• Blogs	• Online databases

Students should be able to interact with and comprehend different texts at different levels.

There are three levels of text comprehension:

- Independent level – students are able to read, view, and understand texts without assistance
- Instructional level – students are able to read, view, and understand most texts but need assistance to fully comprehend some texts
- Frustration level – students are not able to read or view with understanding (i.e., texts may be beyond their current reading level)

Teachers will encounter students working at all reading levels in their classrooms and will need to differentiate instruction to meet their needs. For example, print texts may be presented in audio form; physical movement may be associated with synthesizing new information with prior knowledge; graphic organizers may be created to present large amounts of print text in a visual manner.

When interacting with information that is unfamiliar to students, it is important for teachers to monitor how effectively students are using strategies to read and view texts. Students will need to:

- analyze and think critically about information
- determine importance to prioritize information
- engage in questioning before, during, and after an activity related to a task, text, or problem
- make inferences about what is meant but not said
- make predictions
- synthesize information to create new meaning
- visualize ideas and concepts

Learning Skills for Generation Next

Generation Next is the group of students who have not known a world without personal computers, cell phones and the Internet. They were born into this technology. They are digital natives.

Students need content and skills to be successful. Education helps students learn content and develop skills needed to be successful in school and in all learning contexts and situations. Effective learning environments and curricula challenge learners to develop and apply key skills within the content areas and across interdisciplinary themes.

Learning Skills for Generation Next encompasses three broad areas:

Learning and Innovation Skills

Learning and innovation skills enhance a person's ability to learn, create new ideas, problem solve, and collaborate. These skills will help foster lifelong learning. They include:

- Collaboration
- Communication
- Creative Thinking
- Critical Thinking

Literacy

In addition to the literacy aspects outlined in the previous section, three areas are crucial for Generation Next. These areas are:

- Information and Communication Technology Literacy
- Numeracy
- Reading and Writing

Life and Career Skills

Life and career skills are skills that address leadership, the interpersonal, and the affective domains. These skills include:

- Flexibility and Adaptability
- Initiative and Self-Direction
- Leadership and Responsibility
- Productivity and Accountability
- Social and Cross-Cultural Skills

The diagram below illustrates the relationship between these areas . A 21st century curriculum employs methods that integrate innovative and research-driven teaching strategies, modern learning technologies, and relevant resources and contexts.
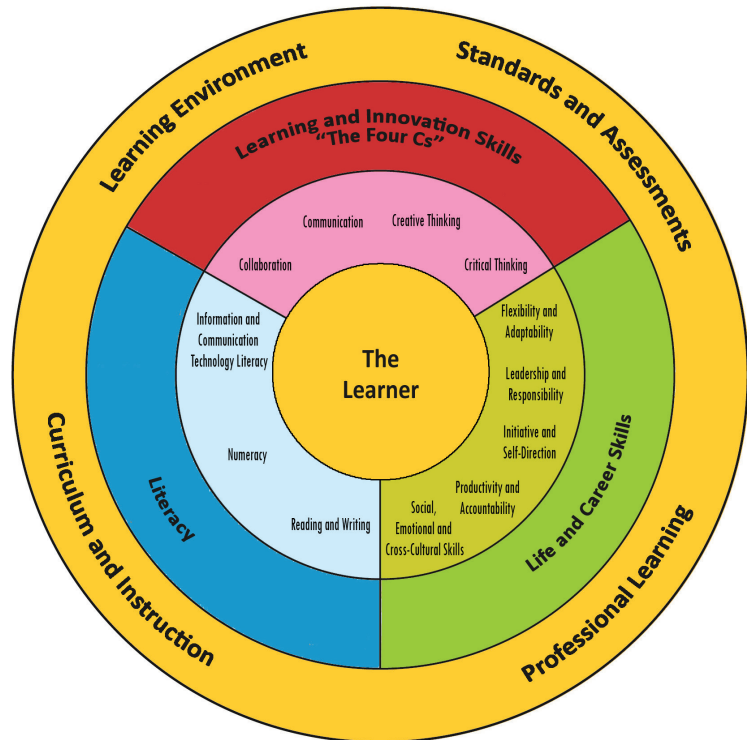
Support for students to develop these abilities and skills is important across curriculum areas and should be integrated into teaching, learning, and assessment strategies. Opportunities for integration of these skills and abilities should be planned with engaging and experiential activities that support the gradual release of responsibility model. For example, lessons in a variety of content areas can be infused with learning skills for Generation Next by using open-ended questioning, role plays, inquiry approaches, self-directed learning, student role rotation, and internet-based technologies.

All programs have a shared responsibility in developing students' capabilities within all three skill areas.

Education for Sustainable Development

Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Our Common Future, 43).

Sustainable development is comprised of three integrally connected areas: economy, society, and environment.

3-Nested-Dependencies Model

ENVIRONMENT

SOCIETY

ECONOMY

Based on Bob Doppelt, *The Power of Sustainable Thinking*; Peter Senge et al., *The Necessary Revolution*
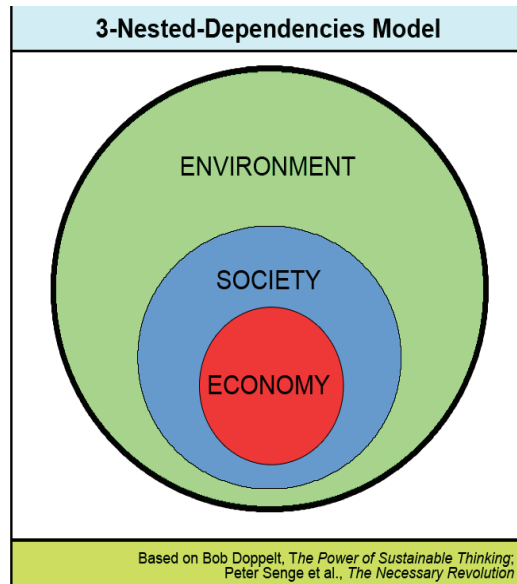
As conceived by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) the overall goal of Education for Sustainable Development (ESD) is to integrate the knowledge, skills, values, and perspectives of sustainable development into all aspects of education and learning. Changes in human behaviour should create a more sustainable future – a future that provides for environmental integrity, economic viability, and results in a just society for both the present and future generations.

ESD is not teaching about sustainable development. Rather, ESD involves teaching for sustainable development – helping students develop the skills, attitudes, and perspectives to meet their present needs without compromising the ability of future generations to meet their needs.

Within ESD, the knowledge component spans an understanding of the interconnectedness of our political, economic, environmental, and social worlds, to the role of science and technology in the development of societies and their impact on the environment. The skills necessary include being able to assess bias, analyze consequences of choices, ask questions, and solve problems. ESD values and perspectives include an appreciation for the interdependence of all life forms, the importance of individual responsibility and action, an understanding of global issues as well as local issues in a global context. Students need to be aware that every issue has a history, and that many global issues are linked.

Assessment and Evaluation

Assessment

Assessment is the process of gathering information on student learning.

How learning is assessed and evaluated and how results are communicated send clear messages to students and others about what is valued.

Assessment instruments are used to gather information for evaluation. Information gathered through assessment helps teachers determine students' strengths and needs, and guides future instruction.

Teachers are encouraged to be flexible in assessing student learning and to seek diverse ways students might demonstrate what they know and are able to do.

Evaluation involves the weighing of the assessment information against a standard in order to make a judgement about student achievement.

Assessment can be used for different purposes:

1. assessment for learning guides and informs instruction
2. assessment as learning focuses on what students are doing well, what they are struggling with, where the areas of challenge are, and what to do next
3. assessment of learning makes judgements about student performance in relation to curriculum outcomes.

1. Assessment for Learning

Assessment for learning involves frequent, interactive assessments designed to make student learning visible. This enables teachers to identify learning needs and adjust teaching accordingly. It is an ongoing process of teaching and learning.

Assessment for learning:

- includes pre-assessments that provide teachers with information of what students already know and can do
- involves students in self-assessment and setting goals for their own learning
- is not about a score or mark
- is used to inform student learning
- provides descriptive and specific feedback to students and parents regarding the next stage of learning
- requires the collection of data, during the learning process, from a range of tools to learn as much as possible about what a student knows and is able to do

2. Assessment as Learning

Assessment as learning involves students' reflecting on their learning and monitoring of their own progress. It focuses on the role of the student in developing and supporting metacognition.

Assessment as learning:

- enables students to use information gathered to make adaptations to their learning processes and to develop new understandings
- engages students in their own learning as they assess themselves and understand how to improve performance
- prompts students to consider how they can continue to improve their learning
- supports students in analyzing their learning in relation to learning outcomes

3. Assessment of Learning

Assessment of learning involves strategies designed to confirm what students know, in terms of curriculum outcomes. It also assists teachers to determine student proficiency and their 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 judgements about student performance by measuring learning after the fact and then reporting it to others. Used in conjunction with the other assessment processes previously outlined, however, 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 evidence to date of student achievement in relation to learning outcomes, to parents/ guardians, and other stakeholders
- reports student learning accurately and fairly, based on evidence obtained from a variety of contexts and sources

Involving Students in the Assessment Process

Students should know what they are expected to learn as outlined in the specific curriculum outcomes of a course as well as the criteria that will be used to determine the quality of their achievement. This information allows students to make informed choices about the most effective ways to demonstrate what they know and are able to do.

It is important that students participate actively in assessment by co-creating criteria and standards which can be used to make judgements about their own learning. Students may benefit from examining various scoring criteria, rubrics, and student exemplars.

Students are more likely to perceive learning as its own reward when they have opportunities to assess their own progress. Rather

than asking teachers, "What do you want?", students should be asking themselves questions such as:

- What have I learned?
- What can I do now that I couldn't do before?
- What do I need to learn next?

Assessment must provide opportunities for students to reflect on their own progress, evaluate their learning, and set goals for future learning.

Assessment Tools

In planning assessment, teachers should use a broad range of tools to give students multiple opportunities to demonstrate their knowledge, skills, and attitudes. The different levels of achievement or performance may be expressed as written or oral comments, ratings, categorizations, letters, numbers, or as some combination of these forms.

The grade level and the activity being assessed will inform the types of assessment teachers will choose.

Types of Assessment Tools:

- Anecdotal Records
- Audio/video clips
- Case Studies
- Checklists
- Conferences
- Debates
- Demonstrations
- Documentation using photographs

- Exemplars
- Graphic Organizers
- Journals
- Literacy Profiles
- Observations
- Podcasts
- Portfolio
- Presentations

- Projects
- Questioning
- Quizzes
- Role Play
- Rubrics
- Self Assessments
- Tests
- Wikis

Assessment Guidelines

It is important that students know the purpose of an assessment, the type, and the marking scheme being used. The following criteria should be considered:

- a rationale should be developed for undertaking a particular assessment of learning at a particular point in time
- all students should be provided with the opportunity to demonstrate the extent and depth of their learning
- assessments should measure what they intend to measure
- criteria used in the assessment should be shared with students so that they know the expectations
- evidence of student learning should be collected through a variety of methods and not be based solely on tests and paper and pencil activities
- feedback should be descriptive and individualized to students
- learning outcomes and assessment criteria together should provide a clear target for student success

Evaluation

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, making judgements or decisions based on the information gathered. Evaluation is conducted within the context of the outcomes, which should be clearly understood by learners before teaching and evaluation take place. Students must understand the basis on which they will be evaluated and what teachers expect of them.

During evaluation, the teacher:
- interprets the assessment information and makes judgements about student progress
- makes decisions about student learning programs

Section Two: Curriculum Design

Rationale

The vision of science education in Newfoundland and Labrador is to develop scientific literacy.

> *Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge 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.*

To develop scientific literacy, students require diverse learning experiences which provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, careers, futures.

Science education which strives for scientific literacy must engage students in science inquiry, problem solving, and decision making.

Science Inquiry

Science inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as "the" scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analyzing 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 phenomenon under investigation. Teachers should engage students in science inquiry activities to develop these skills.

Problem Solving

Problem solving involves seeking solutions to human problems. It may be represented as a cycle consisting of the proposing, creating, and testing of prototypes, products, and techniques in and attempt to reach an optimum solution to a given problem. The skills involved in this cycle facilitate a process which has different aims and procedures from science inquiry. Students should be given opportunities to propose, perform, and evaluate solutions to problem solving or technological tasks.

Decision Making

Decision making involves determining what we 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 process of decision making involves 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. While important in their own right, decision making situations also provide a relevant context for engaging in science inquiry and /or problem solving.

Curriculum Outcomes Framework

The basis of the curriculum outcomes framework are the general curriculum outcomes (GCOs). Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy: science, technology, society, and the environment (STSE), skills, knowledge, and attitudes. These four GCOs are common to all science courses.

General Curriculum Outcomes

GCO 1: Science, Technology, Society, and the Environment

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.

GCO 2: 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.

GCO 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.

GCO 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.

Key Stage Curriculum Outcomes

Key stage curriculum outcomes (KSCOs) align with the GCOs and summarize what students are expected to know and be able to do by the end of Science 6.

GCO 1: STSE	By the end of Science 6, students will 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 technology that 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

GCO 2: Skills	By the end of Science 6, students will be expected to

- ask questions about objects and events in the local environment and develop plans to investigate those questions
- observe and investigate their 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

GCO 3: Knowledge	By the end of Science 6, students will 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

GCO 4: Attitudes	By the end of Science 6, students will 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

Continued

GCO 4: Attitudes *continued*

- 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 the 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 safety and that of others in planning and carrying out activities and in choosing and using materials
- become aware of potential dangers

Specific Curriculum Outcomes

Specific curriculum outcomes (SCOs) align with the KSCOs and describe what students should know and be able to do at the end of each course. They are intended to serve as the focus for the design of learning experiences and assessment tasks.

SCOs are organized into units for each course.

Course Overview

The vision of scientific literacy sets out the need for students to acquire science-related skills, knowledge, and attitudes, and emphasizes that this is best done through the study and analysis of the interrelationships among science, technology, society, and the environment.

Science 4 SCOs are organized into five units:
- Integrated Skills
- Rocks, Minerals, and Erosion
- Sound
- Light
- Habitats and Communities

Note that the Integrated Skills unit is not intended to be taught as a stand alone unit. Rather, it is intended to be used as a reference.

Suggested Yearly Plan

The order in which the units appear in the Science 4 curriculum guide is the recommended sequence.

Unit 1 - Rocks, Minerals, and Erosion

Unit 2 - Sound

Unit 3 - Light

Unit 4 - Habitats and Communities

September	October	November	December	January	February	March	April	May	June
Rocks, Minerals, and Erosion		**Sound**			**Light**			**Habitats and Communities**	

How to Use the Four Column Curriculum Layout

Outcomes

Column one contains specific curriculum outcomes (SCO) and accompanying delineations where appropriate. The delineations provide specificity in relation to key ideas.

Outcomes are numbered in ascending order

Delineations are indented and numbered as a subset of the originating SCO.

All outcomes are related to general curriculum outcomes.

Focus for Learning

Column two is intended to assist teachers with instructional planning. It also provides context and elaboration of the ideas identified in the first column.

This may include:
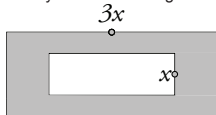
- references to prior knowledge
- clarity in terms of scope
- depth of treatment
- common misconceptions
- cautionary notes
- knowledge required to scaffold and challenge student's learning

---

SPECIFIC CURRICULUM OUTCOMES

Patterns and Relations (Variables and Equations)

Outcomes	Focus for Learning
Students will be expected to	
1.0 model, record and explain the operations of multiplication and division of polynomial expressions (limited to polynomials of degree less than or equal to 2) by monomials, concretely, pictorially and symbolically. [GCO 1]	
1.4 Provide examples of equivalent polynomial expressions.	Students should be encouraged to simplify all polynomials. Students should realize that it is often difficult to compare polynomials for equivalency until they are presented in simplified form. This is also an opportunity to highlight the value of expressing solutions in descending order.
1.5 Identify the error(s) in a given simplification of a given polynomial expression.	Questions requiring error analysis can be effective tools to assess students' understanding of simplifying polynomial expressions because it requires a deeper understanding than simply "doing the problem". Analyzing errors is a good way to focus discussion on "How did you get that?" rather than being limited to "Is my answer right?" This reinforces the idea that the process is as important as the solution.

Sample Performance Indicator

- The inside rectangle in the diagram below is a flower garden. The shaded area is a concrete walkway around it. The area of the flower garden is given by the expression $2x^2 + 4x$ and the area of the large rectangle, including the walkway and the flower garden, is $3x^2 + 6x$.

$3x$

x

(i) Ask students to write an expression for the missing dimensions of each rectangle.

(ii) Ask students to determine the area of the walkway.

Sample Performance Indicator(s)

This provides a summative, higher order activity, where the response would serve as a data source to help teachers assess the degree to which the student has achieved the outcome.

Performance indicators are typically presented as a task, which may include an introduction to establish a context. They would be assigned at the end of the teaching period allocated for the outcome.

Performance indicators would be assigned when students have attained a level of competence, with suggestions for teaching and assessment identified in column three.

SPECIFIC CURRICULUM OUTCOMES

Patterns and Relations (Variables and Equations)

Suggestions for Teaching and Assessment	Resources and Notes
Teachers may use the following activities and/or strategies aligned with the corresponding assessment tasks:	**Authorized Resources**
As students become comfortable with the addition, subtraction, multiplication and division of polynomial expressions, they should progress from concrete to symbolic representations. The distributive property is a common application when simplifying polynomials.	*Math Makes Sense 9* Lesson 5.5: Multiplying and Dividing a Polynomial by a Constant Lesson 5.6: Multiplying and Dividing a Polynomial by a Constant
Activation	
Students may	
• determine which of the following polynomials are equivalent: (i) $2(6x^2 - 4x - 2)$ (ii) $4x(3x - 2 - 1)$ (iii) $2(6x^2 - x - 2)$ (iv) $2(6x^2 - 4x - 2)$	ProGuide: pp. 35-42, 43-51 CD-ROM: Master 5.23, 5.24
Connection	SB: pp. 241-248, 249-257
Students may	PB: pp. 206-213, 214-219
• write two other polynomials which are equivalent to $2(6x^2 - 4)$	
Consolidation	**Suggested Resources**
Teachers may	"Using Error Analysis to Teach Equation Solving" *Mathematics Teaching in the Middle School* 12, 5 (December 2006/January 2007), pp. 238-242
• present a variety of multiplication and division problems, such as the one below, which are not properly simplified, discuss the errors and correct the solutions $\left(12x^2 - 4x\right) \div \left(-2x\right)$ $= \dfrac{12x^2}{-2x} - \dfrac{4x}{-2x}$ $= -6x - 2$ $= -8x$	
Students may	
• explain how to fix this simplification: $5x(3 - x)$ $= 15x - x$ $= 14x$	

Resources and Notes

Column four references supplementary information and possible resources for use by teachers.

These references will provide details of resources suggested in column two and column three.

Suggestions for Teaching and Assessment

This column contains specific sample tasks, activities, and strategies that enable students to meet the goals of the SCOs and be successful with performance indicators. Instructional activities are recognized as possible sources of data for assessment purposes. Frequently, appropriate techniques and instruments for assessment purposes are recommended.

Suggestions for instruction and assessment are organized sequentially:
- Activation - suggestions that may be used to activate prior learning and establish a context for the instruction
- Connection - linking new information and experiences to existing knowledge inside or outside the curriculum area
- Consolidation - synthesizing and making new understandings
- Extension - suggestions that go beyond the scope of the outcome

These suggestions provide opportunities for differentiated learning and assessment.

How to use a Unit overview

At the beginning of each unit there is explanation of the focus for the unit and a flow chart identifying the relevant GCOs, KSCOs and SCOs.

GCO 1: Students will be expected to examine the historical impact of religion on beliefs, cultures, and traditions.

Key Stage 6
- develop an understanding that throughout history people have been in relationship with the divine (e.g., animism, polytheism, monotheism)
- explore how religions are based on belief systems with distinct stories, symbols, and celebrations (e.g., Easter, the Khanda, Star of David)
- develop an appreciation of how society's morals and values are often rooted in religious teachings
- explore how religion is expressed through art, architecture, music, drama, and literature (e.g., Michelangelo, Handel's Messiah)

Specific Curriculum Outcomes
1.0 explore the origins of Buddhism, Christianity, Hinduism, and Sikhism
2.0 explain the significance of sacred signs and symbols
3.0 investigate how religious teachings and laws influence the development of morals and values
4.0 examine how religious beliefs are often expressed through the architecture of places of worship

GCO 2: Students will be expected to develop an understanding of the beliefs, principles, and practices of Christianity and other living belief systems.

Key Stage 6
- explore what is meant by belief
- demonstrate a knowledge of basic beliefs of various religions
- demonstrate an understanding that religious principles are founded in religious texts, both oral and written (e.g., Bible, Qur'an, Bhagavad Gita)
- recognize that religious principles emerged from the life and teachings of founders, prophets, teachers, and leaders of various religions
- examine the importance of religious values in developing a code of living
- explore the importance of religious practices (e.g., rites of passage, confirmation, Bar Mitzvah)

Specific Curriculum Outcomes
5.0 investigate prayer, meditation, and worship as expressions of belief
6.0 describe basic beliefs of Buddhism, Christianity, Hinduism, and Sikhism

GCO 3: Students will be expected to examine the meaning and relevance of sacred texts.

Key Stage 6
- demonstrate an understanding of the sources of sacred texts, both oral and written (e.g., Bible, Qur'an)
- demonstrate an appreciation of the importance placed on sacred texts by their adherents
- demonstrate a knowledge of important events and characters within sacred texts (e.g., Passover, Last Supper, Paul, Krishna)

Specific Curriculum Outcomes
7.0 recognize that principles of empathy, forgiveness, and justice are evident in Buddhist, Christian, Hindu, and Sikh texts and teachings
8.0 describe key events in Buddhism, Christianity, Hinduism, and Sikhism

GCOs

KSCO

SCOs

Previous Grade

Current Grade

Next Grade

GCO

GCO 1: Students will be expected to examine the historical impact of religion on beliefs, cultures, and traditions.

SCOs

	Grade 4	Grade 5	Grade 6
1.0	explore the origins of Judaism, Christianity, and Islam	explore the origins of Buddhism, Christianity, Hinduism, and Sikhism	explore the origins of Bahá'í Faith, Christianity, and Islam
2.0	explain the significance of religious celebrations	explain the significance of sacred signs and symbols	examine stories of creation and the afterlife in Aboriginal Spirituality, Christianity, and Islam
3.0	explore how teachings and laws of Christianity, Islam and Judaism influence the development of morals and values	investigate how religious teachings and laws influence the development of morals and values	compare the teachings and laws of Christianity and Islam
4.0		examine how religious beliefs are often expressed through the architecture of places of worship	examine how religious beliefs are often expressed through art, music, drama, and dance

The SCOs Continuum follows the chart to provide context for teaching and assessment for the grade/course in question. The current grade is highlighted in the chart.

Section Three:
Specific Curriculum Outcomes

Unit i: Integrated Skills

Focus

Students use a variety of skills in the process of answering questions, solving problems, and making decisions. While these skills are not unique to science, they play an important role in the development of scientific understandings and in the application of science and technology to new situations.

The listing of 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.

Four broad areas of skills are outlined and developed:

- Initiating and Planning - These are the skills of questioning, identifying problems, and developing initial ideas and plans.
- Performing and Recording - These are the skills of carrying out action plans, which involves gathering evidence by observation and, in most cases, manipulating materials and equipment.
- Analyzing and Interpreting - These are the skills of examining information and evidence, of processing and presenting data so that it can be interpreted, and interpreting, evaluating, and applying the results.
- Communication and Teamwork - In science, as in other areas, communication skills are essential at every stage where ideas are being developed, tested, interpreted, debated, and agreed upon. Teamwork skills are also important, since the development and application of science ideas is a collaborative process both in society and in the classroom.

Students should be provided with opportunities to develop and apply their skills in a variety of contexts. These contexts connect to the STSE component of the curriculum by linking to three processes for skills application:

- science inquiry - seeking answers to questions through experimentation and research
- problem solving - seeking solutions to science-related problems by developing and testing prototypes, products, and techniques to meet a given need.
- decision making - providing information to assist the decision making process.

Outcomes Framework

GCO 2 (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.

1.0 propose questions to investigate and practical problems to solve
2.0 rephrase questions in a testable form
3.0 state a prediction and a hypothesis
4.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate
5.0 devise procedures to carry out a fair test and to solve a practical problem
6.0 identify appropriate tools, instruments, and materials to complete investigations
7.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
8.0 select and use tools
9.0 follow procedures
10.0 select and use tools for measuring
11.0 make observations and collect information that is relevant to the question or problem
12.0 record observations
13.0 identify and use a variety of sources and technologies to gather relevant information
14.0 construct and use devices for a specific purpose
15.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
16.0 compile and display data
17.0 identify and suggest explanations for patterns and discrepancies in data
18.0 draw a conclusion that answers an initial question
19.0 suggest improvements to a design or constructed object
20.0 evaluate personally constructed devices
21.0 identify new questions or problems that arise from what was learned
22.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations
23.0 communicate procedures and results
24.0 work with group members to evaluate processes used in solving a problem
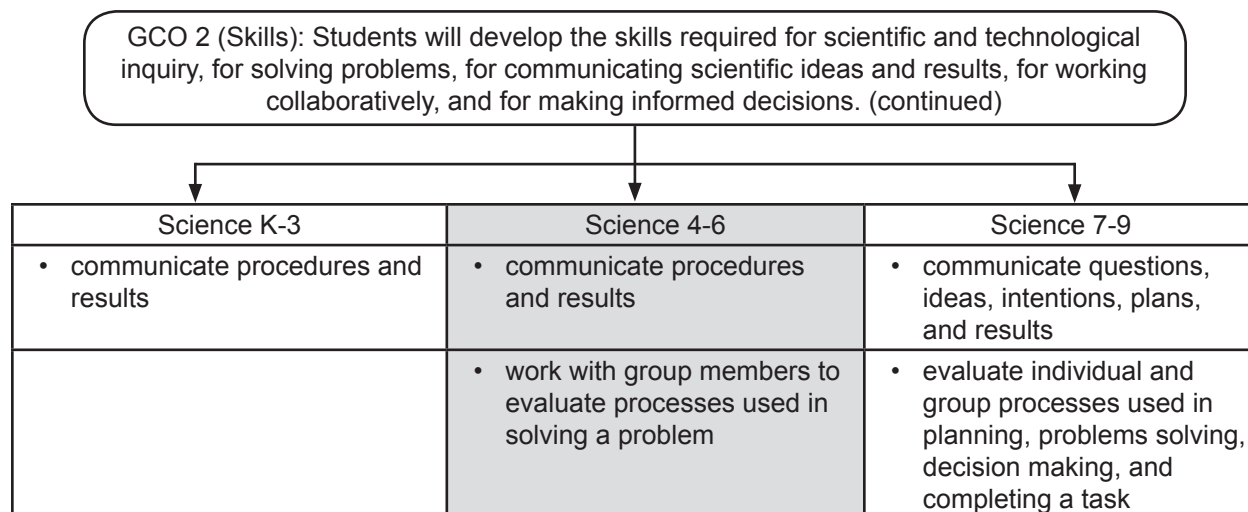
SCO Continuum

GCO 2 (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.

Science K-3	Science 4-6	Science 7-9
• pose questions that lead to exploration and investigation • identify problems to be solved	• propose questions to investigate and practical problems to solve	• identify questions to investigate arising from practical problems and issues
	• rephrase questions in a testable form	• rephrase questions in a testable form and clearly define practical problems
• predict based on an observed pattern	• state a prediction and a hypothesis	• state a prediction and a hypothesis based on background information or an observed pattern of events
	• identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate	• propose alternative solutions to a given practical problem, select one, and develop a plan
• identify materials and suggest a plan for how they will be used	• devise procedures to carry out a fair test and to solve a practical problem	• design an experiment and identify major variables
• select and use materials to carry out their own explorations and investigations	• identify appropriate tools, instruments and materials to complete investigations	• select appropriate methods and tools for collecting data and information and for solving problems
	• carry out procedures to explore a given problem and to ensure a fair test, controlling major variables	• carry out procedures controliing the major variables
• use appropriate tools	• select and use tools • select and use tools for measuring	• use instruments effectively and accurately for collecting data
• follow a simple procedure	• follow procedures	
• make and record observations and measurements	• make observations and collect information that is relevant to the question or problem • record observations	• organize data using a format that is appropraite to the task or experiment
• use a variety of sources of science information	• identify and use a variety of sources and technologies to gather relevant information	• select and integrate information from various print and electronic sources or from several parts of the same source

GCO 2 (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. (continued)

Science K-3	Science 4-6	Science 7-9
	• construct and use devices for a specific purpose	
• use personal observations when asked to describe materials and objects • sequence or group materials and objects • identify the most useful method of sorting	• classify according to several attributes and create a chart or diagram that shows the method of classifying	• use or construct a classification key
• construct and label concrete-object graphs, pictographs, or bar graphs	• compile and display data by hand or computer, in a variety of formats	• compile and display data, by hand or computer, in a variety of formats • identify the strengths and weaknesses of different methods of collecting and displaying data
• identify and suggest explanations for patterns and discrepancies in objects and events	• identify and suggest explanations for patterns and discrepancies in data	• interpret patterns and trends in data, and infer and explain relationships among the variables • identify, and suggest explanations for, discrepacines in data
• propose an answer to an initial question or problem and draw a simple conclusion	• draw a conclusion that answers an initial question	• state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea
• compare and evaluate personally constructed objects	• suggest improvements to a design or constructed object • evaluate personally constructed devices	• evaluate designs and prototypes in terms of functionality, reliability, safety, efficiency, use of materials, and impact on the environment
• pose new questions that arise from what was learned	• identify new questions or problems that arise from what was learned	• identify new questions and problems that arise from what was learned
• communicate while exploring and investigating	• communicate questions, ideas, and intentions, and listen to others while conducting investigations	• receive, understand, and act on the ideas of others

GCO 2 (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. (continued)

Science K-3	Science 4-6	Science 7-9
• communicate procedures and results	• communicate procedures and results	• communicate questions, ideas, intentions, plans, and results
	• work with group members to evaluate processes used in solving a problem	• evaluate individual and group processes used in planning, problems solving, decision making, and completing a task

Suggested Unit Plan

The Integrated Skills unit is not intended to be taught as a stand alone unit. Rather, it is intended to be used as a reference. When skill outcomes [GCO 2] are encountered in units 1-4, teachers should refer to the focus for learning elaborations and teaching and assessment suggestions provided here.

Skill outcomes have been integrated within Units 1-4 and students should be provided with opportunities to develop and apply these skills in varied contexts:

- science inquiry - seeking answers to questions through experimentation and research.
- problem solving - seeking solutions to science-related problems by developing and testing prototypes, products, and techniques to meet a given need.
- decision making - providing information to assist the decision making process.

September	October	November	December	January	February	March	April	May	June

Integrated Skills

Initiating and Planning

Outcomes	**Focus for Learning**
Students will be expected to 1.0 propose questions to investigate and practical problems to solve [GCO 2]	Science begins with a question; engineering begins with a problem. In Science K-3, students posed questions that led them to explore and investigate. In Science 4-6, students are expected to suggest questions to investigate. Questions that can be investigated are testable questions; they can be answered by making measurements and observations. Proposing testable questions is the first stage of scientific inquiry processes. Science 4-6 students are also expected to suggest practical problems to solve. Proposing problems to solve is the first stage of engineering design and problem solving processes. Student proposed questions and problems flow from their personal observations, prior knowledge, and experiences. Students will experience difficulty coming up with them if simply asked to brainstorm them at the outset. Students should consider whether proposed questions are testable and problems practical to solve. Where possible, questions investigated and problems solved should be suggested by students.
2.0 rephrase questions in a testable form [GCO 2]	To initiate science investigations, students are expected to rephrase initial questions in a testable form. Testable questions can be answered by making measurements and observations. They are specific, use precise language, and suggest an investigation. In experiments, testable questions are about changing one variable to see the affect on another. They have two parts; a variable to test (i.e., the independent variable) and a variable to measure or observe (i.e., the dependent variable): • What is the effect of ___ on ___? • What is the relationship between ___ and ___? • How does changing ___ affect ___? Students should recognize that the independent variable is deliberately changed by the experimenter as part of the investigative design and that the dependent variable is measured or observed by the experimenter during the experiment. Good experiments have only one independent variable.

Initial Question	Testable Question
What makes a shadow bigger?	How does changing the distance an object is placed in front of a light source affect the size of the shadow?
What makes the sound of an elastic band different?	What is the effect of stretching an elastic band on the pitch of sound produced when plucked?
What causes erosion?	What is the relationship between the slope of the land and the amount of erosion?

Initiating and Planning

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Discuss "What are science and engineering?" and "What do scientists and engineers do?" to highlight the importance of proposing questions and problems to initiate scientific inquiry and engineering design and problem solving processes.
- Prompt students to generate questions and problems using provocations to spark their curiosity and interest (e.g., artifacts, children's literature, demonstrations, field trips, guest speakers, introductory hands on activities, nature walks, video clips).

Connection

Teachers may

- Model proposing questions from provocations. Bounce a ball on the floor or roll it down a ramp, for example, and propose aloud testable questions to investigate (i.e., I wonder what effect ball size has on the height the ball bounces?, I wonder if the slope of the ramp affects the distance the ball rolls?).
- Model proposing practical problems to solve.
- Provide examples of testable questions.
- Provide students feedback on their initial questions and opportunities to rephrase their questions to make them testable.

Students may

- Use a question matrix to generate initial questions.
- Record questions on an "I Wonder" wall, KWHL chart, or in their personal science learning journal. New questions should be added as they arise.
- Determine if questions are testable (i.e., Does the question suggest an investigation?, Does it have a variable to test?, Does it indicate a variable to measure or observe?) and, if necessary, rephrase questions to make them testable.
- Identify the independent and dependent variables in testable questions.

Consolidation

Students may

- Carry out student initiated inquiry investigations and design and problem solving experiences, throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes	Focus for Learning
Students will be expected to 3.0 state a prediction and a hypothesis [GCO 2]	In Science K-3, students made predictions. In Science 4-6, students are expected to make predictions and state hypotheses. Predictions are statements about what will or what might happen in the future. Predictions are made in relation to testable questions. In experiments, students predict how a change in the independent variable will affect the dependent variable. Experimental predictions may be written as "If..., then..." statements. Predictions in science are not guesses. They should be based on prior observations and knowledge. Predictions supported by detailed reasoning are referred to as hypotheses; they explain predictions. Hypotheses may be written as "If..., then... because..." statements. The statement includes a prediction (i.e., "If..., then...") and the explanation (i.e., "because..."). Example: • If coloured toothpicks are scattered in the grass, then the green toothpicks will be collected in smaller numbers, because they are camouflaged and harder to find. • If light is shone on a brick, then the light will not pass through it because the brick is opaque and opaque objects do not transmit light. Science investigations test predictions and hypotheses. They are supported or rejected by the evidence collected. Students whose hypotheses are rejected may attempt to change them after the fact in order to be viewed as "correct". Encourage students to appreciate the importance of accuracy and honesty in science investigations. In practice, the vast majority of scientific hypotheses fail. Investigations are considered successful regardless of whether the evidence supports or rejects a hypothesis because something has been learned. Cross curricular connections may be made to the predicting strategy unit in English Language Arts.

Initiating and Planning

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present relevant texts from the *Moving Up with Literacy Place 4: Predicting Unit* and ask students to make predictions before and during reading. Explicitly connect making predictions in reading to making predictions in science.
- Ask students to make predictions about the weather.

Connection

Teachers may

- Distinguish between guessing and predicting.
- Model making predictions and communicate the reasoning behind them.
- Make predictions that will be rejected to illustrate that rejection is not failure; something is still learned.
- Ask students to provide a rationale when making predictions. Is the prediction based on an observed pattern, prior knowledge, or prior experience?
- Model making predictions using "If..., then..." statements and hypotheses using "If..., then... because..." statements.

Students may

- Use "If..., then..." and "If..., then... because..." templates to make predictions and hypotheses.
- Practice making predictions and hypotheses for silly scenarios (e.g., If I eat too much candy, then ... because ...).
- Practice making predictions and hypotheses in relation to testable questions:
    - What is the effect of rock size on how fast it sinks in water?
    - What affect does tightening a guitar string have on the pitch of the sound?
    - How does moving a light source closer to an object affect the size of the shadow produced?
    - Do earthworms prefer dry or moist soils?

Consolidation

Students may

- Make and record predictions and hypotheses using "If..., then..." and "If..., then... because..." formats, when investigating inquiry questions throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 4*: *Predicting Strategy Unit (*ELA 4)
    - *To the Top of Everest*
    - *Puss in Boots*
    - *Why Rabbit has a short Tail*

Initiating and Planning

Outcomes

Students will be expected to

4.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate
[GCO 2]

Focus for Learning

When planning inquiry investigations and design and problem solving experiences, students should identify various methods for finding answers to their question and solutions to their problem, and select one that is appropriate.

Scientists employ various scientific methods depending on the question being investigated. Scientific methods include

- field studies (e.g., observing living things in their natural habitat);
- surveys (e.g., collecting rock and mineral samples, surveying aquatic plants or animals in a freshwater pond);
- modelling (i.e., creating models to observe and investigate when the focus is something very small or very large, or an event that occurs over a very long time period); and
- experiments (i.e., organized procedures to study something under controlled conditions).

Experimental processes also vary. Processes followed by scientists do not always include the same steps, or use them in the same order. Sometimes steps are repeated. Typically, scientists initiate an experiment by proposing a testable question and stating a prediction and hypothesis. The experiment is carefully planned; methods chosen, variables identified, materials compiled, and a detailed procedure devised. Scientists then perform the experiment; making, recording, and organizing observations and measurements. The collected data is analyzed and interpreted, enabling scientists to draw conclusions and communicate what is learned to others.

Similarly, engineers use various methods to solve problems. Engineering design and problem solving processes always begins with identification of a problem to be solved (i.e., a need). Engineers research the problem to see if it has been solved before. They may choose to modify or improve an existing solution or follow a process to find a new solution (i.e., technology) to the problem. Engineers work in teams to brainstorm possible solutions and select an idea worth trying considering the design criteria and constraints (e.g., time, materials and tools available, cost, ease of construction). A working model of their idea (i.e., prototype) is constructed and tested. Prototypes are rarely perfect the first time. They require iterative design changes and modifications to improve them. Sometimes prototypes do not show promise and are abandoned in favour of trying a different idea. Once testing and evaluation confirms that a prototype works well, it is deemed finished and the new technology can be shared with others.

Students should recognize the stages of typical scientific inquiry and design and problem solving processes.

Initiating and Planning

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Demonstrate various strategies to find an answer to a mathematics question and explicitly make the connection to using various methods in science and engineering.

Students may

- Brainstorm multiple ways that everyday questions can be answered and practical problems solved. For example:
    - How could we find out what movies are playing at a cinema?
    - How could you open a jar that is difficult to open?

Connection

Teachers may

- Discuss various methods (e.g., field studies, surveys, modelling, experiments) that could be used to find answers to scientific inquiry questions. "What do Gray seals eat?", for example, could be answered through research, expert interviews, observations in the field, surveying stomach contents of hunted seals, or experimenting with seals in captivity. Ask students to consider the costs and benefits of the various methods.
- Discuss various methods that could be used to solve problems. Preventing soil erosion from a hillside, for example, could be prevented by reducing the slope of the hill, terracing, installing retaining walls (e.g., gabions), or planting trees and shrubs. Ask students to consider the costs and benefits of various methods.

Students may

- Brainstorm ways to find answers to questions and select the most appropriate method:
    - What organisms live in the pond nearest your school?
    - What factors affect amount of erosion from local beaches?
- Brainstorm various ways to solve problems and select the most promising method:
    - How can we prevent weathering of granite counter tops?
    - Construct a device that allows you to see behind you without turning around.

Consolidation

Students may

- Identify various methods for finding answers to their questions and solutions to their problems, when investigating and problem solving throughout Science 4, and select one method that is appropriate.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes	**Focus for Learning**
Students will be expected to 5.0 devise procedures to carry out a fair test and to solve a practical problem [GCO 2]	Students are expected to develop procedures to investigate questions and solve practical problems. Students should devise procedures with clear, ordered, and replicable steps. Experimental procedures should be devised in a manner such that, when carried out, they ensure a fair test. Fair testing requires the identification of all the variables of influence. The independent variable is the condition the experimenter chooses to change. The dependent variable is the condition the experimenter measures or observes during the investigation. All other conditions that could influence the dependent variable are called controlled variables. These controlled variables must be kept the same for a test to be fair.

Testable Question	How does changing the distance an object is placed in front of a light source affect the size of the shadow produced on the wall?
Independent Variable	Distance the object is placed in front of the light source (i.e., variable to test)
Dependent Variable	Size of the shadow on the wall (i.e., variable to measure)
Controlled Variables	Variables that must be kept the same • use the same light source each time • keep the light source in the same position (i.e., same distance from the wall) • use the same object • use the same measuring tool • use the same method to measure each time

To be a fair test, identical procedures must be uniformly performed, where only one variable, the independent variable, is changed.

Planning procedures is equally important in engineering design and problem solving processes. Once a problem has been identified and researched, possible solutions generated, and an idea worth trying selected, students should plan a set of steps to construct a working model of their solution (i.e., prototype). Devised procedures should be clear, ordered, and replicable and may include drawings. To evaluate whether a prototype solves a problem it must be tested. Students should also devise procedures to fairly test prototypes.

Cross curricular connections may be made to English Language Arts outcomes related to the creation of procedural texts.

Initiating and Planning

Sample Teaching and Assessment Strategies	Resources and Notes

Activation
 	
Teachers may
• Have students devise procedures for everyday tasks (e.g., sharpening a pencil, opening a window or door). Ask specific students to read aloud their procedures while you attempt to carry out their steps. Act confused when procedures are unclear, lack detail, are out of order, or fail to include necessary steps. Provide opportunities for students to orally revise their procedures.
 	
Connection
 	
Teachers may
• Provide students unordered procedural steps and have them sequence the steps in the appropriate order.
• Demonstrate unfair testing procedures (e.g., biased procedures, procedures with inconsistent methods for different trials, procedures that contain more than one independent variable) and ask students to identify the problem with the procedure and suggest solutions.
• Provide testable questions and ask students to identify all the conditions the procedure would need to keep the same (i.e., controlled variables) in order for the test to be fair.
• Use question prompts when students are devising procedures
  - Have you omitted any steps?
  - Would a diagram or sketch help to explain your procedure?
  - Have you controlled all important variables?
  - Can your steps be followed by someone else?
• Assess written, visual, or oral procedures for clarity, order, replicability of steps, and fairness (i.e., control of major variables).
 	
Students may
• Work in collaborative groups to devise fair procedures. Groups should exchange procedures and provide feedback with respect to the clarity, order, replicability of steps, and fairness.
 	
Consolidation
 	
Students may
• Devise procedures to ensure fairness, controlling major variables, when investigating and problem solving throughout Science 4.
	Authorized
	
	NL Science 4: Online Teaching Centre
	• Science Skills Toolkit
	• Skills and Processes for Scientific Inquiry rubric builder (BLM)
	• Skills and Processes for Design and Problem Solving rubric builder (BLM)
	
	NL Science 4: Online Student Centre
	• Science Skills Toolkit

Initiating and Planning

Outcomes	Focus for Learning
Students will be expected to 6.0 identify appropriate tools, instruments, and materials to complete investigations [GCO 2]	In Science K-3, students identified and selected materials, suggested how the materials could be used, and used them to carry out explorations and investigations. In Science 4-6, students are expected to identify tools, measuring instruments, and materials needed to conduct an investigation. Sometimes the materials needed to complete investigations are given to students. However, to address this outcome, students should determine what tools (e.g., scientific tools, construction tools, household tools, and digital tools), measuring instruments (e.g., ruler, triple beam balance, graduated cylinder, force meter, thermometer, sound meter), and materials they need and generate a materials list. The list should identify the quantity and size of materials required and may be revised as problems carrying out the procedure are encountered. Devised procedures may include diagrams of how some materials will be set up. Students should identify tools, measuring instruments, and materials by name and determine their appropriateness for a specified task. Identifying appropriate tools, measuring instruments, and materials is equally important in design and problem solving processes.

Initiating and Planning

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Display anchor charts of commonly used scientific, construction, and household tools and measurement instruments.
- Act out silly situations where they select an inappropriate tool, measuring instrument, or material for a task (e.g., trying to cut cardboard with a hammer, measuring distance with a thermometer).

Connection

Teachers may
- Provide varied materials from which students can select. When investigating whether objects are transparent, translucent or opaque, for example, have students select the materials they wish to test.
- Provide varied tools and measuring instruments from which students can select when planning investigations and design and problem solving experiences. Include appropriate and inappropriate tools for the task.
- Prompt students to identify tools, measuring instruments, and materials by name.

Students may
- Compare the tools, measuring instruments, and materials selected by different groups and critically evaluate their effectiveness.

Consolidation

Students may
- Devise a list of required materials, tools, and measuring instruments, when investigating and problem solving throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Performing and Recording

Outcomes	Focus for Learning
Students will be expected to	
7.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables [GCO 2]	Students are expected to carry out investigative and design and problem solving procedures in a manner that ensures fair testing and controls major variables.
	Introduce the concept of bias. Holding a bias means unfairly favouring one variable over another. When testing paper airplanes, for example, releasing one with more force is not fair. All airplanes must be thrown uniformly. Fair testing requires that identical procedures be uniformly performed. Students are expected to carry out procedures in a manner that eliminates bias and controls major variables of influence.
	Multiple trials are recommended to ensure that results are accurate, reliable, and reproducible. If a variable is changed accidentally, this will only become evident if further trials are performed and discrepancies in data identified. Once evident, this error can be corrected in future trials. Procedures may need to be revised as they are carried out to ensure fairness.
	Whether conducting experiments or testing prototypes, carrying out procedures to ensure a fair test is important.
8.0 select and use tools [GCO 2]	In Science K-3, students used tools to make observations, manipulate materials, and build simple models. In Science 4-6, students are expected to select and use tools to complete tasks. Tools include:
	• scientific tools (e.g., funnels, geology hammers, glassware, lenses, magnets, magnification tools, eye droppers, ray boxes);
	• construction tools (e.g., crowbars, hacksaws, hammers, pulleys, screwdrivers, snips, wrenches, utility knives);
	• household tools (e.g., flashlights, hole punches, glue guns, mirrors, scissors, toothpicks, tweezers); and
	• digital tools (e.g., digital cameras, computer programs, and mobile device applications).
	Sometimes the tools needed to complete a task are given to students. To address this outcome, however, students should select the tools they need. Students should identify tools by name and use them safely and correctly. Safe and proper use of some tools may require explicit instruction and adult supervision.
	Encourage students to show concern for the safety of themselves and others when using tools.

Performing and Recording

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Teachers may • Act out situations where procedures are not fairly carried out. • Review the role of controlled variables in experiments. **Connection** Teachers may • Discuss the concept of bias in experimental procedures and the importance of conducting multiple trials. • Assess whether students carry out procedures, to ensure a fair test, using direct observations or digital video. • Provide varied tools from which students can select. Students may • Communicate the variables they are attempting to control when carrying out procedures. • Videotape their group carrying out procedures and review the video to ensure that identical procedures are uniformly performed, controlling major variables. • View videos of other groups carrying out procedures and identify variables that were not controlled. • Provide reasons for their tool choice and describe any difficulties encountered while using the tool. • Reflect on their tool choice following use and consider whether it was an appropriate choice for the task. • Compare the tools selected by different groups and critically evaluate their effectiveness for the task. **Consolidation** Students may • Select and use tools accurately and safely, and carry out procedures to ensure fair tests, controlling major variables, when investigating and problem solving throughout Science 4.	**Authorized** *NL Science 4: Online Teaching Centre* • Science Skills Toolkit • Skills and Processes for Scientific Inquiry rubric builder (BLM) • Skills and Processes for Design and Problem Solving rubric builder (BLM) *NL Science 4: Online Student Centre* • Science Skills Toolkit

Performing and Recording

Outcomes	Focus for Learning
Students will be expected to 9.0 follow procedures [GCO 2]	In Science K-3, students followed simple procedures where instructions were given one at a time. In Science 4-6, students are expected to follow complete sets of procedures. Procedures may be teacher or student devised and be presented in written, visual, or oral formats. Students should review all procedural steps prior to beginning an investigation or problem solving experience and clarify steps that are not understood. Unless there is a potential safety issue, teachers should not intervene when students fail to follow procedures. Students will learn more about the importance of accurately, precisely, and sequentially following procedures without intervention. Connections may be made to following procedures in other curricular (e.g., English Language Arts - *Sequencing Unit*) and non-curricular settings.
10.0 select and use tools for measuring [GCO 2]	Students are expected to select appropriate measuring tools and use them accurately with the correct unit of measure. Students should select the best measuring tool from collections that measure • length (e.g., callipers, laser distance meter, meter sticks, various rulers, tape measures, trundle wheel); • mass (e.g., bathroom scale, digital mass scale, food scale, pan balance, spring scales, triple beam balance); • time (e.g., analog clock, mechanical timer, sand timers, digital stop watches); • volume (e.g., beakers, eye droppers, graduated cylinders, measuring cups, measuring spoons); • force (e.g., force meter, digital force meters); • temperature (e.g., digital probe thermometers, various liquid in glass thermometers, infrared thermometers, liquid crystal thermometers); and • sound and light intensity (e.g., decibel meter, light meter). Teachers should demonstrate use of various scientific measuring tools. Sometimes the measuring tools needed to conduct an investigation or test a prototype are given to students. To address this outcome, however, students should select their own measuring tools. Students should select scientific measurement tools when provided a choice; selecting a graduated cylinder, for example, rather than a measuring cup. Metric or SI units (e.g., meter, gram, litre, °C, hertz, decibel), rather than imperial units, should be used. To ensure measurement accuracy, students should calibrate instruments prior to use, use consistent measurement techniques, and take repeated measurements. Cross curricular connections may be made to Mathematics 4 outcomes related to measurement of time.

Performing and Recording

Sample Teaching and Assessment Strategies	Resources and Notes

Activation

Students may

- Play "Simon Says" and barrier games to practice following procedures accurately.
- Follow visual building instructions (i.e., procudures) to construct Lego™ toys.

Connection

Teachers may

- Demonstrate use of various scientific measuring tools.
- Provide students with a varied measuring tools (e.g., scientific and non-scientific, appropriate and inappropriate) to select from when conducting investigations or constructing and testing prototypes.

Students may

- Practice using various scientific measuring tools accurately.
- Communicate the reasoning behind their selected measuring tool.
- Discuss the appropriateness of their selected measuring tool, following use, and describe any difficulties encountered.
- Compare and critically evaluate the effectiveness of measuring tools used by different groups.
- Demonstrate accurate use of scientific measuring tools using the correct unit measurement.

Consolidation

Students may

- Follow procedures and select and use measuring tools appropriately, when investigating and problem solving throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes	Focus for Learning
Students will be expected to 11.0 make observations and collect information that is relevant to the question or problem [GCO 2]	In Science K-3, students made measurements and observations. In Science 4-6, the expectation is for students to make observations and collect information relevant to the investigated question or problem being solved. Making observations is a critical science and engineering skill that must be continually developed. Students will have little difficulty making simple observations, however, explicit instruction and practice will be needed to make more detailed scientific and technological observations. Students should use all appropriate senses when observing and, where applicable, use appropriate physical and digital tools to measure, observe, and collect information. Determining what measurements, observations, and information are relevant to the question or problem should be considered during the initiating and planning phase. What evidence is needed to answer the question? What design criteria must be met to solve the problem? Students should, when relevant, collect both quantitative and qualitative data. Quantitative data is measured and is expressed in numbers (e.g., length, mass, time, volume, force, temperature). Qualitative data is observed but not measured. It usually describes characteristics or qualities using words (e.g., colour, texture, lustre, appearance, behaviour).
12.0 record observations [GCO 2]	Observations capture a moment in time. To be analyzed and interpreted, observations must be recorded for future use. Records may take various forms • digital images, video, and audio recordings; • two column observational notes (i.e., time and observations); • charts (tally charts, tables); and • diagrams (e.g., drawings, graphic organizers, Venn diagrams). Students may be directed to record their observations a specific way and be provided with a recording form. Sometimes, however, students should record observations in a format of their choosing and create their own recording form. Students should consider the type of measurements, observations, and information being collected in choose an appropriate recording format. Explicit instruction on the use and appropriateness of common formats will be required. Students should record all measurements and observations, even when they are not what was expected. Encourage students to appreciate the importance of accuracy and honesty in recording, whether investigating questions or solving problems.

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Provide a focus object (e.g., a celery stalk) and have students make observations using all appropriate senses.

Connection

Teachers may
- Differentiate between qualitative and quantitative observations.
- Have students make quantitative and qualitative observations of a focus object (e.g., glass of water) using personally selected tools and measuring instruments.
- Explicitly instruct students on the use and appropriateness of common recording formats (e.g., two column observational notes, scientific drawings, graphic organizers, Venn diagrams, tally charts, tables).
- Assess the level of detail and accuracy of qualitative and quantitative observations.

Students may
- Brainstorm relevant measurements, observations, and information that can be collected to answer questions or solve problems.
- Classify observations as quantitative or qualitative.
- Consider various methods of recording observations and select one that is appropriate for the measurements, observations, or information being collected.
- Communicate the reasoning behind their selected recording format.
- Compare and critically evaluate the effectiveness of the recording methods used by different groups.

Consolidation

Students may
- Make observations and measurements, and record them in a various formats, when investigating and problem solving throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

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- Science Skills Toolkit

Performing and Recording

Outcomes	Focus for Learning
Students will be expected to 13.0 identify and use a variety of sources and technologies to gather relevant information [GCO 2]	Finding answers to questions and designing solutions to problems requires the gathering of information. Gathering information occurs at multiple stages in inquiry and design and problem solving processes. However, this skill outcome pertains to information collected while conducting investigations or testing and evaluating prototypes. The measurements, observations, and information to be collected and the sources and technologies to be used are identified during initiation and planning stage. The collected measurements, observations, and information represent the evidence to be analyzed and interpreted in answering the question or evaluating the prototype. Students are expected to use various sources and technologies to collect evidence. Evidence may be collected from field studies, surveys, modelling, experiments, and prototype testing using various physical and digital technologies. Evidence may also be obtained from interviews and questionnaires. Cross curricular connections may be made to English Language Arts outcomes related to selecting, interpreting, and combining information using a variety of strategies, resources, and technologies.
14.0 construct and use devices for a specific purpose [GCO 2]	Students are expected to solve practical problems by personally constructing and using devices (i.e., technology). As part of engineering design and problem solving processes, students should construct prototypes of their selected ideas to test. Prior to beginning construction, students should review their procedures and design sketches, and make sure they know how to use all required tools correctly and safely. Materials may be measured and cut, if required, in preparation for construction. Students should follow the procedure in constructing their prototype. Problems encountered during construction, however, may result in changes to the procedure, design, or tools, measuring instruments, and materials used. Prototypes rarely work perfectly the first time. They require iterative design changes and modifications, testing and retesting, to make improvements. Once satisfied that the prototype works well, the final device can be constructed and the solution shared. Encourage students to follow given safety procedures and rules when constructing devices and show concern for their safety and that of others.

Performing and Recording

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Students may • Observe and manipulate unfamiliar devices and infer for what purpose they may be used. **Connection** Teachers may • Review potential sources of information (e.g., field studies, surveys, modelling, experiments, prototype testing, interviews, questionnaires) and the use of varied magnification tools, measuring tools, and digital technologies. • Display an anchor chart of a design and problem solving process for students to follow. • Model a design and problem solving process in solving a problem. Students may • Practice collecting measurements, observations, and information using various magnification tools, measuring tools, and digital technologies. • Participate in design challenges to practice following design and problem solving processes (e.g., building the tallest tower using dry spaghetti, mini-marshmallows, and straws). **Consolidation** Students may • Use varied information sources and technologies to collect measurements, observations, and information to analyze and interpret, when investigating and problem solving throughout Science 4. • Personally construct useful devices to solve problems throughout Science 4.	**Authorized** *NL Science 4: Online Teaching Centre* • Science Skills Toolkit • Skills and Processes for Scientific Inquiry rubric builder (BLM) • Skills and Processes for Design and Problem Solving rubric builder (BLM) *NL Science 4: Online Student Centre* • Science Skills Toolkit Teaching and Learning Strategies • www.k12pl.nl.ca/learning-skills/stucomp/literacy/numeracy/lnt/processes/infer.html - Inferring

Analyzing and Interpreting

Outcomes	Focus for Learning
Students will be expected to	
15.0 classify according to several attributes and create a chart or diagram that shows the method of classifying [GCO2]	Classification involves sorting items into categories or groups according to similarities and differences in their attributes. In Science K-3, students sorted items according to a single attribute. In Science 4-6, students are expected to classify items using multiple attributes at once. Minerals, for example, may be classified by lustre and hardness (i.e., two attributes), or colour, lustre, and hardness (i.e., three attributes) at once. Classifying using multiple attributes is a challenging skill that will require explicit instruction and practice.
	Classification is a method of analysis and interpretation. Students should create a chart or diagram to show their method of classification (e.g., tree diagrams, Venn diagrams, Carroll diagrams, tables). Explicit instruction in the proper use of some charts and diagrams may be required.
16.0 compile and display data [GCO2]	This skill pertains to organizing and displaying the measurements, observations, and information collected from science investigations and prototype testing. Compiling and displaying evidence makes it easier to identify patterns and relationships. Measurements, observations, and information organized for analysis and interpretation are referred to as data.
	In Science 4-6, students are expected to compile and display data in a variety of formats (e.g., frequency tables, data tables, graphs), by hand, or using computer or mobile device applications. Students collected and organized first-hand data and constructed and interpreted bar graphs in Mathematics 3. Limit the types of graphs used to those addressed in the Mathematics program. In Mathematics 4, students are expected to construct and interpret pictographs and bar graphs. Double bar and line graphs are introduced in Mathematics 5 and 6 respectively.
	Selecting the most effective format to compile and display data is very challenging. Explicit instruction on common formats and when appropriate to use them, will be required. Line graphs, for example, are used to show the relationship between two quantitative variables. Bar graphs are used when at least one of the variables is qualitative. Explicit instruction may also be required regarding the use computer and mobile device applications (e.g., Apple Numbers, Google Sheets, Microsoft Excel) to compile and display data.
	Cross curricular connections may be made to Mathematics outcomes in *Data Relationship* units.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Students may
- Discuss classification methods used in supermarkets, libraries, and music stores.

Connection

Teachers may
- Provide explicit instruction on the use of Venn diagrams, Carroll diagrams, T-charts, and tables when classifying items.
- Provide a collection of items classified into two groups based on a single attribute (e.g., light and dark coloured rocks). Have students further sub divide groups into sub-groups and provide a classification rule.
- Model classifying items according to multiple attributes at one time (e.g., sorting Lego™ pieces by colour and size).
- Introduce items that do not fit neatly within a student's classification scheme and have them modify their scheme accordingly (e.g., adding oobleck to solids vs. liquids).
- Explicitly instruct on the use of frequency tables, data tables, pictographs, and bar graphs to display data, by hand or using computer or mobile device applications (e.g., Apple Numbers, Google Sheets, Microsoft Excel).
- Compile authentic data from the classroom (e.g., tally the number of times the pencil sharpener is used each period) and discuss appropriate formats to compile and display the data (e.g., frequency table, data table, pictograph, or bar graph).

Students may
- Practice, in non-science contexts, classifying items according to several attributes at one time (e.g., gym equipment, library books, Legos™, playing cards, recess items, trading cards) and create a diagram or chart to show the method of classifying.
- Practice compiling and displaying data using frequency tables, spreadsheets, data tables, pictographs, bar graphs, by hand or using computer applications.
- Provide reasons for their selected data display format.
- Compare and critically evaluate the effectiveness of methods used by different groups to compile and display data.

Consolidation

Students may
- Compile and display data to analyze and interpret, when investigating and problem solving throughout Science 4. Classification may be used as a method of analysis and interpretation.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Analyzing and Interpreting

Outcomes	Focus for Learning
Students will be expected to	
17.0 identify and suggest explanations for patterns and discrepancies in data [GCO 2]	In Science K-3, students identified patterns and discrepancies in objects and events. In Science 4-6, students are expected to identify and suggest explanations for patterns and discrepancies in data.
	Patterns refer to general trends (e.g., shadows get larger as the object moves closer to the light source). Patterns are not always immediately obvious, however, they are easier to identify when data is compiled and visually displayed in tables and graphs. Students are expected to identify patterns, describe the relationship in words, and suggest reasonable explanations for them.
	Discrepancies refer to unexpected data; measurements or observations that do not seem to fit the expected pattern or trend. Students should identify discrepancies and suggest reasonable explanations for them. Most discrepancies can be explained by measurement errors or uncontrolled variables (i.e., sources of error).
	Data collected by multiple groups should be compared. Differences identified provide opportunities for critical analysis. Reflection on the controlled variables, procedures employed, and measurement tools and techniques may identify possible sources of error and provide plausible explanations for differences identified.
18.0 draw a conclusion that answers an initial question [GCO 2]	Following analysis and interpretation of data, students should draw conclusions. Good conclusions answer the initial question, cite the supporting evidence, and express support for or rejection of the prediction or hypothesis.
	Students should be expected to: • identify possible sources of error, • comment on the fairness of the investigation, • suggest improvements to the investigative design, • discuss potential applications of what was learned, and • identify new questions to investigate.
	Cross curricular connections may be made to the synthesizing strategy unit in English Language Arts.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies	Resources and Notes

Connection

Teachers may

- Provide data in tables and graphs for students to identify patterns and discrepancies and draw conclusions.
- Prompt students to reflect on their data:
  - Is there a pattern in the data you compiled? How would you describe it? Can you explain why the pattern occurs?
  - Did you get the results you expected? Were there any unexpected results? Can you explain the discrepancy?
  - Is your data similar to that of other groups? If not, why not?
  - How could you improve the accuracy and reliability of your data?
- Prompt students to reflect on their investigative methods when drawing conclusions:
  - What question were you investigating?
  - What was your prediction and hypothesis?
  - What were your independent and dependent variables?
  - What variables did you attempt to control?
  - Was there a pattern observed in the data? Did it suggest a relationship between the independent and dependent variables? Can you explain the relationship?
  - Were potential sources of error identified? How could you modify the procedure to reduce or eliminate them?
  - Was the investigation a fair test?
  - What did you conclude from the data?
  - Did your data support or refute your hypothesis?
  - If you could redo your investigation, what would you do differently?
  - Why are your findings important? Who might want to know what you have learned?
  - What new questions do you want to investigate next?

Students may

- Compare their compiled data with that of other groups, identify similarities and differences, and explain discrepancies.
- Review digital video of their group carrying out procedures to formulate explanations for discrepancies identified in data.

Consolidation

Students may

- Analyze and interpret data to identify patterns and discrepancies and draw conclusions, when investigating throughout Science 4.

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Analyzing and Interpreting

Outcomes	Focus for Learning
Students will be expected to 19.0 suggest improvements to a design or constructed object [GCO 2]	Engineering design and problem solving experiences provide multiple opportunities for students to suggest improvements to a design or constructed object: • Students may attempt to solve a problem by suggesting improvements to an existing device. • During prototype construction and testing, students may suggest improvements to the design in response to problems encountered. • Suggestions for improvement may arise from evaluation of prototypes with respect to function, reliability, aesthetics, safety, and efficient use of materials. Engineering design and problem solving processes are not linear; rather they are iterative cycles of constructing, testing, evaluating, and redesigning for improvement. With respect to scientific inquiry processes, students may suggest improvements to the design of an investigation. Student suggestions should improve the fairness of the investigative methods or the accuracy and reliability of the data obtained (e.g., modifying procedures to reduce error, eliminate bias, or incorporate multiple trials).
20.0 evaluate personally constructed devices [GCO 2]	During engineering design and problem solving experiences, constructed prototypes are repeatedly tested and evaluated. Students should ensure fair testing procedures and conduct multiple trials of each test. The measurements, observations, and information collected are used to evaluate the prototype. Evaluation should determine if the potential solution works, if it meets the design criteria, and if there are any unanticipated problems. Evaluation may result in a prototype being abandoned in favour of another solution, or, if it continues to show promise, being redesigned for improvement and retested. This iterative process of testing, evaluating, and redesigning for improvement, continues until the prototype is deemed finished. Once completed, the personally constructed device (i.e., solution) should be evaluated one final time. In Science K-3, students evaluated devices with respect to form and function. In Science 4-6, students are expected to evaluate their personally constructed devices with respect to • function (i.e., Does the device work? Does it solve the problem?); • reliability (i.e., Will the device work consistently over time? Can I count on it to work when I need it?); • aesthetics (i.e., Does the device have a pleasing appearance?); • safety (i.e., Is the device safe to use?); and • efficient use of materials (i.e., Does the design waste materials? Does it use found or recycled materials?).

Analyzing and Interpreting

Sample Teaching and Assessment Strategies	**Resources and Notes**
Connection	**Authorized**
Teachers may	*NL Science 4: Online Teaching Centre*
• Provide a focus object (e.g., plastic shopping bag, manual can opener) and have students evaluate it with respect to function, reliability, aesthetics, safety, and efficient use of materials and make suggestions for improvement.	• Science Skills Toolkit
	• Skills and Processes for Scientific Inquiry rubric builder (BLM)
• Present various backpacks, lunch bags/boxes, pencil cases, or sandwich containers and have students evaluate them, select their preferred design, and provide reasons for their choice.	• Skills and Processes for Design and Problem Solving rubric builder (BLM)
Students may	*NL Science 4: Online Student Centre*
• Participate in a gallery walk to view the prototype design sketches of other groups and make suggestions for improvement.	• Science Skills Toolkit
• View the final constructed devices of different groups and provide TAG feedback (i.e., <u>T</u>ell something you like, <u>A</u>sk a question, <u>G</u>ive a suggestion).	
• Listen to classmates communicating the procedure and results of their investigations and respond with suggestions to improve the investigative design.	
Consolidation	
Students may	
• Evaluate and suggest improvements to prototype designs and constructed devices, when problem solving throughout Science 4.	

Analyzing and Interpreting

Outcomes	Focus for Learning
Students will be expected to 21.0 identify new questions or problems that arise from what was learned [GCO 2]	Scientific inquiry investigations inevitably lead to new questions. As students analyze and interpret data, draw conclusions, and answer their initial question, new questions to investigate should be proposed. Similarly, engineering solutions to problems often uncovers, or even creates, new problems to solve. As students construct, test, and evaluate their prototypes, they should identify problems encountered. Additionally, they should identify new problems that may arise from the use of their constructed device. Scientific inquiry and engineering design and problem solving are cyclical processes. Investigating questions and solving problems leads to new questions and problems. New questions and problems that arise provide natural opportunities for students to engage further in open inquiry and design and problem solving.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Connection

Teachers may
- Following completion of inquiry investigations and design and problem solving experiences, facilitate brainstorming sessions to to propose new questions or problems to investigate and solve.

Students may
- Identify questions they would like to investigate next, when communicating the procedure and results of their investigation.
- Identify problems they encountered during design and problem solving experiences and describe how they solved them.
- Identify new problems that arise from use of their personally constructed device, when orally presenting their solution.
- Record new questions to investigate on an "I Wonder" wall, KWLM chart, or in their personal science learning journal.

Consolidation

Students may
- Investigate new questions and solve new problems that arise from what was learned, throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Communication and Teamwork

Outcomes	Focus for Learning
Students will be expected to	
22.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations [GCO 2]	Science and engineering are social enterprises where people work in groups to investigate questions and solve problems. In these collaborative environments, the ability to communicate so that others understand is an essential skill.
	When possible, students should work in collaborative groups to investigate and solve problems. Students should think aloud; orally communicating their questions, sharing their ideas, and describing what they are doing or intending to do. Additionally, students should listen and respond to other members of their group. Appropriate scientific and technological terminology should be used.
	Cross curricular connections may be made to English Language Arts outcomes related to the speaking and listening.
23.0 communicate procedures and results [GCO 2]	Scientists communicate the findings of their investigations by publishing articles in science journals and making presentations at conferences. Communicating their procedures and results enables other members of the science community to replicate their investigations to confirm or extend the results and conclusions. Engineers communicate their constructed devices and solutions to end users.
	Communicating what is learned is the final stage in both scientific inquiry and engineering design and problem solving processes. With respect to scientific inquiry investigations, students should communicate to others their question, procedure, and results. For engineering design and problem solving experiences, students should communicate their problem, procedure, and solution.
	In Science K-3, students demonstrated their procedure to others and shared what was learned using drawings, and written and oral language. In Science 4-6, students should communicate their procedures and results using various methods (e.g., lists, notes in point form, sentences, charts, graphs, digital images or video, drawings, and oral language). Students should consider their audience and the nature of the information to be shared when selecting an appropriate communication method.
	Cross curricular connections may be made to English Language Arts outcomes related to communicating information and ideas effectively and clearly.

Communication and Teamwork

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Model appropriate communication and listening skills.
- Use appropriate scientific and technological terminology when communicating.
- Provide opportunities for students to develop communication and teamwork skills through group work.
- Encourage students to think aloud; enabling other group members to listen and respond to their questions, ideas, and intentions.
- Assign a manager role to ensure that group members communicate aloud, listen, and respond to each other.
- Assign a group reporter role to share with classmates what their group did and what they found out.
- Provide a structured template for students to communicate the procedures they followed and the results they obtained.
- Record group communication, using digital audio applications on mobile devices, for assessment purposes.
- Assess the ability of individual students to communicate, clearly and concisely, complete and accurate information about procedures and results.

Student may

- Work in collaborative groups to investigate and solve problems.
- Communicate to others what was learned from an investigation or design and problem solving experience; sharing what they did (i.e., procedure) and what they found out (i.e., results or solution).
- Use mobile device applications to record a video that shares their question, procedure, and results, or problem, procedure, and final solution.

Consolidation

Teachers may

- Organize a class science fair or science conference for students to present to classmates the results of independent scientific inquiry investigation or design and problem solving experiences.

Students may

- Communicate with and listen to others, explain what they did, and share what they found out, when investigating and problem solving throughout Science 4.

Resources and Notes

Authorized

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Communication and Teamwork

Outcomes	Focus for Learning
Students will be expected to	
24.0 work with group members to evaluate processes used in solving a problem [GCO 2]	Scientists and engineers often collaborate with colleagues of widely different cultural and professional backgrounds, but still must work together as a team. Teamwork and collaboration are important science and engineering skills.

Upon completion of collaborative design and problem solving activities, students should evaluate the processes undertaken to find a solution. Students collaboratively brainstormed solutions, selected solutions to try, tested and evaluated prototypes, and suggested modifications for improvement. Each stage involves communicating questions, ideas, and intentions, listening and responding to others, and collaboratively making judgements and decisions. Students should reflect on and evaluate the collaborative processes they employed at various stages:

- Was every team member encouraged to contribute?
- Did everyone share aloud their questions, ideas, and suggestions?
- Did we listen to and acknowledge contributions of others?
- Did we ask clarifying questions when we didn't fully understand the ideas or intentions of others?
- Did we keep an open-mind and carefully consider each idea or suggestion?
- Were there workable solutions that we dismissed or failed to fully consider?
- How did we resolve differences of opinion?
- What decision making processes did we use?
- Were decisions made by consensus?
- Did everyone willingly accept their role?
- Did we work well together as a team?

Evaluation of problem solving processes should be based on evidence. Documenting the various stages of design and problem solving experiences is necessary. Documentation may include brainstorming and design sketches, procedures, testing records, and digital images, video, or audio recordings of the process.

Communication and Teamwork

Sample Teaching and Assessment Strategies	Resources and Notes
Connection	**Authorized**

Connection

Teachers may
- Review with students the typical stages of engineering design and problem solving processes.
- Facilitate a class discussion regarding what makes a successful problem solving group and establish criteria to evaluate problem solving processes.
- Assign a group manager role to ensure that processes are followed and an encourager role to ensure everyone participates.
- Prompt students to evaluate their group processes
  - Did your group follow all the typical stages of a design and problem solving process?
  - How did your group ensure that everyone's ideas and suggestions were heard and considered?
  - What process did your group use to make decisions?
  - How did your group overcome differences in opinion?
  - What lessons about teamwork has your group learned?
  - What things would your group do differently next time?
- Assess the ability of individual students to work effectively with group members.

Students may
- Use peer- and self-assessments to assess group performance.

Consolidation

Students may
- Work together in collaborative groups and communicate to solve problems throughout Science 4.

Authorized

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Section Three:
Specific Curriculum Outcomes

Unit 1: Rocks, Minerals, and Erosion

Focus

Students should explore and become familiar with the Earth materials that make up their world. They should be provided with opportunities to learn that rocks are used for many things within a community and that rock properties help determine their use. Students can then explore the changing landscape by examining the processes of weathering, erosion, and deposition; and determine how wind, water, and ice reshape the landscape. An examination of these processes also leads to discussion of ways humans prevent landscapes from changing or adapt to a changing landscape.

Scientific inquiry is the process focus of this unit. The unit emphasizes the development of skills related to proposing questions, making predictions and hypotheses, carrying out procedures to ensure a fair test, controlling major variables, following procedures, making and recording observations and measurements, identifying new questions that arise from what was learned, and communicating procedures and results.

Outcomes Framework

GCO 1 (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.

25.0 demonstrate that specific terminology is used in science and technology contexts
30.0 demonstrate processes for investigating scientific questions and solving technological problems
31.0 compare the results of their investigations to those of others and recognize that results may vary
32.0 describe examples, in the home and at school, of tools, techniques, and materials that may be used to respond to their needs
34.0 describe examples of modern technologies that did not exist in the past
35.0 identify examples of scientific questions and technological problems that are currently being studied
36.0 consider the positive and negative effects of familiar technologies
37.0 contemplate their own and their family's impact on natural resources
38.0 describe how personal actions help conserve natural resources and care for living things and their habitats
41.0 explore how science and technology have been used to solve problems in the home and at school
43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications

GCO 2 (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.

1.0 propose questions to investigate and practical problems to solve
3.0 state a prediction and a hypothesis
6.0 identify appropriate tools, instruments, and materials to complete investigations
7.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
9.0 follow procedures
11.0 make observations and collect information that is relevant to the question or problem
12.0 record observations
21.0 identify new questions or problems that arise from what was learned
23.0 communicate procedures and results

GCO 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.

26.0 compare different rocks from their local area with those from other places
27.0 describe rocks according to their physical properties
28.0 identify and describe clues about Earth's history contained in rocks
29.0 describe minerals according to their physical properties
33.0 relate the characteristics of rocks and minerals to their uses
39.0 describe effects of wind, water, and ice on the landscape
40.0 model examples of weathering and erosion
42.0 describe how soil is formed from rocks
44.0 describe natural phenomena that cause rapid and significant changes to the landscape

GCO 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.

Students are encouraged to:
- appreciate the role and contributions 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
- show an interest in 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
- be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment

SCO Continuum

GCO 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.

Science 3	Science 4	Science 7
Exploring Soils	*Rocks, Minerals, and Erosion*	*Earth's Crust*
• living things affect and are affected by soils • compare different soils • soil components • absorption of water by different soils • effects of moisture on soils • effects of moving water on different soils • using Earth materials to make useful objects	• compare rocks and minerals • describe rocks and minerals • rocks contain records of Earth's history • uses of rocks and minerals • ways soil is formed from rocks • effects of wind, water, and ice on the landscape • methods of weathering and erosion • natural phenomenon that cause landscape changes	• composition of Earth's crust • classify rocks and minerals • classify types of soil • mountain formation, folding and faulting • ways rocks can be weathered • meteorological, geological, and biological processes of soil formation • catastrophic events that occur on or near Earth's surface • geological and chronological distribution of catastrophic events • time scale of major events in Earth's history

Suggested Unit Plan

The Rocks, Mineral, and Erosion unit is positioned at the start of the school year to capitalize on opportunities for outdoor learning.

September	October	November	December	January	February	March	April	May	June

Rocks, Minerals, and Erosion

Communicating Using Specific Terminology

Outcomes	Focus for Learning
Students will be expected to 25.0 demonstrate that specific terminology is used in science and technology contexts [GCO 1]	Whether engaged in scientific inquiry or problem solving, the ability to communicate so that others understand is an essential skill. Effective communication in science and technology requires students to use appropriate terminology. Science and technology have their own language (i.e., specific terminology, symbols, diagrams, graphs, and equations). Scientists and engineers use this language to collaborate and communicate. Students are expected to communicate using appropriate terminology in science and technology contexts. They are not, however, expected to memorize definitions. When viewing ocean waves carrying away rocks and sand, for example, students should understand and use the term erosion to describe what they are observing; they should not be expected to define erosion. Appropriate terminology should be introduced as the need emerges. Presenting all the unit terminology at the outset is strongly discouraged. Scientific inquiry and design and problem solving process-related terminology includes • question, problem, solution; • prediction, hypothesis, procedure, materials, tools, instruments; • observations, measurements, record, classify, data, patterns, discrepancies, results, conclusion; • fair test, independent variable, dependent variable, controlled variables; and • design, construct, test, evaluate, prototype, constructed device. Earth science-related terminology includes • natural resources, rock, mineral, geology, geologist, mining; • igneous rock, sedimentary rock, metamorphic rock; • physical properties, colour, texture, lustre, streak, hardness; • crystals, layers, air holes, fossils; • landscape, weathering, erosion, deposition; and • soil, humus, compost. Communicating using appropriate, specific terminology is a constant expectation. As students progress through the unit their use of scientific and technological terminology should increase. Rocks, minerals, and erosion are readdressed in Science 7.

Communicating Using Specific Terminology

Sample Teaching and Assessment Strategies

Whenever students are investigating or problem solving, their use of appropriate terminology in communication can be assessed. Assessments may include self, peer, and teacher assessments using terminology checklists in conjunction with direct observations or digital audio recordings of collaborative group work.

Activation

Teachers may

- Pre-assess student use of appropriate terminology with graffiti board activities using question prompts
    - What is science? What is engineering? What is technology?
    - What are science investigations?
    - What is the design process?
    - What are rocks? What are minerals? How do we use them?
- Introduce terminology through relevant children's literature.
- Create a class concept map or brainstorming web of Earth science-related terminology.
- Create a science word wall and add new words as they are introduced. Alternatively, science words can be added to an existing word wall using a different coloured font or background.

Connection

Teachers may

- Model the use of appropriate scientific and technological terms and encourage students to adopt them.
- Incorporate specific terminology into literacy block activities.
- Facilitate collaborative group investigations and design and problem solving experiences where students are encouraged to think aloud; communicating their ideas, questions, and intentions.

Students may

- Use alpha-boxes to record new specific terminology. This may be initiated with a book walk through *NL Science 4, Unit 1: Rocks Minerals and Erosion.* Alternatively, terms can be recorded on an egg carton used to house personal rock collections.
- Create a visual glossary of specific terminology using personal illustrations and definitions in their own words.
- Record their questions related to rocks, minerals, and erosion on the class "I Wonder" wall.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (Student Resource [SR])
- pp. 1-55, 56-59

NL Science 4: Online Teaching Centre
- Science Skills Toolkit

NL Science 4: Online Student Centre
- Science Skills Toolkit

Suggested

Children's Literature
- *A Rock Can be...* by L. Salas
- *A Rock is Lively* by D. Aston and S. Long
- *Everybody Needs a Rock* by B. Baylor
- *If You Find a Rock* by P. Christian
- *Spenser and the Rocks* by L. Lowery

How Can We Compare Rocks?

Outcomes	Focus for Learning

Outcomes

Students will be expected to

26.0 compare different rocks from their local area with those from other places [GCO 3]

Focus for Learning

Provide hands-on opportunities for students to observe different rocks from their local area and other locations. Students should compare these rocks and come to recognize that the type of rock found in any particular location or region is often different from those found in other locations.

Students should compare and contrast rocks through hands-on activities where they sort collections of rocks into groups according to one or more attributes. Students may initially group rocks using "unscientific" sorting rules (e.g., interesting vs. uninteresting) and describe them using everyday language (e.g., sparkly, skipping rocks). Wetting rocks with water and using magnifying lenses will aid student observations. Describing and sorting rocks according to physical properties is addressed in subsequent outcomes.

Teachers may choose to address the skill of classifying at this time. Refer to outcome 15.0 in the *Integrated Skills* unit*, pp. 52-53.

Common rocks found in different regions of our province include
- basalt, diorite, gabbro, granite (i.e., igneous rocks);
- conglomerate, limestone, sandstone, shale (i.e., sedimentary rocks); and
- gneiss, marble, quartzite, schist, slate (i.e., metamorphic rocks).

Interesting rocks from other places for comparison include
- obsidian - glass-like igneous rock formed from hardened lava;
- pumice or scoria - igneous rocks containing air holes; and
- sedimentary coal - formed mainly from plant remains.

Attitude

Encourage students to show interest and curiosity about objects and events within different environments. [GCO 4]

How Can We Compare Rocks?

Sample Teaching and Assessment Strategies	Resources and Notes
Students should collect rocks from their local area to use in this unit. Rocks may be stored in clean egg cartons. Students may add to their collection as they work through the unit. Discuss with students the importance of not disturbing habitats when rock collecting. Do not collect rocks from environmentally sensitive or protected areas.	**Authorized**

Students should collect rocks from their local area to use in this unit. Rocks may be stored in clean egg cartons. Students may add to their collection as they work through the unit. Discuss with students the importance of not disturbing habitats when rock collecting. Do not collect rocks from environmentally sensitive or protected areas.

The Government of Newfoundland and Labrador Department of Natural Resources previously provided a *Newfoundland and Labrador Rock and Mineral Kit* to schools in the province. This kit contains 46 different rock and mineral samples. Rock samples may also be collected locally or purchased from science suppliers.

Connection

Teachers may

- Model comparing rocks using a Venn diagram and sorting rocks according to a sorting rule (e.g., light coloured vs. dark coloured).
- Provide diverse samples of rocks from other places. Have students compare and contrast them with rocks from their collection.

Students may

- Record similarities and differences between two rocks from their collection in a foldable T-chart or Venn diagram.
- Sort rock collections using a personal sorting rule, ask a classmate to guess their rule, then re-sort using a different rule.

Consolidation

Teachers may

- Provide a sorting rule and have students sort their rock collections. Ask if a particular rock was hard to sort and why.
- Use video conference technology to connect with schools in other areas of the province and have students compare and contrast the rocks found in both places.

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (Teacher Resource [TR])
- pp. 10-15, 16-21

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 6-7, 8-11

NL Science 4: Online Teaching Centre
- IWB Activity 1

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning-strategies.html
   - Rocks, Minerals, and Erosion Activities

Supplementary

Newfoundland and Labrador Rock and Mineral Kit

Suggested

Children's Literature
- *A Field Guide to Identification of Pebbles* by E. Van der Flier-Keller
- *Canada's Rocks and Minerals* by J. Richter and I. Coutts
- *Let's Go Rock Collecting* by R. Gans

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/rocks. html
- Local rocks (images)
- Geology related regional support organizations (websites)
- Science suppliers (websites)

How Can We Describe Rocks?

Outcomes	Focus for Learning
Students will be expected to	
27.0 describe rocks according to their physical properties [GCO 3]	Rocks are extremely variable. To describe them, geologists use specific terminology based on their different physical properties. Students should observe rocks using appropriate senses and describe them according to
	• colour;
	• shape (i.e., rounded or angular);
	• texture (i.e., smooth, rough, sharp);
	• grain size and shape (e.g., coarse or fine, rounded or angular);
	• the presence or absence of crystals;
	• the presence or absence of layers or banding patterns; and
	• the presence or absence of air holes.
	Students should use these properties to re-sort rock collections.
6.0 identify appropriate tools, instruments, and materials to complete investigations [GCO 2]	Students should identify the tools, measuring instruments, and materials they require to conduct a guided inquiry investigation into the physical properties of rocks
	• magnification tools (e.g., magnifying glass, illuminated pedestal magnifier, flex camera, stereo microscope);
	• measuring instruments (e.g., ruler, balance or digital scale);
	• geology-related tools (e.g., geology hammer, safety glasses); and
	• other tools (e.g., eye dropper, flashlight, mirror, digital camera, mobile device applications).
	Students should investigate selected rocks from their collection supplemented by teacher provided samples. Provide an opportunity for students to carry out their guided inquiry investigation.
	Refer to the *Integrated Skill* unit for elaboration of this skill outcome (pp. 42-43).
	Sample Performance Indicator
	Create a trading card for a rock sample that includes a colour illustration and a detailed description of its physical properties using appropriate terminology (e.g., rounded, angular, smooth, rough, sharp, fine grained, coarse grained, crystals, layers, bands, air holes).

How Can We Describe Rocks?

Sample Teaching and Assessment Strategies	Resources and Notes

Provide hands-on opportunities for students to investigate and describe the physical properties of rocks from their local area and other places. Assessment may include student use of appropriate specific terminology.

Activation

Teachers may

- Facilitate a brainstorming session to identify physical properties that can be used to describe rocks, and tools and measuring instruments that could help students observe and describe them.

Connection

Teachers may

- Model describing the physical properties of rocks using specific terminology, and add terminology to the science word wall.

Students may

- Investigate and describe the physical properties of a rock using the "naked eye". Then use various magnification tools and measuring instruments to re-observe the rock and add new details to their initial description.
- Use a geology hammer to break off pieces of rocks to determine their unweathered colour.
- Use an eye dropper to place drops of vinegar on rock samples to determine if they "fizz". Limestone and marble are the most likely local rocks to produce a positive test.
- Compare and contrast the physical properties of two rocks using a Venn diagram.
- Re-sort their rock collections according to physical properties.

Consolidation

Teachers may

- Provide a collection of diverse, labelled rocks and a set of index cards with a description of each rock on a separate card. Have students match the cards to the rock samples. Cards may be prepared by students.

Students may

- Play "Who Am I?" describing a rock from a collection and having peers guess the identity.
- Create a lost and found poster for their missing "pet rock".
- Sort rock collections according to two physical properties at one time (e.g., colour, texture).
- Create a digital video describing rocks in their collection.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 10-15

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 6-7

NL Science 4: Online Teaching Centre
- IWB Activity 1
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

Supplementary

Newfoundland and Labrador Rock and Mineral Kit

Suggested

Children's Literature
- *A Field Guide to Identification of Pebbles* by E. Van der Flier-Keller
- *Canada's Rocks and Minerals* by J. Richter and I. Coutts

What Can We Learn from Rocks?

Outcomes

Students will be expected to

28.0 identify and describe clues about Earth's history contained in rocks [GCO 3]

Focus for Learning

Students should describe what can be learned about Earth's history from clues contained in rocks. For example:

- The presence of large crystals in igneous rock (e.g., granite) indicates that the rock formed slowly, deep within Earth from magma.
- The presence of small crystals in igneous rock (e.g., basalt) indicates that the rock formed quickly, at or near Earth's surface from lava.
- The presence of air holes in igneous rock (e.g., pumice, scoria) indicates that the rock formed super fast from lava.
- Sedimentary rocks usually form underwater. The grain size (i.e., clay, silt, sand, pebbles), shape (i.e., rounded or angular), and arrangement provide clues about their formation. Shale, for example, forms from fine clay particles that settle slowly in deep, slow-moving bodies of water.
- Tilt, observed in sedimentary rock landforms, provides evidence of past geologic forces at work. At formation, the layers of sedimentary rock were horizontal.
- Fossils, found within sedimentary rocks, tell the story of past life on Earth (e.g., Ediacara biota, Trilobites).
- Folded banding patterns, found in some metamorphic rocks (e.g., gneiss), provide evidence of the geologic forces at work during formation of the rock.
- Landforms may contain evidence of the presence and movement of glaciers during past ice ages (e.g., striations, glaciated valleys, fjords, glacial pavement, erratics).

Attitude

Encourage students to consider their own observations and ideas as well as those of others during investigations and before drawing conclusions. [GCO 4]

Sample Performance Indicator

Answer questions on exit cards

- Trilobite fossils are found in sedimentary rocks near the top of a mountain. What can you infer about the history of the area?
- Sedimentary rock layers on Signal Hill are tilted? What does this clue tell you?
- Igneous granite with large crystals is found in an area. What can you infer about the history of an area from this clue?

What Can We Learn from Rocks?

Sample Teaching and Assessment Strategies	Resources and Notes
Connection	**Authorized**

Connection

Teachers may
- Provide samples of common igneous, sedimentary, and metamorphic rocks for students to observe and relate what they tell about Earth's history.
- Display images of rocks and landforms showing evidence of glaciation (e.g., striations, glaciated valleys, fjords, erratics).
- Model the formation of igneous rock by melting broken crayons in tart sized, aluminum foil plates on a hot plate and allowing the wax to cool and harden.
- Use the online activity "*Tricky Tracks*" to differentiate between observations and inferences and show how observations may be interpreted in multiple ways.

Students may
- Model the formation of sedimentary rock layers. Layer grated crayons, alternating colours, between two sheets of wax paper, place a heavy book on top, and compact by pushing down on the book. Alternatively, sediment-like materials (e.g., aquarium gravel, brown sugar, coffee grinds, flour, Jell-o powder, rolled oats, salt) can be layered in clear plastic cups. Models could be compared with sedimentary rock samples.
- Model the formation of fossils in sedimentary rock. Place gummy bears between alternating slices of white and whole wheat bread and compacting under heavy books. Alternatively, press natural objects (e.g., shells, tree cones, twigs, leaves) into modelling clay.
- Model the formation of metamorphic rock. Stack folded, coloured dish towels on top of each other, horizontally, in layers. Push the ends toward each other to create folded banding patterns.
- Investigate the formation of striations caused by moving glaciers. Freeze sand and small pebbles in ice cubes. Let the ice melt slightly to expose rock particles and slide it across wax paper to form parallel scratches. Compare markings with those created by a normal ice cube.

Consolidations

Students may
- Describe what can be learned about a local area if the rocks are predominantly sedimentary, igneous, or metamorphic rocks.
- Select a rock and tell it's "life story". Stories may be communicated orally or as a comic strip using a six block template or mobile device application.
- Explain why fossils are rarely found in igneous and metamorphic rocks.

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 10-15, 16-21, 22-27

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 6-7, 8-11, 12-13

NL Science 4: Online Teaching Centre
- IWB Activity 2

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

Supplementary

Newfoundland and Labrador Rock and Mineral Kit

Hot plate

Suggested

Other curriculum resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *Glaciers, Rivers of Ice*

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/rocks. html
- Rocks and glaciated landforms (images)
- Tricky Tracks (activity)
- Geology related regional support organizations (websites)

How Can We Describe Minerals?

Outcomes	Focus for Learning
Students will be expected to 29.0 describe minerals according to their physical properties [GCO 3]	Rocks are made up of minerals. There are thousands of different minerals. Each mineral has a distinct set of properties. The properties of a rock depend on the properties of the minerals it contains (e.g., granite is largely composed of quartz, feldspar, and mica) and their composition ratio (e.g., granite with a high proportion of quartz will be lighter in colour, granite with a high proportion of feldspar is more orange in colour). Students are expected to describe minerals according to their physical properties. Treatment should be limited to • colour (e.g., white, yellow, colourless); • lustre (whether a mineral is shiny or dull); • streak (colour of powder when scratched on a streak plate); and • hardness (ability to scratch another mineral). Other mineral properties include cleavage and fracture, crystal shape, electrical conductivity, fluorescence, magnetism, and reaction with acid. Common minerals in Newfoundland and Labrador include: barite, calcite, chalcopyrite, fluorite, galena, gypsum, hematite, labradorite, magnetite, native copper, pyrite, pyrophilite, quartz, sphalerite, and talc. **Attitude** Encourage students to show interest in the activities of individuals working in scientific and technological fields. [GCO 4] **Sample Performance Indicator** Investigate the colour, lustre, and streak of selected minerals and create "What Am I" cards to describe their properties. Completed cards may be used for group activities.

How Can We Describe Minerals?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Provide hands-on opportunities for students to investigate and describe the physical properties of minerals. Limit treatment, at this time, to colour, lustre, and streak. Hardness will be investigated in a subsequent outcome.

The Government of Newfoundland and Labrador Department of Natural Resources previously provided a *Newfoundland and Labrador Rock and Mineral Kit* to schools in the province. This kit contains 46 different rock and mineral samples. Mineral samples may also be purchased from science suppliers.

Activation

Teachers may
- Add mineral-related terminology to the science word wall.
- Present a chocolate chip granola bar as a model of a rock made of different types of minerals.

Connection

Teachers may
- Provide streak plates and magnification technology to aid observation and investigation of minerals.
- Display images of Newfoundland and Labrador minerals.

Students may
- Make small model rocks using dry food items (e.g., beans, cereals, chocolate chips, coconut, pasta, popping corn, rice) to represent different minerals. Students roll a die. The number rolled determines the number of food items they can use to make their rock. Students rolling 1 make minerals. Dry food items can be stuck together with glue or honey. Completed models can be used for classification activities.

Consolidation

Students may
- Investigate and sort a collection of minerals according to colour, streak, and lustre. Digital recordings of group sorting may be used for assessment purposes.

Extension

Students may
- Investigate other mineral properties (e.g., cleavage and fracture, crystal shape, electrical conductivity, fluorescence, magnetism, and reaction with acid).

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 28-33

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 14-17

NL Science 4: Online Teaching Centre
- IWB Activity 4

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

Supplementary

Newfoundland and Labrador Rock and Mineral Kit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/rocks.html
- Local minerals (images)
- Science suppliers (websites)

How Can We Describe the Hardness of Minerals?

Outcomes	Focus for Learning
Students will be expected to	
30.0 demonstrate processes for investigating scientific questions and solving technological problems [GCO 1]	While it is generally accepted that there is no one single scientific method, most have processes that includes • proposing a question to investigate and making a prediction and a hypothesis; • gathering tools, instruments and materials and developing a procedure; • carrying out the experiment, making and recording observations and measurements; • analyzing and interpreting data to draw conclusions; and • communicating what is learned to others. Students should demonstrate these processes as they investigate how to describe the hardness of minerals. Introduce the Mohs scale of hardness as a 1 to 10 scale, with 1 being the softest and 10 being the hardest. The scale uses the hardness of 10 minerals as standards for comparison. The hardness of a mineral sample can be determined by scratching it with a mineral from the Moh's scale or a common object of known hardness (e.g., soft pencil point, finger nail, dime, copper, iron nail, butter knife, steel file, streak plate, sandpaper). If an object scratches a mineral sample, the mineral is softer than the object. Students are not expected to memorize the minerals of the Moh's scale or their hardness, but should use the scale to measure hardness.
7.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables [GCO 2]	Students should plan and carry out a guided inquiry investigation to sequence a collection of minerals by hardness. This investigation provides an opportunity to address and assess skill outcomes 7.0, 12.0, 21.0, 23.0, and others. Refer to the *Integrated Skill* unit for elaboration of these skill outcomes (pp. 44-45, 48-49, 58-61).
12.0 record observations [GCO 2]	Following completion of the investigation, students should compare their results to those of other groups; recognizing that results may vary. If discrepancies are observed, students should infer possible explanations for the discrepancy (e.g., inconsistency among mineral samples, differences in how the minerals were scratched). Additional trials may be performed to confirm results or, if necessary, the investigation may be repeated using a modified procedure to reduce error or eliminate bias.
21.0 identify new questions or problems that arise from what was learned [GCO 2]	
23.0 communicate procedures and results [GCO 2]	Scientists routinely check each other's work; repeating their procedures and comparing results. Confirming results is an important part of the scientific inquiry process; it adds precision and accuracy to the findings. The importance of devising and communicating detailed procedures, to facilitate comparison, should be underscored.
31.0 compare the results of their investigations to those of others and recognize that results may vary [GCO 1]	**Attitude** Encourage students to appreciate the importance of accuracy and honesty. [GCO 4]

How Can We Describe the Hardness of Minerals?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation	**Authorized**

Activation

Teachers may
- Address or readdress the stages of scientific inquiry processes. Stages may be provided on sentence strips to be sequenced.
- Add scientific inquiry-related terminology to the science word wall.
- Display an anchor chart of the scientific inquiry process.

Students may
- Create a foldable of the scientific inquiry process as a reference.

Connection

Teachers may
- Facilitate a directed inquiry investigation to introduce the typical stages of a scientific inquiry process (e.g., How does the size of a pebble affect how fast it sinks in water?).
- Model determining the hardness of a mineral sample using a set of Moh's minerals or common objects of known hardness (e.g., soft pencil point - 1.0, finger nail - 2.5, dime - 3.0, copper - 3.5, iron nail - 4.5, butter knife - 5.5, steel file - 6.5, streak plate - 7.0, sandpaper - 7.5)

Students may
- Determine the hardness of an unknown mineral using common objects and compare their result with those of others for the same mineral.

Consolidation

Students may
- Investigate the hardness of a collection of minerals using a set of Moh's minerals or common objects of known hardness and sequence them from softest to hardest. Digital images of the sequence may be used as records. Minerals tested may include talc, gypsum, calcite, fluorite, hematite, pyrite, and quartz.
- Compare their mineral sequence to those of other groups and note any discrepancies. Minerals can be retested to confirm results. Small group discussions could be used to infer possible explanations for differences in results.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 34-35

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 18-19

NL Science 4: Online Teaching Centre
- IWB Activity 3
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities
  - Scientific Methods

Supplementary

Newfoundland and Labrador Rock and Mineral Kit

How Do We Use Rocks and Minerals?

Outcomes	Focus for Learning

Outcomes

Students will be expected to

32.0 describe examples, in the home and at school, of tools, techniques, and materials that may be used to respond to their needs [GCO 1]

33.0 relate the characteristics of rocks and minerals to their uses [GCO 3]

Focus for Learning

For thousands of years, humans have used rocks and minerals to meet our needs. We use these natural resources for building materials, electrical and communications networks, transportation, decoration, tools, and for other purposes. Sometimes we use rocks and minerals in their natural form with minimal processing (e.g., crushed rock for roads, polished granite slabs for counter tops, and cut gemstones for jewellery). More often we use items that are made from rocks and minerals; having undergone significant physical and chemical processing (e.g., cement, glass, stainless steel cutlery).

Most of the items that we use everyday are made from the minerals contained in rocks (e.g., batteries, cell phones, coins, makeup, salt, soap, toothpaste). Students should research everyday items to determine which, if any, minerals they are made from. Toothpaste, for example, may contain white mica abrasives to clean teeth and fluorite to kill germs and fight cavities.

Students should relate the properties of a rock or mineral to its use.

Examples

- Diamond is a hard, durable mineral. This makes it ideal for grinding, cutting, drilling, and polishing when used as an abrasive; very small pieces are embedded into grinding wheels, saw blades, and drill bits.
- Halite cleaves into small cubic crystals and tastes salty. These properties make it useful for seasoning food (i.e., table salt).
- Copper is a metal that conducts electricity, resists corrosion, and can be stretched into wires. This makes it useful for electric wiring.
- Talc is an extremely soft mineral that absorbs moisture and has a silky texture making it ideal for use as baby powder.
- Slate is a hard metamorphic rock that can be split into thin sheets. These properties make slate useful as roofing and flooring tiles.

Attitudes

Encourage students to appreciate the role and contributions of science and technology in their understanding of the world. [GCO 4]

Sample Performance Indicator

Predict the properties of these rocks or minerals based on their uses:

- Gemstones are used to make expensive jewellery.
- Marble can be used as a kitchen counter top.
- Graphite is used in making leads for pencils.
- Quartz is used to make glass and lenses for telescopes.
- Gypsum is used to make plaster and gyproc.

How Do We Use Rocks and Minerals?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Students may • Populate a KWLM chart to list everyday objects and materials that they know are made from rocks and minerals and add to the chart as these outcomes are addressed. **Connection** Teachers may • Display a wooden pencil and ask students what parts they think contain minerals (The "lead" is primarily graphite, the metal ferrule attaching the eraser is likely aluminum, and the coloured paint is made from pigments that may contain powdered minerals). • Provide a collection of small, physical items found on the *Minerals in Our Everyday Lives* poster. Ask students to locate the items on the poster and record the minerals they are made from. • Relate the properties of a rock or mineral to its use (e.g., iron ore is used to make frying pans. To be useful for this purpose, iron must be strong, conduct heat, have a high melting point, and be malleable). Students may • Use interactive websites to identify everyday items in their home that are made from rocks and minerals. • Research how a favourite mineral is processed and used. **Consolidation** Teachers may • Provide grab bags of several small, everyday items made from rocks and minerals. Have students research and create an information card for each item. Include the name of the item, the minerals used to make it, properties that make it useful, and new questions they might have about it. Students may collaboratively design a museum exhibit from these items and information cards. Students may • Relate the properties of nickel that made it useful for coin making. • Research and show and share a small, everyday item brought from home that is made from rocks and minerals and relate their properties to their uses. • Research a mineral mined in Newfoundland and Labrador and describe its properties and uses. • Create a physical or digital collage of everyday items made from rocks and minerals. • Invent a fictitious rock or mineral, and describe its properties and potential uses.	**Authorized** *NL Science 4 Unit 1: Rocks Minerals and Erosion* (TR) • pp. 28-33, 40-43 *NL Science 4 Unit 1: Rocks Minerals and Erosion* (SR) • pp. 14-17, 24-27 *NL Science 4: Online Teaching Centre* • IWB Activity 5 **Suggested** Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/rocks.html • Mineral uses (posters and interactive websites) • Geology related regional support organizations (websites)

How Has Mining Technology Improved?

Outcomes	Focus for Learning
Students will be expected to	
34.0 describe examples of modern technologies that did not exist in the past [GCO 1]	Students should describe examples of modern mining related technologies that did not exist in the past. A miner's headlamp is one example. In the early 1900s, miners used candles for lighting underground mines. It was several decades before battery-powered electric headlamps were introduced. Over time, as advancements in chemistry and physics led to the development of new types of batteries and light bulbs, miner's headlamps continued to evolve. Modern headlamps use LED lights and have rechargeable battery packs.
	Mining technologies (i.e., tools, processes, and techniques) have changed dramatically in the past 100 years. Modern mining companies use global positioning systems (GPS), satellite imagery, magnetic and seismic surveying, and drill cores to find valuable mineral deposits. Gathering rocks and minerals no longer relies on human physical labour; the mining is done using sophisticated, powerful equipment. The processing of minerals also uses advanced technologies that more efficiently extract minerals from ore and are designed to reduce air, soil, and water pollution.
35.0 identify examples of scientific questions and technological problems that are currently being studied [GCO 1]	Science and technology develop over time. New questions arise from what is known and are investigated to find answers. New problems are identified, to which scientific understandings are applied, leading to the development of new tools, processes and techniques.
	Students should identify current examples of mining related technologies being developed and used in Newfoundland and Labrador.
	<u>Example</u>
	Traditionally, metals such as nickel were removed from ore by smelting (i.e., melting the metals using extreme heat) and refining. While effective, the process is costly, requires huge amounts of energy, and causes pollution, including significant amounts of carbon dioxide gas that contribute to climate change. Hydrometallurgy is a new cutting-edge mineral processing technology being developed and used in Long Harbour to extract nickel and other metals from Voisey's Bay ore. Hydrometallurgy, or "hydromet" for short, uses a chemical process combining water, oxygen, and sulphuric acid in pressurized vessels to dissolve metals from the ore. Additional chemical processes remove the nickel and other metals from the solution. Hydrometallurgy was developed to address some of the problems associated with smelting and refining. Hydrometallurgy produces less pollution, and is more cost effective and energy efficient.

How Has Mining Technology Improved?

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Present images of old technologies (e.g., cassette tapes, floppy disks, gramophones, rotary dial telephones, typewriters) to illustrate how technology changes over time. Ask students to infer reasons why it changes over time.

Connection

Teachers may
- Facilitate a simulated mining activity where students mine for chocolate chips in chocolate chip cookies or granola bars. Provide a variety of tools (i.e., technologies) and materials for student use in extracting their "minerals". Tools should include effective and ineffective tools (e.g., bamboo and metal skewers, bobby pins, chop sticks, flat and round toothpicks, forks and knives made from various materials, paper clips, paper and plastic straws, tweezers). Additional tools and materials could include water, vinegar, vegetable oil, graters, mortar and pestle, sieve, and magnification tools. Following the activity, students should discuss which tools, materials, and techniques worked best and why. Connections should be made to actual mining practices and the important role of technology in mining.

Students may
- Find and take digital images of old technologies in their home. Students may show and share their images with classmates.
- Compare images of older and newer models of the same technology and identify what changes were made to improve the technology (e.g., cameras, cars, cell phones, televisions).

Consolidation

Teachers may
- Present images of modern mining practices and those from the early 1900s. Ask students to contrast the mining technologies (i.e., tools, processes, techniques) displayed in the images.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 44-47, 48-51

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 28-29, 30-31

NL Science 4: Online Teaching Centre
- IWB Activities 6 and 7

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/rocks.html
- Mining related regional support organizations (websites)

What Are Some Effects of Using Rocks and Minerals?

Outcomes	Focus for Learning
Students will be expected to	
36.0 consider the positive and negative effects of familiar technologies [GCO 1]	Mining is an essential part of our society. Students should recognize, however, that mining technologies, like all technologies, have both positive and negative effects.
	Mining provides us with needed rocks and minerals for a variety of uses, employment, and economic and social benefits. Mining technology (i.e., extraction and processing) and our use of rocks and minerals also has negative impacts
	• pollutes the air, soil, and water;
	• requires large quantities of energy;
	• produces solid wastes (e.g., tailings, slag);
	• depletes natural resources;
	• may result in large scale environmental accidents; and
	• impacts wildlife and their habitat, as well as Indigenous peoples and their way of life (large surface mines).
37.0 contemplate their own and their family's impact on natural resources [GCO 1]	Canadian per capita resource consumption continues to rise at alarming rates. Students should reflect on their family's consumption of consumer products made from rocks and minerals (e.g., batteries, electronics, glass and aluminum beverage containers, metal food cans) and the impact one person has on natural resources. To maintain current standards of living, it is estimated that each person uses more that 10 000 kg of mining-related natural resources per year.
38.0 describe how personal actions help conserve natural resources and care for living things and their habitats [GCO 1]	Having noted the negative impacts of mining and the consumption of products, students should consider ways to reduce or minimize these impacts. Focus students on ways to reduce, reuse, and recycle consumer products made from rocks and minerals:
	• Reducing what is consumed will have the greatest positive impact on conserving natural resources; if we use less, there is less need to produce more (e.g., using rechargeable batteries, renting rather than purchasing products used infrequently).
	• What products or materials made from rocks and minerals can we donate to be reused by others (e.g., appliances, cellphones, computers, electronics, eyeglasses, home construction and renovation materials, televisions)?
	• What products or materials made from rocks and minerals can we recycle (e.g., batteries, beverage containers, e-waste, fluorescent bulbs, glass, paint, paper, metals)?
	Attitude
	Encourage students to
	• realize that the applications of science and technology can have both intended and unintended effects.
	• be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment. [GCO 4]

What Are Some Effects of Using Rocks and Minerals?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation	**Authorized**
Students may	*NL Science 4 Unit 1: Rocks Minerals and Erosion* (TR)
• Brainstorm the benefits and possible harms caused by mining.	• pp. 52-55
Connection	*NL Science 4 Unit 1: Rocks Minerals and Erosion* (SR)
Teachers may	• pp. 32-33
• Discuss the positive environmental impacts of donating, selling, and purchasing used items (e.g., "second-hand" and consignment stores, ReStores) and sharing resources (i.e., sharing economy).	**Suggested**
Students may	Other curriculum resources
• Research environmental impacts associated with mining and mineral processing.	• *Moving Up with Literacy Place 4* (ELA 4)
• Research what local mining companies are doing to minimize environmental impacts.	- *Recycling*
• Model an oil spill as an example of a large scale environmental accident. Fill a small container with water and add a cork and six drops of cooking oil. Investigate ways to clean the cork and remove the oil from the water.	Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/rocks. html
	• Recycling organizations (websites)
Consolidation	
Students may	
• Review the reduce, reuse, and recycle suggestions on the MMSB website and identify those that would reduce the need for mined materials.	
• Track personal, family, or class use of a product made from mined materials (e.g., aluminum cans, batteries, plastic beverage containers or shopping bags) for a period of time and estimate yearly consumption rates.	
• Imagine a mining company wants to construct a mine a couple of kilometres from your school. Debate the positive and negative impacts of the mine on your family, other members of the community, and the environment at a mock town meeting.	
Extension	
Students may	
• Research and develop a presentation on recent large-scale mining accidents (Mount Polley disaster, 2014).	

What Shapes Landscapes?

Outcomes	Focus for Learning
Students will be expected to 39.0 describe effects of wind, water, and ice on the landscape [GCO 3]	Newfoundland and Labrador has many unique areas of land. These areas, called landscapes, were formed and shaped over thousands of years. Naturally formed features within these landscapes are called landforms (e.g., barren, beach, delta, drumlin, erratic, cliff, fjord, glacial pavement, glaciated valley, river valley, sea cave, arch or stack). Students should describe how wind, moving water, and ice shaped, and continue to shape, our landscapes and landforms, through the processes of weathering, erosion, and deposition. Ice in the form of glaciers, for example, covered almost the entire province during past ice ages. As these thick ice sheets advanced and retreated, they sculpted and carved the landscape and transported massive quantities of rock to new locations. Many of the landforms we observe in our province today (e.g., glaciated valley, fjords, erratics, drumlins) were created by glaciers and the processes of weathering, erosion, and deposition. Numerous examples of weathering and erosion caused by wind, moving water, and ice are provided in subsequent outcomes. Weathering, erosion, and deposition are readdressed, in greater detail, in Science 7. **Sample Performance Indicator** Describe how wind, moving water, and ice can change a river valley, rocky beach, river delta, erratic boulder, steep cliff face, or a sea stack.

What Shapes Landscapes?

Sample Teaching and Assessment Strategies	**Resources and Notes**

Assessment should include student use of appropriate specific terminology (e.g., weathering, erosion, deposition).

Activation

Teachers may
* Provide students with beach rocks and ask students to infer why they are smooth.

Students may
* View online Newfoundland and Labrador tourism ads to identify a variety of provincial landscapes and landforms.

Connection

Teachers may
* Introduce the processes of weathering, erosion, and deposition and add the terms to the science word wall.
* Present an image of a local landscape or landform and model inferring how it may have been created or may be changed by wind, moving water, or ice.

Students may
* Share personal experiences with wind, moving water, or ice (e.g., swimming or paddling against the current in a fast moving water, wading out into the ocean waves on a sandy beach, sediment hitting your face on a windy day).
* Collect and share digital images of local landforms.

Consolidation

Students may
* View digital images of local landforms and infer how they may have been created by the effects of wind, water, or ice (e.g., drumlin, fjord, glaciated valley, sea cave).
* View digital images of local landforms and describe how they may change in future as a result of the effects of wind, water, or ice (e.g., sandy beach, sea arch, stream bed).
* Illustrate how a landform, such as a sea arch, erratic, or rocky beach, may change over time. Students may create before and after sketches, a series of sequential sketches on a time line, or a flip book.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
* pp. 60-65

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
* pp. 38-41

NL Science 4: Online Teaching Centre
* IWB Activity 8

Suggested

Other curriculum resources
* *Moving Up with Literacy Place 4* (ELA 4)
  - *Rocks on the Move*

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/rocks. html
* Tourism ads (video)

How Can We Model Weathering and Erosion?

Outcomes	Focus for Learning
Students will be expected to 40.0 model examples of weathering and erosion [GCO 3]	Weathering and erosion are usually slow processes that shape the landscape over thousands of years. Consequently, to investigate these processes, models are used (e.g., stream tables), rather than studying them directly in the field. Students should explore how rocks are broken down and carried away by conducting several activities designed to model examples of weathering and erosion. Weathering activities could model the • splitting apart of rock when water freezes in a crevice, • grinding down of beach rocks caused by the actions of waves, • scratching of rocks as glaciers with protruding rock slide past, • dissolving of calcite from rocks by acidic rainwater, or • rusting of metallic minerals exposed to air and water. Erosion activities could model the • plowing away of rock and soil by moving glaciers, • carrying away of rocks and soil by moving water in stream, • movement of sand on a beach by ocean waves, or • carrying away of rocks and soil by strong winds. Weathering and erosion are readdressed in Science 7.
41.0 explore how science and technology have been used to solve problems in the home and at school [GCO 1]	Students should identify problems associated with weathering and erosion and explore ways the problems have been solved: • Ice wedging forms potholes from cracks in pavement. Sealing the pavement or filling the cracks prevents further weathering. • Chemicals dissolve minerals in marble counter tops forming pit holes. Sealing the counter may prevent this weathering. • Oxidation causes metal objects like cars to rust. Painting the objects or coating them with a rust-proof material or wax may prevent this weathering. • Rainwater erodes soil on steep slopes. To prevent erosion, the slope may be terraced or retaining walls built. • Rivers erode soil from their banks. Trees and shrubs may be planted or large rocks placed on the banks to prevent erosion. • Wind eroding soils is a problem faced by some farmers. One solution is to plant tree line wind breaks to block the wind. Students could design activities to model these problems and solutions.

How Can We Model Weathering and Erosion?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Facilitate a neighbourhood walk and have students find evidence of weathering and erosion (e.g., potholes, cracks in concrete, rusting metals, washed out road shoulders, eroded banks). Digital images of weathering and erosion should be collected.
- Model rock abrasion using the rock tumbler and soft rocks.

Consolidation

Students may

- Model examples of weathering and erosion at prepared centres. Students may cycle though all centres or groups may be assigned specific centres to model and capture digital images and video to share with classmates.
  - Soak clay pots in water for several hours and freeze overnight or completely fill a plastic water bottle with water, screw on the cap, and freeze overnight (i.e., ice wedging).
  - Place soft rocks (e.g., sandstone) in a jar with water, shake vigorously, and pour through a coffee filter to see evidence of weathering or place sugar cubes in a jar and shake vigorously (i.e., abrasions).
  - Freeze bits of sand in an ice cube, allow it to partially melt, then slide it across parchment or wax paper (i.e., striations).
  - Place drops of vinegar on rocks containing calcite (e.g., marble and limestone) (i.e., chemical weathering).
  - Place small, prewashed metal objects (e.g., washers, steel wool, common nails) in water and observe (i.e., rusting)
  - Create glacial landscapes by pushing a wood block through sand in a sandbox.
  - Use a hair dryer to erode cereals of various sizes.
  - Place water in the trough of a paint tray and sand on the sloped surface. Direct waves at the sand.

Teachers may

- Present problematic examples of weathering and erosion on exit cards and have students brainstorm possible solutions:
  - Soil is eroding away from a hillside farm every time it rains.
  - A local sandy beach is being eroded away by ocean waves.
  - Old headstones in a graveyard are weathering away.
  - Copper rooves on buildings at Memorial University have turned green due to oxidization.
  - Ice wedging is causing rock slides at a highway rock cut.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 60-65, 65-67, 68-73, 74-75

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 38-41, 42-43, 44-45, 46-47

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

Supplementary

Rock tumbler/polisher kit

How Does Erosion Affect Landscapes?

Outcomes	Focus for Learning

Outcomes

Students will be expected to

1.0 propose questions to investigate and practical problems to solve [GCO 2]

3.0 state a prediction and a hypothesis [GCO 2]

9.0 follow procedures [GCO 2]

11.0 make observations and collect information that is relevant to the question or problem [GCO 2]

Focus for Learning

Students are expected to carry out guided inquiry investigations using stream tables to model erosion. In small collaborative groups, students should investigate the effect of one variable on the amount of erosion. Have students propose factors that could affect the amount of erosion, such as

- volume of water poured on to the stream table;
- speed of pouring;
- slope (i.e., steepness) of the stream table;
- sediment type in the stream table (e.g., sand, potting soil, aquarium gravel, pea gravel);
- presence or absence of rock in the soil; or
- presence or absence of vegetation (e.g., clumps of sod).

Students should select one variable to test (e.g., slope), pose a testable question (e.g., What is the effect of slope on the amount of erosion?), and make a prediction and hypothesis (e.g., If the slope of the stream increases, then the amount of erosion will increase because the water will flow at a faster speed). Refer to the *Integrated Skill* unit for elaboration of these skill outcomes (pp. 34-37)

Students should devise a procedure to carry out a fair test (Outcome 5.0, *Integrated Skills* unit, pp. 40-41) of their independent variable on the amount of erosion (i.e., the dependent variable). To be a fair test, only one variable can be changed while keeping all other conditions the same. The amount of erosion may be measured quantitatively by placing toothpicks in a grid pattern and counting the number that topple over or qualitatively by ranking the amount on a 1-5 scale or using words such as more and less.

Students should follow their devised procedure, carry out their investigation in a manner that ensures all other variables of influence are controlled, and make observations and measurements (Outcomes 7.0, 9.0 and 11.0, *Integrated Skills* unit, pp. 44-49).

Following analysis and interpretation of collected data, students should draw a conclusion that answers their initial question and expresses support for or rejection of their prediction and hypothesis (Outcome 18.0, *Integrated Skills* unit, pp. 54-55). If student groups tested different variables, students should present to their classmates; communicating their procedures and results (Outcome 22.0, *Integrated Skills* unit, pp. 60-61).

Attitude

Encourage students to willingly observe, question, explore and investigate. [GCO 4]

How Does Erosion Affect Landscapes?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Stream tables are available from science supply companies, however, any large plastic, metal, or aluminum foil container will work. Ideally, each group should have a stream table.

Activation

Teachers may

- Review the stages of the scientific inquiry process with students.

Students may

- Record their inquiry questions on a class "I Wonder" wall.

Connection

Teachers may

- Provide instruction regarding skill outcomes related to proposing questions, phrasing questions in a testable form, making predictions and hypotheses, devising procedures that ensure fair testing, carrying out procedures, making quantitative and qualitative measurements and observations, and drawing conclusions.
- Provide sticky notes for student use, then demonstrate erosion using a stream table. Have students record on a separate sticky note each variable they could change about the stream table that could affect the amount of erosion observed (e.g., slope, sediment type, volume of water, speed of pouring). These recorded variables are possible independent variables. To pose a testable question, students select and insert a sticky note into the template, What is the effect of _____ on the amount of erosion? This process proposes multiple testable questions that can be investigated by different groups. Having selected one sticky note as the independent variable, all the variables on the remaining sticky notes must now be controlled during testing to ensure fair testing.

Consolidation

Students may

- Propose a question to investigate and devise and carry out a fair test to determine the effect of a selected variable on the amount of erosion using a stream table. As part of the planning stage, students should decide what evidence (i.e., measurements and observations) will be collected and how it will be recorded.
- Capture digital video recordings of erosion tests. The recordings may be used as evidence for analysis and interpretation or to confirm that procedures were carried out fairly.
- Capture before and after digital images as evidence of the amount of erosion.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)

- pp. 66-67

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)

- pp. 42-43

NL Science 4: Online Teaching Centre

- IWB Activity 9
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning- strategies.html
  - Rocks, Minerals, and Erosion Activities
  - Scientific Methods

Suggested

Science suppliers (websites)

How Can We Reduce Soil Erosion?

Outcomes	Focus for Learning
Students will be expected to	
42.0 describe how soil is formed from rocks [GCO 3]	*Exploring Soils* is a unit in Science 3. Consequently, students should have prior knowledge of various types of soil and their components. In Science 4, students are expected to describe the process of soil formation.
	Soil is a natural resource that forms very slowly. It is composed of fine rock and mineral particles, water and air spaces surrounding these particles, decomposing organic matter (humus), and living organisms.
	Soil formation begins with the weathering of parent rocks to form sediments. The speed of weathering depends on the type of rock and the climate of the area. Weathered sediments are carried away by erosion (e.g., moving water) and deposited in new locations (e.g., flood plain, delta). Here, living and dead organisms add organic matter to the sediments which is broken down by decomposers (e.g., earthworms and bacteria) to release nutrients.
43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications [GCO 1]	Scientific ideas and discoveries lead to new inventions and applications. Students should relate this outcome to amending soils to improve fertility. Soils in Newfoundland and Labrador vary from one location to another, however, they are typically shallow, compacted, clay-based, acidic, slow draining, contain low amounts of air, and are nutrient poor. Students should describe efforts employed to improve soils and discuss the scientific ideas upon which they are based.

Soil improvement efforts could include
- amending soils to improve their structure (e.g., sand is added to lighten heavy clay-based soils);
- adjusting soil pH (e.g., lime is added to lawns and crushed egg shells are added to gardens to neutralize acidic soil);
- adding organic or synthetic fertilizers to improve fertility (e.g., adding fertilizers high in nitrogen, phosphorous, potassium, and other minor plant nutrients);
- adding organic matter (e.g., capelin, kelp, manure, compost) to add nutrients, improve water retention, and create air spaces.
- adding biological organisms (e.g., earthworms, fungi, and bacteria) to break down organic matter and, in the case of earthworms, create air spaces.
- aerating lawns to reduce compaction and create air spaces.

Sample Performance Indicator

Create a labelled flow chart to describe soil formation.

How Can We Reduce Soil Erosion?

Sample Teaching and Assessment Strategies	**Resources and Notes**

Activation

Teachers may
- Activate students prior knowledge using a place mat activity. Place the term soil in the centre of a place mat divided into four sections. In groups of four, ask students to individually record their prior knowledge in one section.
- Add soil-related terminology to the science word wall.

Connection

Teachers may
- Provide the steps of the process of soil formation on sentence strips and ask students to logically sequence them.

Students may
- Compare soil and sediment in a Venn diagram.
- Investigate decomposition of organic matter in a compost bin.
- Establish and maintain a class vermicomposter (Vermicomposters could also be used in the *Habitats and Communities* unit).

Consolidation

Teachers may
- Model rainwater eroding soil from a hill in a stream table, plastic paint tray, or similar container. Ask students to apply what they have learned about erosion to design and build a solution to reduce erosion by rainwater. Students should follow a design process and construct and test prototypes. Digital video of each test can be recorded for analysis. Students should evaluate their solution, make changes, and retest; continuing this cycle until satisfied with their solution. The experience should be used as an example of how scientific understandings lead to new inventions and applications.

Students may
- Present their final solution to rainwater erosion to classmates for peer evaluation with respect to function, reliability, aesthetics, and efficient use of materials.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 68-73, 74-75

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 44-45, 46-47

NL Science 4: Online Teaching Centre
- IWB Activity 10
- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/ sci-4/teaching-and-learning-strategies.html
  - Rocks, Minerals, and Erosion Activities

What Causes Rapid Changes to Landscapes?

Outcomes

Students will be expected to

44.0 describe natural phenomena that cause rapid and significant changes to the landscape [GCO 3]

Focus for Learning

Weathering and erosion slowly change landscapes over thousands of years. Rapid changes to landscapes also occur. Rapid changes may be caused by

- hurricanes, floods, heavy rainstorms;
- earthquakes, landslides, tsunamis; and
- erupting volcanoes.

Students should describe examples of natural phenomena that cause rapid and significant changes to the landscape. Students should focus on changes to the natural landscape, as opposed to the damage and destruction of buildings and infrastructure. Flooding, for example, commonly occurs when heavy rains enter rivers and streams causing them to overflow their banks. The increased water volume causes rapid and significant erosion. Muddy floodwaters carry away significant amounts of sediment. Once floodwaters slow and recede, the sediments they were carrying are deposited in new locations.

Where applicable, local examples of rapid landscape changes could be highlighted:

- Hurricane Igor (2010)
- Burin Peninsula tsunami (1929)
- Badger flood (2003)
- Daniel's Harbour landslide (2007)

Catastrophic events, such as earthquakes and volcanic eruptions, are readdressed in Science 7.

What Causes Rapid Changes to Landscapes?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Show digital video of the Badger flood (2003), Daniel's Harbour landslide (2007), and Hurricane Igor (2010).

Connection

Teachers may
- Present before and after images of an area rapidly and significantly changed by a natural phenomenon. Ask students to identify and discuss how the area has changed.

Students may
- Create a collage of landscapes that have been significantly and rapidly altered as a result of natural phenomenon.
- Model an earthquake by pressing their thumb and middle finger together and pressing until it slides past and snaps.

Consolidation

Students may
- Create a news report describing landscape changes caused by a recent natural phenomena.

Resources and Notes

Authorized

NL Science 4 Unit 1: Rocks Minerals and Erosion (TR)
- pp. 76-79

NL Science 4 Unit 1: Rocks Minerals and Erosion (SR)
- pp. 48-49

NL Science 4: Online Teaching Centre
- IWB Activity 11

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/rocks. html
- Local examples of rapid landscape changes (websites and video)
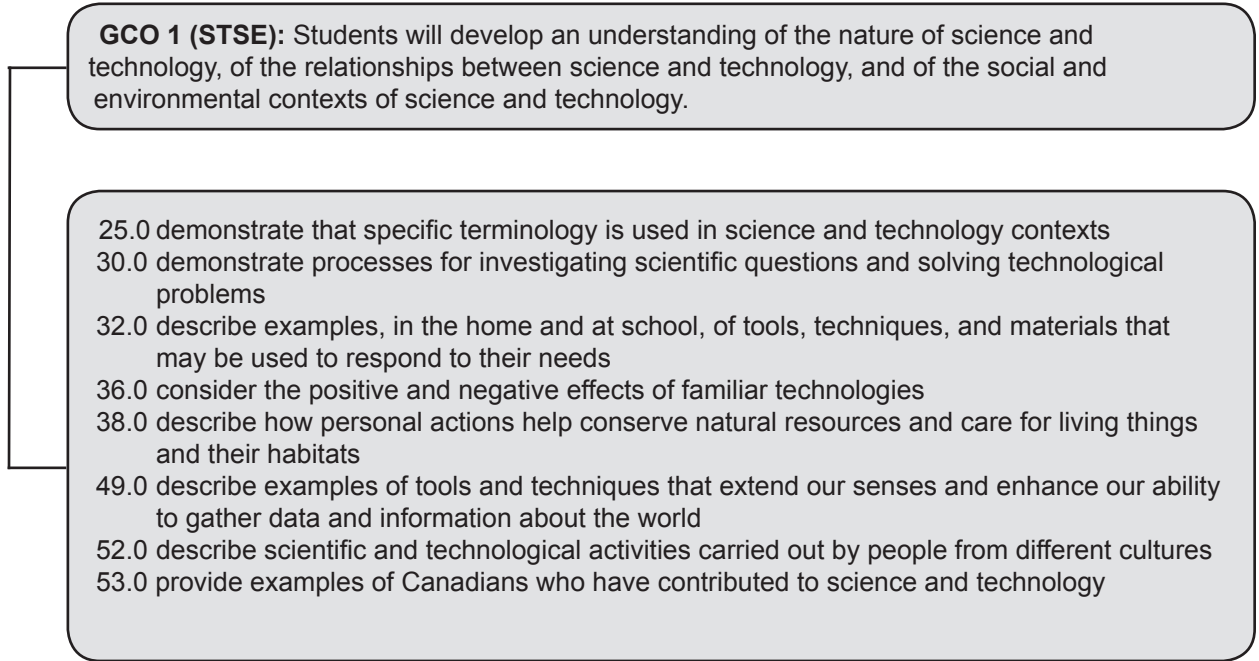
Section Three:
Specific Curriculum Outcomes

Unit 2: Sound

Focus

Sound is a phenomenon that can be observed, measured, and manipulated in various ways. Learning how sound is caused by vibrations is important as students explore both how sound travels and factors that affect the sounds produced. The varying ability of humans and other animals to detect sound is also examined. This leads to discussion about the necessity of protecting your sense of hearing.

This unit has both a scientific inquiry and a design and problem solving focus. The unit emphasizes the development of inquiry skills related to phrasing questions in a testable form, making predictions and hypotheses, communicating procedures and results, and identifying new questions that arise from what was learned. Design and problem solving experiences, develop the skills of gathering information from a variety of sources and technologies, selecting and using tools, evaluating personally constructed devices, and working collaboratively with group members to evaluate processes used in solving a problem.

Outcomes Framework

GCO 1 (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.

25.0 demonstrate that specific terminology is used in science and technology contexts
30.0 demonstrate processes for investigating scientific questions and solving technological problems
32.0 describe examples, in the home and at school, of tools, techniques, and materials that may be used to respond to their needs
36.0 consider the positive and negative effects of familiar technologies
38.0 describe how personal actions help conserve natural resources and care for living things and their habitats
49.0 describe examples of tools and techniques that extend our senses and enhance our ability to gather data and information about the world
52.0 describe scientific and technological activities carried out by people from different cultures
53.0 provide examples of Canadians who have contributed to science and technology

GCO 2 (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.

2.0 rephrase questions in a testable form
3.0 state a prediction and a hypothesis
8.0 select and use tools
13.0 identify and use a variety of sources and technologies to gather relevant information
19.0 suggest improvements to a design or constructed object
20.0 evaluate personally constructed devices
21.0 identify new questions or problems that arise from what was learned
23.0 communicate procedures and results
24.0 work with group members to evaluate processes used in solving a problem

GCO 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.

45.0 identify objects by the sounds they make
46.0 relate vibrations to sound production
47.0 compare how vibrations travel differently through a variety of solids and liquids and through air
48.0 investigate and describe how the human ear is designed to detect vibrations
50.0 demonstrate and describe how the pitch and loudness of sounds can be modified
51.0 compare the range of sounds heard by humans to that heard by other animals

GCO 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.

- appreciate the role and contributions 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 men and women of any cultural background can contribute equally to science
- show an interest in 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
- 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 safety and that of others in planning and carrying out activities and in choosing and using materials

SCO Continuum

GCO 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.

Science 1	Science 4	Physics 2204
Materials and Our Senses	*Sound*	*Waves*
• identifying attributes of materials using our sense of hearing • using materials to make different sounds	• identify sound producing objects • relate vibrations to sound • compare sound transfer through solids, liquids and air • investigate human hearing • modify pitch and loudness of sounds • compare human hearing to that of other animals	• describe the characteristics of waves • apply wave equations to explain and predict wave behaviour • compare and describe properties of sound and electromagnetic radiation • describe how sound and electromagnetic radiation are produced and transmitted • apply the laws of reflection and refraction to predict wave behaviours • explain quantitatively and qualitatively the phenomenon of wave interference, diffraction, reflection, refraction, and the Doppler-Fizeau effect

Suggested Unit Plan

The Sound unit is the first of two consecutive physical science units. It directly follows the Rocks, Minerals, and Erosion unit.

September	October	November	December	January	February	March	April	May	June
			Sound						

Communicating Using Specific Terminology

Outcomes	Focus for Learning
Students will be expected to 25.0 *demonstrate that specific terminology is used in science and technology contexts* [GCO 1]	Students are expected to communicate using appropriate terminology in science and technology contexts. When describing how we hear, for example, students should understand and use terms such as outer ear, ear drum, and cochlea. There is no expectation that students be able to define these terms or label them on a diagram of the ear. Specific terminology should be introduced as the need emerges. The term pitch, for example, should be introduced when students are describing high or low sounds. Presenting all the unit terminology at the outset is strongly discouraged. Scientific inquiry and design and problem solving process-related terminology includes • question, problem, solution; • prediction, hypothesis, procedure, materials, tools, instruments; • observations, measurements, record, classify, data, patterns, discrepancies, results, conclusion; • fair test, independent variable, dependent variable, controlled variables; and • design, construct, test, evaluate, prototype, constructed device. Sound-related terminology includes • sound, natural sounds, artificial sounds; • sound wave, vibration; • outer ear, ear canal, ear drum, middle ear bones, cochlea, cilia, auditory nerve, brain; • loudness, volume, decibel; • pitch, frequency, hertz; and • noise, noise pollution. Communicating using appropriate, specific terminology is a constant expectation. As students progress through the unit their use of scientific and technological terminology should increase. Refer to pp. 70-71 of the *Rocks, Minerals, and Erosion* unit for previous elaboration of this outcome.

Communicating Using Specific Terminology

Sample Teaching and Assessment Strategies

Whenever students are investigating or problem solving, their use of appropriate terminology in communication can be assessed. Assessments may include self, peer, and teacher assessments using terminology checklists in conjunction with direct observations or digital audio recordings of collaborative group work.

Activation

Teachers may

- Pre-assess student use of specific terminology using graffiti board activities and question prompts
    - What makes sound? How are sounds made?
    - How do you describe sounds? How do we use sounds?
- Introduce specific terminology through relevant children's literature including titles from the *Moving Up With Literacy Place 4: Arts Book Club - Sounds Like Music!*
- Create a curiosity centre of sound-related items. Add to the centre as you progress through the unit and have students contribute items.

Students may

- Engage in a book walk through *NL Science 4 Unit 2: Sound* to identify sound-related terminology.
- Sit quietly in a chosen location on the school grounds, close their eyes, and listen to the sounds around them. Students should then communicate what is heard to others (orally, visually, or in written format utilizing a graphic organizer).

Connection

Teachers may

- Model the use of appropriate scientific and technological terminology and encourage students to adopt them.
- Add sound-related terminology to the science word wall as the need emerges.
- Incorporate specific terminology into literacy block activities.
- Facilitate collaborative group investigations and design and problem solving experiences where students are encouraged to think aloud; communicating their ideas, questions, and intentions.

Students may

- Use alpha-boxes to record sound-related terminology.
- Create a visual glossary of sound-related terminology
- Record sound-related questions on the class "I Wonder" wall.

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (Student Resource [SR])

- pp. 1-55, 56-59

NL Science 4: Online Teaching Centre

- Science Skills Toolkit

NL Science 4: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up With Literacy Place 4* (ELA 4)
    - *Arts Book Club - Sounds Like Music!*

What Can We Hear?

Outcomes	Focus for Learning
Students will be expected to 45.0 identify objects by the sounds they make [GCO 3]	Sound is made when something vibrates. They can be created by nature (i.e., natural sounds) or human-made devices (i.e., artificial sounds). Students should actively listen to various sounds and identify the sound (i.e., identify the vibrating object producing). Students should be encouraged to describe the sounds they hear using descriptive terminology. Introduce specific terminology as the need emerges. Different objects produce different sounds. The sound produced depends on the material the object is made from and the object's size. Generally, larger objects produce lower sounds, while smaller objects produce higher sounds. Students may use this generality, and others, to help identify the sound producing object. Teachers may choose to address or readdress the skill of classifying at this time; classifying sounds as natural or artificial (SCO 15.0 *Integrated Skills* unit*,* pp. 52-53). Teachers may also choose to address the skill of identifying new questions arising from what was learned; encouraging students to record sound-related questions thought of while identifying objects by the sounds they make (SCO 21.0 *Integrated Skills* unit*,* pp. 58-59). Cross curricular connections may be made to Music 4 outcomes related to identifying aurally, musical instruments from different orchestral families. **Attitude** Encourage students to show interest and curiosity about objects and events within different environments. [GCO4]

What Can We Hear?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Provide opportunities for students to integrate sound recording technologies (e.g., mobile device applications); recording sounds in their home, school, and community.

Activation

Students may

- Engage with sound-making objects at the curiosity centre and bring sound-making items from home to add to the centre.
- Play "Who Am I?" children's games, identifying animals by the sounds they make.

Connection

Students may

- Conduct a sound audit of the different sounds heard in various locations in and around the school.

Consolidation

Teachers may

- Play sounds from online or mobile device applications and ask students to identify the sound.
- Record a collection of everyday sounds. Select and play one sound daily as the "secret sound of the day" for students to identify.

Students may

- Record everyday sounds from their home and community and test the ability to their classmates to identify them.

Extension

Students may

- Create music from everyday objects using physical objects or online and mobile device applications (e.g., MadPad).

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (Teacher Resource [TR])

- pp. 10-11

NL Science 4 Unit 2: Sound (SR)

- pp. 6-7

NL Science 4: Online Teaching Centre

- IWB Activity 1
- Science Skills Toolkit

NL Science 4: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html

- What's that sound? (mobile device applications, websites, and videos)
- Everyday sound songs (mobile device applications and videos)

Other curriculum resources

- *Moving Up With Literacy Place 4* (ELA 4)
  - *Music for the End of Time (Arts Book Club - Sounds Like Music!)*

What Makes Sound?

Outcomes	Focus for Learning
Students will be expected to 46.0 relate vibrations to sound production [GCO 3]	Outcome 46.0 may be addressed in conjunction with outcome 45.0 on the spread. Students should recognize that sounds are produced when objects vibrate: • When you speak, your vocal chords vibrate. • When plucked, a guitar string vibrates. • When air is blown over the reed in a clarinet, the reed vibrates. • When struck with a striker, a triangle vibrates. • The cone-shaped surface of an audio speaker vibrates. • When air is blown across a blade of grass, the grass vibrates. • When air is blown into a recorder the column of air vibrates. • When air is blown across the top of a bottle, the air inside the bottle vibrates. Vibrating objects move back and forth repeatedly creating sound waves that emanate in all directions. A visual of concentric ripples created after a pebble is dropped in water may aid student understanding of sound waves. Students should represent sounds in illustrations as concentric circles emanating from the source. **Sample Performance Indicator** Explain how sound is produced when a tuning fork is struck and draw a sketch to illustrate how sound emanates from it.

What Makes Sound?

Sample Teaching and Assessment Strategies	Resources and Notes
Assessment may include student use of appropriate sound-related terminology.	**Authorized**
	NL Science 4 Unit 2: Sound (TR)
Activation	• pp. 12-19
Teachers may	*NL Science 4 Unit 2: Sound* (SR)
• Play a whistle or a kazoo and ask students to explain how they think it produces sound.	• pp. 8-11
Students may	**Supplementary**
• Demonstrate how to make sounds using a variety of objects and musical instruments from the curiosity centre.	Tuning fork set
	Suggested
Connection	Resource Links: www.k12pl.
Teachers may	nl.ca/curr/k-6/sci-4/links/sound. html
• Explicitly connect sound production to vibrations.	• What makes sound? (mobile device applications, websites, and videos)
• Play a recorder and explain how blowing air into the mouthpiece causes a vibration within the air column inside. Students may take apart their recorder to visualize the air column within.	Other curriculum resources
Students may	• Recorders (Music 4-6)
• Feel the vibration of their vocal chords as they speak or hum.	• *Moving Up With Literacy Place 4* (ELA 4)
• Create wave patterns by striking a tuning fork and placing it in a shallow pan of water.	- *Make a Song (Arts Book Club - Sounds Like Music!)*
• Touch audio speakers while in operation to sense the vibrations produced.	
• Attempt to make sound by blowing on a blade of grass held tightly between their thumbs or by blowing on a comb covered in wax paper.	
• Create vibrations in a ruler extended over the edge of a desk.	
• Observe grains of rice vibrating on the surface of a struck drum head.	
• Blow air across the top of an empty pop bottle to produce sound.	
• Make sounds using a variety of percussion, string, and wind instruments and identify the part of the instrument that is moving to make the sound.	
Consolidation	
Students may	
• Produce sound with an object or musical instrument and explain how the sound is made.	
• Contemplate how animals without visible ears (e.g., earthworms, snakes) can 'hear".	

How Does Sound Travel?

Outcomes	Focus for Learning
Students will be expected to 47.0 compare how vibrations travel differently through a variety of solids and liquids and through air [GCO 3]	Students should conduct directed inquiry investigations to compare how sound vibrations travel through different solids, liquids, and air. Through investigation, students should come to learn that sound can travel through solids, liquids, and air (i.e., it can be heard) and it generally travels more efficiently (i.e., the sound remains louder and travels farther) through solids than liquids, and liquids than air. In conducting these investigations, students should • make predictions and hypotheses (SCO 3.0); • follow procedures (SCO 9.0); • make and record observations and qualitative measurements of sound loudness (SCOs 11.0, 12.0); • display their data and identify patterns (SCOs 16.0, 17.0); and • draw conclusions (SCO 18.0) Refer to the *Integrated Skills* unit for elaboration of these outcomes. While the particle theory of matter is not introduced to students until Science 7, understanding that matter is made of particles and that the distances between particles vary according to state should enable students to understand differences in sound travel. Sound vibrations travel from particle to particle through collisions, like dominoes toppling in sequence. Particles in solids are very close together. Particles in liquids are slightly farther apart. Particles in gases, such as air, are widely spaced. When particles are close together, vibrations transfer more efficiently. When more widely spaced, particle to particle collisions are more difficult.
21.0 identify new questions or problems that arise from what was learned *[GCO 2]*	Following completion of investigations, encourage students to identify new questions to investigate that arise from what was learned. For example, will sound travel more efficiently through Jello™ or yogurt, wood or metal, modeling clay or sponge? Refer to the *Integrated Skills* unit (pp. 58-59) for elaboration of this skill outcome. **Attitude** Encourage students to demonstrate perseverance and a desire to understand. [GCO4] **Sample Performance Indicator** Sequence a collection of plastic sandwich bags filled with different materials (e.g., air, pancake syrup, wood block) based on their predicted effectiveness transferring sound, if placed between your ear and a sound producing object. Provide a rationale for your prediction.

How Does Sound Travel?

Sample Teaching and Assessment Strategies	**Resources and Notes**

Sample Teaching and Assessment Strategies

In Science 2, students explored liquids and solids and the states of water. Pre-assess student understanding.

Activation

 Students may
- Construct and use a tin can telephone (i.e., connect two metal cans with a taut string) to communicate with a classmate.

Connection

Teachers may
- Model the spacing of particles in solids, liquids, and air using marbles.

Students may
- Create a stereo hanger by tying two pieces of string to the bottom corners of a metal clothes hanger. Investigate the sound produced when the hanger is struck while
  - pulling tightly on the strings in air
  - partially submerged in a container of water with your ear on the container
  - each string is coiled around a finger and the fingers are pressed against your ears
- Compare the sound heard from strumming a comb's teeth in the air, while submerged in a container of water with your ear pressed against the container, and against a desktop with your ear on the desk. Alternatively, students can use a tuning fork.
- Set up and topple dominoes varying the space between the them for each trial, as models of the efficiency of sound transfer in solids, liquids, and air.

Consolidation

Students may
- Investigate how vibrations travel through plastic sandwich bags filled with various solids, liquids (e.g., flour, split peas, molasses, water), and air. Students should place the sandwich bags between their ear and a table top and compare the sound heard when the table is tapped from below. Observations may lead to new questions which prompt students to extend the investigation; testing different solids and liquids, or different sounds.
- Explain why some indigenous people place their ear to the ground to hear distant sounds.
- Explain why we should not tap on the glass of an aquarium.

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (TR)
- pp. 12-19

NL Science 4 Unit 2: Sound (SR)
- pp. 8-11

NL Science 4: Online Teaching Centre
- IWB Activity 2
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Supplementary

Tuning fork set

How Do Our Ears Detect Sound?

Outcomes

Students will be expected to

48.0 investigate and describe how the human ear is designed to detect vibrations
[GCO 3]

Focus for Learning

Students should describe how the human ear detects sound. The outer ear collects, amplifies, and directs vibrations from the environment down the ear canal. At the end of the ear canal, the ear drum vibrates, moving the three small bones of the middle ear. This transfers the vibration to the cochlea.   Tiny hairs within the cochlea (i.e., cilia) vibrate and send an electrical signal through the auditory nerve to the brain. The brain interprets the signal as sound.

Introduce specific terminology as needed. Students are expected to use appropriate terminology when describing how we hear.

Students should conduct guided inquiry investigations related to human hearing (e.g., Can you hear sounds better in front of you or behind you?). Students should

- make a prediction and a hypothesis (SCO 3.0);
- devise their own procedure to carry out a fair test (SCO 5.0);
- identify appropriate tools, measuring instruments, and materials to complete their investigation (SCO 6.0);
- carry out their procedure ensuring a fair test (SCO 7.0);
- make observations relevant to the question (SCO 11.0);
- record observations (SCO 12.0); and
- draw a conclusion that answers their initial question (SCO 18.0).

Students should also construct a model of the human ear and use their model to describe how our ears detect sound. As part of this design and problem solving experience, students should

- select materials and tools to construct their model (SCO 6.0);
- design and build their model of a human ear (SCO 14.0);
- suggest improvements to their design or model, and those of classmates (SCO 19.0);
- evaluate their model, and those of classmates, with respect to function and use of materials (SCO 20.0).

Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Attitude

Encourage students to work collaboratively while exploring and investigating. [GCO4]

Sample Performance Indicator

Describe how your ear is designed to help you hear the announcements from the school's public address system.

How Do Our Ears Detect Sound?

Sample Teaching and Assessment Strategies	Resources and Notes
Assessment may include student use of appropriate sound-related terminology.	**Authorized**
	NL Science 4 Unit 2: Sound (TR)
Activation	• pp. 20-25
Students may	*NL Science 4 Unit 2: Sound* (SR)
• Communicate personal hearing-related experiences.	• pp. 12-15
	NL Science 4: Online Teaching Centre
Connection	• Science Skills Toolkit
Teachers may	• Skills and Processes for Scientific Inquiry rubric builder (BLM)
• Present physical models, diagrams, and/or videos to instruct how the various parts of outer, middle, and inner ear help detect vibrations and enable us to hear.	• Skills and Processes for Design and Problem Solving rubric builder (BLM)
• Represent the steps of how our ears detect sound on a series of 8-10 index cards. Have students place the cards in the correct sequence.	*NL Science 4: Online Student Centre*
• Model how the hairs in the cochlea receive vibrations by holding pipe cleaners upright in one hand and moving the other hand through them to vibrate them.	• Science Skills Toolkit
• Invite hearing itinerants or other knowledgeable community members to deliver a class presentation on human hearing.	Teaching and Learning Strategies
	• www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
Consolidation	- Sound Centres
Students may	
• Plan and conduct a guided inquiry investigation to determine how far humans can hear sounds in front of them and behind them (The forward facing orientation of the human ear should allow sounds in front of them to be heard from greater distances than those behind them).	**Suggested**
• Design and construct a model of the human ear using a teacher provided collection of found and recycled materials and communicate their design to others. Student constructed models may be used as a visual aid in meeting the sample performance indicator. Alternatively, students may construct their models from modelling clay.	Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/sound.html
• Plan and conduct a guided inquiry investigation to determine how placing their hands in various orientations around their ears (i.e., cupped behind, cupped in front, covering their ear) affects how far they can hear sounds in front of them.	• How do we hear? (mobile device applications, websites, and videos)
• Describe how design features of the human ear (e.g., outer ear shape, ear drum, cilia, auditory nerves) help us hear.	
• Explain how a cupped hand placed behind your ear might help you hear more clearly.	

How Does Technology Help Us Hear?

Outcomes

Students will be expected to

49.0 describe examples of tools and techniques that extend our senses and enhance our ability to gather data and information about the world
[GCO 1]

Focus for Learning

Students should describe examples of technologies (i.e., tools and techniques) that enable us to extend our sense of hearing. This outcome illustrates an important aspect of the relationship between science and technology. Technology enhances our ability to make observations and gather data and information that enables us to answer previously unanswered questions, leading to new questions, applications, and inventions.

Sound-related technologies that extend our sense of hearing include

- cupping you hand behind your ear;
- holding a glass rim down against a wall and placing your ear on the bottom of the glass;
- the use of ear trumpets, hearing aids, personal FM radio technologies, and cochlear implants by the hearing impaired;
- parabolic microphones; and
- stethoscopes.

Attitude

Encourage students to appreciate the role and contribution of science and technology in their understanding of the world. [GCO 4]

Sample Performance Indicator

Your parents are having a discussion in the next room. Describe examples of technologies you could use to enhance your ability to hear their conversation.

How Does Technology Help Us Hear?

Sample Teaching and Assessment Strategies

Regardless of the strategies selected, the focus should be how technology (i.e., tool, process, or technique) extends our sense of hearing; enabling us to gather information that could not have been obtained without its use.

Connection

Teachers may

- Present visuals of technologies that extend our sense of hearing (e.g., ear trumpets, hearing aids, personal FM radio units, cochlear implants, sonar, fish finders, ultrasound, parabolic microphones, stethoscopes).
- Show online video clips explaining how specific sound-related technologies work.
- Invite hearing itinerants, individuals with hearing impairments, or other knowledgeable community members to present to the class on technologies used by the hearing impaired.

Students may

- Use a stethoscope to listen to their own heartbeat.

Consolidation

Teachers may

- Present visuals of sound-related technologies and have students describe how the technology extends our sense of hearing and our ability to gather data and information.

Students may

- Construct paper ear trumpets of varying heights and diameters and test them to determine which variable is most important to extend hearing. To construct ear trumpets
  - draw circles with different diameters on sheets of paper and cut them out,
  - cut a line from the edge of each circle to the centre
  - overlap the cut edges and tape them to create a cone, and
  - cut the point off each cone to make a small hole.

Extension

Students may

- Investigate American Sign Language and learn the finger spelling alphabet.

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (TR)
- pp. 26-29

NL Science 4 Unit 2: Sound (SR)
- pp. 16-17

NL Science 4: Online Teaching Centre
- IWB Activity 3

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html
- How do sound technologies work? (videos)

How Can We Change Pitch and Loudness of Sound?

Outcomes	Focus for Learning
Students will be expected to 50.0 demonstrate and describe how the pitch and loudness of sounds can be modified [GCO 3]	Loudness is a measure of how much sound there is. The larger the vibration the louder the sound. The smaller the vibration the softer the sound. Loudness is measured in decibels (dB). Pitch is another property of sound. Objects that vibrate quickly produce high-pitched sounds (e.g., a whistle). Objects that vibrate slowly produce low-pitched sounds (e.g., a fog horn). Generally, longer or more massive objects vibrate more slowly than shorter or less massive objects. The number of times an object vibrates in a second is called frequency. Sound frequency is measured in Hertz (Hz). Students should come to recognize that shorter objects generally vibrate more quickly than longer objects. Students are expected to demonstrate and describe how objects can be modified to make their sounds louder and softer or higher- and lower-pitched. Additionally, students should demonstrate how to play sounds of different pitches and loudness on musical instruments.
2.0 rephrase questions in a testable form [GCO 2] *3.0 state a prediction and a hypothesis* [GCO 2]	Students should conduct guided inquiry investigations to determine how changing a variable affects the sound produced by an object. To activate investigations, make sound using an object. Have students brainstorm what they could change about the object before experimenting (i.e., independent variable) and what they could observe or measure about the sound while experimenting (i.e., dependent variable).

<table>
<tr><td colspan="2" align="center">Example: Produce sound by blowing across the top of a bottle</td></tr>
<tr><td align="center">Variables you could change before experimenting (Independent Variable)</td><td align="center">Variables you could observe or measure while experimenting (Dependent Variable)</td></tr>
<tr><td>• bottle size
• bottle material
• bottle colour
• bottle neck size
• amount of water in the bottle
• how hard you blow</td><td>• does it produce sound
• loudness
• pitch</td></tr>
</table>

Students should select one variable from each category to create their unique testable question (e.g., What is the effect of bottle size on the pitch of the sound produced?), devise a procedure to carry out a fair test, and make a prediction and hypothesis. To ensure fairness, all other potential independent variables listed in the table must be controlled during testing.

These investigations provide opportunities to address and assess numerous inquiry-related outcomes from the *Integrated Skills* unit.

Attitude

Students are encouraged to willingly observe, question, explore, and investigate. [GCO 4]

How Can We Change Pitch and Loudness of Sound?

Sample Teaching and Assessment Strategies	Resources and Notes
Students should use various tools or mobile device applications to measure the pitch and loudness of sounds.	**Authorized**
	NL Science 4 Unit 2: Sound (TR)
Activation	• pp. 30-35, 36-39, 52-57
Student may	*NL Science 4 Unit 2: Sound* (SR)
• Explore tuning forks of varying frequencies. Modelling clay may be added to the prongs and changes observed.	• pp. 18-21, 22-23, 34-37
• Create ripples in shallow pans of water using stones of varying sizes or tuning forks of varying frequencies.	*NL Science 4: Online Teaching Centre*
	• IWB Activities 4 and 6
Connection	• Science Skills Toolkit
Teachers may	• Skills and Processes for Scientific Inquiry rubric builder (BLM)
• Demonstrate loud, soft, high-pitched, and low-pitched sounds on a musical instrument and relate differences in what is heard to the height and length of waves (i.e., loud sounds - high waves, soft sounds - low waves, high-pitched sounds - short waves, low-pitched sounds - long waves). Teachers may represent sound waves as waves in water to illustrate differences.	NL Science 4: Online Student Centre
	• Science Skills Toolkit
• Relate the size and shape of musical instruments to the pitch of the sounds they produce. Include human voice changes due to puberty resulting from lengthening vocal chords.	**Supplementary**
	Tuning fork set
• Pluck a stretched elastic band to produce sound. Ask students to identify ways to change the elastic band, or the way it is played, (i.e., potential independent variables) and what can be measured or observed about the sound produced (i.e., possible dependent variables). Develop testable questions from the variables identified. Select one to collaboratively investigate and devise a procedure to ensure a fair test, controlling major variables.	**Suggested**
	Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html
	• What are pitch and loudness? (websites and videos)
Consolidation	• Measuring pitch and loudness (mobile device applications)
Students may	Other curriculum resources
• Investigate testable questions related to changing pitch or loudness of sounds produced by:	• Recorders (Music 4-6)
- running a finger around the edge of a glass of water	• *Moving Up With Literacy Place 4* (ELA 4)
- dragging an index card across the teeth of a comb	- *Fiddling Fun: Sierra Noble* in *Music Forever (Arts Book Club - Sounds Like Music!)*
- vibrating a plastic ruler extended over the edge of a desk	
- striking a partially filled water glass	
- blowing across the mouth of a bottle	
Student groups can investigate different questions and communicate their procedure and results orally or in written format using a shutter foldable.	
• Explore different musical instruments, at centres, and demonstrate how to change their pitch and loudness.	

What Can Humans and Other Animals Hear?

Outcomes	Focus for Learning
Students will be expected to 51.0 compare the range of sounds heard by humans to that heard by other animals [GCO 3]	Students are expected to identify their personal hearing range (i.e., the highest and lowest frequencies they can perceive) using an online tone generator or mobile device application and come to recognize that different people have different hearing ranges. Once identified, students should compare their personal hearing range to the range generally heard by humans and other animals. Provide students with charts or graphs depicting the range of sounds heard by humans and other animals for interpretation and analysis. Comparisons should lead students to recognize that many animals hear higher- and lower-pitched sounds than humans and that these differences may be due to differences in ear structures. Students should also consider how hearing ranges help animals, including humans, survive in their habitats. **Attitude** Students are encouraged to appreciate the importance of accuracy and honesty. [GCO 4] **Sample Performance Indicator** Analyze a chart or graph depicting hearing ranges of humans and other animals and answer questions, such as • Which animals can hear higher-pitched sounds than humans? • Which animals have a narrower hearing range than humans?

What Can Humans and Other Animals Hear?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation	**Authorized**
Teachers may	*NL Science 4 Unit 2: Sound* (TR)
• Demonstrate use of a dog whistle and discuss why humans can not hear it.	• pp. 40-43
	NL Science 4 Unit 2: Sound (SR)
Connection	• pp. 24-27
Students may	**Suggested**
• Determine their personal hearing range (i.e., the highest and lowest frequencies they can perceive) using an online tone generator or mobile device application.	Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html
• Compare their personal hearing range with the range indicated for humans on charts and graphs.	• Hearing range testing (mobile device applications and websites)
Consolidation	• Animal hearing ranges (websites)
Teachers may	
• Provide multiple charts and graphs representing the hearing ranges of humans and other animals. Have students compare the frequency range heard by humans to that heard by other animals.	
Students may	
• Contemplate why different animals hear different sound frequencies.	
• Research to identify the highest and lowest frequencies heard by local animals and describe how hearing at these frequencies may help them survive in their habitat.	
• Identify new questions about animal hearing to add to the "I Wonder" wall.	
Extension	
Students may	
• Research local animals that use echolocation and how it helps them survive in their habitat.	

How Do We Use Sound?

Outcomes	Focus for Learning

Students will be expected to

32.0 describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs [GCO 1]

Students should reflect on and describe the different ways they use sound in their everyday lives. Sounds, for example,

- provide us with information (e.g., listening to your heartbeat);
- signal us (e.g., door bell, mobile device notifications);
- warn us (e.g., fire alarm, siren, animal growl); and
- help us communicate with others (e.g., spoken language, music).

52.0 describe scientific and technological activities carried out by people from different cultures [GCO 1]

Address outcome 52.0 using examples of musical instruments (i.e., technologies) developed by people from different cultures.

Canada is home to people from many different cultures. Each culture has developed, from available materials, unique musical instruments to help share their stories and traditions. Instruments used in traditional Newfoundland and Labrador music include

- percussion instruments (e.g., bodhran, spoons, ugly stick);
- wind instruments (e.g., accordion, tin whistle); and
- string instruments (e.g., mandolin, fiddle).

Students should compare local musical instruments with those from other cultures. Teachers may choose to readdress outcome 50.0, demonstrating and describing how the pitch and loudness of these musical instruments can be modified.

Cross curricular connections may be made to Music 4 outcomes related to performing, listening to, and creating varied selections representing different cultures.

13.0 identify and use a variety of sources and technologies to gather relevant information [GCO 2]

To demonstrate the technological activities carried out by people in the development of musical instruments, students should follow a design and problem solving process to construct a musical instrument that can play more than one pitched note. Using the instrument to play the first line of a children's song (e.g. *Twinkle, Twinkle, Little Star)* may be design criteria. Students should

- research, using a variety of sources, simple musical instruments they can make (SCO 4.0, 13.0);
- identify the tools and materials needed (SCO 6.0);
- construct a prototype of their musical instrument (SCO 14.0);
- test and evaluate their prototype using information gathered from a variety of sources and technologies (SCOs 13.0, 20.0); and
- suggest and make changes to their instrument until it meets the established design criteria (SCO 19.0).

Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Attitude

Students are encouraged to recognize that men and women of any cultural background can contribute equally to science. [GCO 4]

How Do We Use Sound?

Sample Teaching and Assessment Strategies

Technologies (i.e., tools, processes, techniques) are designed to solve problems and meet needs. Whistles, school bells, "1, 2, 3, eyes on me", and raising your voice, for example, are all sound-related technologies designed to solve specific problems.

Activation

Teachers may

- Facilitate a brainstorming session to identify sounds heard in and around the school and discuss the purpose of each sound.
- Provide a collection of local musical instruments and instruments from other cultures for students to compare. Students may also show and share musical instruments brought from home.

Connection

Students may

- Classify everyday sounds according to their use (e.g., to inform, signal, warn, communicate).
- Create a collage of sound-related technologies humans use to help them survive in their habitat.

Consolidation

Students may

- Follow an engineering design and problem solving process to personally construct a simple, pitched musical instrument that can be used to play the song *Hot Cross Buns* (i.e., notes B, A, and G). Students should demonstrate how their personally constructed musical instrument works (i.e., how you change pitch and loudness) and answer questions posed by their peers.

Extension

Students may

- Research musical instruments developed by our local indigenous peoples or other cultures and share what is learned with others.

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (TR)

- pp. 48-51, 52-57

NL Science 4 Unit 2: Sound (SR)

- pp. 32-33, 34-37

NL Science 4: Online Teaching Centre

- IWB Activities 5 and 6

NL Science 4: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html

- How to make musical instruments (websites and videos)

Other curriculum resources

- *Moving Up With Literacy Place 4* (ELA 4)
  - *Go Make a Song! (Arts Book Club - Sounds Like Music!)*
  - *A Little Veggie Music in Music Everywhere (Arts Book Club - Sounds Like Music!)*

How Did Canadians Invent New Ways to Use Sound?

Outcomes	Focus for Learning
Students will be expected to 53.0 provide examples of Canadians who have contributed to science and technology [GCO 1]	Students are expected to research and explore examples of Canadians who have contributed to sound-related science and technology. Treatment may be limited to individuals who invented new ways to use sound. Examples of Canadians and their sound-related inventions include: • Donald Hings - walkie talkie • Dr. Jon Lien - whale pinger • Robert Foulis - fog horn • Alexander Graham Bell - telephone • Hugh Le Caine - polyphonic synthesizer, multi-track tape recorder • James P. Clarke - glass tube organ • Morse Robb - electronic organ • Norman McLaren - techniques for combining and synchronizing animation with music • Osmond Kendall - composer-tron • Oswald Michaud - electric piano • Philippe Menard - synchoros • Reginald A. Fessenden - radio telephony and fathometer (i.e., an early form of sonar) **Attitude** Students are encouraged to show interest in the activities of individuals working in scientific and technological fields. [GCO 4] **Sample Performance Indicator** Describe examples of sound-related Canadian inventions. Select one invention and discuss what problem or need it was designed to solve, and explain how the invention relates to sound waves, loudness, and frequency.

How Did Canadians Invent New Ways to Use Sound?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Teachers may • Present the telephone as an example of a sound-related invention (Alexander Graham Bell) and discuss how this technology helps us and how it has been improved over time to suit our evolving needs. Students may • Brainstorm sound-related inventions and contemplate what problem the invention was attempting to solve.	**Authorized** *NL Science 4 Unit 2: Sound* (TR) • pp. 58-63 *NL Science 4 Unit 2: Sound* (SR) • pp. 38-41 *NL Science 4: Online Teaching Centre* • IWB Activity 7
Connection Teachers may • Facilitate a brainstorming activity to generate possible sources of science information related to Canadian sound scientists, engineers, and inventors. Students may • Research the Newfoundland and Labrador connection to Guglielmo Marconi's invention of long distance radio transmission.	**Suggested** Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html • Canadian sound inventions (websites)
Consolidation Teachers may • Assign names of Canadians who have contributed to sound-related science and technology or their inventions for students to research. Students should identify and describe their sound-related invention, discuss what problem or need the invention solved, and explain how the invention relates to sound waves, loudness, and frequency. Alternatively, teachers may provide age appropriate information related to a number of Canadian inventors and their sound-related inventions and facilitate a cooperative jigsaw learning activity.	

Constructing a Useful Sound-Related Device

Outcomes

Students will be expected to

30.0 demonstrate processes for investigating scientific questions and solving technological problems
[GCO 1]

8.0 select and use tools
[GCO 2]

19.0 suggest improvements to a design or constructed object
[GCO 2]

20.0 evaluate personally constructed devices
[GCO 2]

24.0 work with group members to evaluate processes used in solving a problem
[GCO 2]

Focus for Learning

Students, in small collaborative groups, are expected to follow an engineering design and problem solving process to construct a sound-related alarm to protect something.

Students should

- propose something they wish to design and build an alarm to protect (SCO 1.0);
- generate several possible design solutions, including sketches, and select one to try (SCO 4.0);
- devise a procedure to construct a prototype of their preferred solution (SCO 5.0);
- identify the tools, instruments, and materials they need to construct their prototype and build it (SCOs 6.0, 8.0, 14.0);
- test and evaluate their prototype (SCO 20.0);
- suggest and make improvements to their prototype and retest until a final solution is reached (SCO 19.0);
- communicate their procedure and solution to others (SCO 23.0);
- identify new problems they wish to solve (SCO 21.0); and
- evaluate their processes used in solving the problem (SCO 24.0).

Refer to the *Integrated Skill* unit for elaboration of these outcomes.

Attitude

Encourage students to show concern for their safety and that of others in planning and carrying out activities and in choosing and using materials. [GCO 4]

Sample Performance Indicator

Present your alarm system to classmates and answer questions, such as:
- What is your alarm designed to protect?
- How does your alarm system work?
- What action triggers your alarm? How does the device react?
- Why did you select this solution over other possible solutions?
- What problems did you encounter in constructing your prototype?
- How did you solve these problems?
- What did you do to improve your design?
- Could your solution be applied to solve other problems?
- What new problems would you like to solve?

Constructing a Useful Sound-Related Device

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Teachers may • Review the engineering design and problem solving process and associated skills. Students may • Share experiences where they personally constructed objects. Teachers can draw out stages of the design and problem solving process from their experiences. • Recount types of sound alarms they are familiar with. **Connection** Teachers may • Create and display an anchor chart indicating the typical stages of a design and problem solving process. • Assess student use of sound and process-related terminology as students engage in design and problem solving experiences. Students may • Analyze images of Rube Goldberg machines. • Collaboratively decide on criteria that will be used to evaluate their personally constructed sound-related alarm. **Consolidation** Students may • Follow, in small collaborative groups, an engineering design and problem solving process to construct a sound-related alarm from recycled, found, and sourced materials. • Review design sketches of classmates, prior to construction, and make suggestions for improvement. • Demonstrate use of their sound-related alarm and answer questions posed by classmates related to their solution and problem solving process.	**Authorized** *NL Science 4 Unit 2: Sound* (TR) • pp. 52-57 *NL Science 4 Unit 2: Sound* (SR) • pp. 42-43 *NL Science 4: Online Teaching Centre* • Science Skills Toolkit • Skills and Processes for Design and Problem Solving rubric builder (BLM) *NL Science 4: Online Student Centre* • Science Skills Toolkit

When is Sound Harmful?

Outcomes

Students will be expected to

36.0 consider the positive and negative effects of familiar technologies
[GCO 1]

38.0 describe how personal actions help conserve natural resources and care for living things and their habitats
[GCO 1]

Focus for Learning

We use sound-related technologies everyday to solve practical problems and meet human needs, however, unwanted or unpleasant sounds (i.e., noise pollution) may have negative effects on our lives, the lives of other people, and other animals.

Initial treatment should focus on noise induced hearing loss in humans. Permanent damage to the ear can be caused by prolonged exposure to sounds above 85 dB and brief exposure to sounds over 130 dB. For comparison, a lawnmower operates at 90 dB and a rock concert may register above 110 dB. Students should contemplate personal actions they and others can undertake to reduce noise pollution and prevent personal hearing loss:

- Turn the volume down on devices.
- Reduce or eliminate unnecessary noise.
- Wear ear plugs when operating lawn mowers, chain saws, or similar devices.
- Wear ear protection when working in environments with excessive noise.
- Install sound barriers along highways that run through residential areas.
- Install sound proofing materials in homes and businesses.

Extend treatment to consider how other animals are affected by urban, industrial, and transportation-related noise pollution. For example,

- physiological effects (i.e., increased heart and breathing rates, stress);
- behavioural effects (i.e., abandoning habitat, loss of reproduction); and
- inability to hear environmental cues and animal signals.

Local contexts include the impacts of low level flying on caribou populations and sonar and ocean transportation-related noise on whales and other marine life.

Students should consider these problems and propose possible solutions to protect living things from noise pollution.

Attitude

Encourage students to

- realize that the applications of science and technology can have both intended and unintended effects; and
- be sensitive to and develop a sense of responsibility for the welfare of other people, other living things and the environment. [GCO 4]

When is Sound Harmful?

Sample Teaching and Assessment Strategies	Resources and Notes

Activation

Teachers may
- Have students relate personal experiences when they found noises annoying or distracting and introduce the term noise pollution for harmful or unwanted sounds.

Connection

Teachers may
- Model the impact on human hearing of exposure to loud sounds by holding pipe cleaners upright in one hand, representing the cilia in the cochlea, and flattening them with the other hand so that they no longer stand upright.
- Inform that permanent damage to the human ear can be caused by prolonged exposure to sounds greater than 85 dB and very brief exposure to sounds greater than 130 dB.

Students may
- Use tools or mobile device applications to measure the loudness of everyday sounds.
- Propose questions to investigate related to noise levels in and around their school.
- Recount personal observations and discuss the impacts of noise pollution on household pets (e.g., fireworks on dogs).

Consolidation

Students may
- Survey average noise levels in specific locations in and around their school and create a sound map. Students may make recommendations to school administrators on how to reduce noise pollution in specific areas.
- Follow, in small collaborative groups, an engineering design and problem solving process to construct a device that blocks the sound of a noise producing object, using recycled, found, and sourced materials.

Extension

Students may
- Conduct research on the affect of sound producing wind turbines on humans.

Resources and Notes

Authorized

NL Science 4 Unit 2: Sound (TR)
- pp. 66-71, 72-75

NL Science 4 Unit 2: Sound (SR)
- pp. 44-47, 48-49, 18-19

NL Science 4: Online Teaching Centre
- IWB Activity 8

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/sound. html
- Measuring loudness (mobile device applications)
- Hearing impaired regional support organizations

Section Three:
Specific Curriculum Outcomes

Unit 3: Light

Focus

Students become familiar with the properties of light by observing how light interacts with various objects in the environment. These observations help them gain an understanding of light sources, and of materials that block or change the path of light and reflect light. From these investigations, students should begin to infer that light travels in a straight line, and they begin to construct simple optical devices.

This unit has both a scientific inquiry and a design and problem solving focus. The unit emphasizes the development of inquiry skills related to phrasing questions in a testable form, devising and following procedures, identifying patterns, and drawing conclusions. The design and problem solving experience is the construction of an optical device to be used for a specific purpose.

Outcomes Framework

GCO 1 (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.

25.0 demonstrate that specific terminology is used in science and technology contexts
32.0 describe examples, in the home and at school, of tools, techniques, and materials that may be used to respond to their needs
34.0 describe examples of modern technologies that did not exist in the past
35.0 identify examples of scientific questions and technological problems that are currently being studied
36.0 consider the positive and negative effects of familiar technologies
37.0 contemplate their own and their family's impact on natural resources
41.0 explore how science and technology have been used to solve problems in the home and at school
43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
49.0 describe examples of tools and techniques that extend our senses and enhance our ability to gather data and information about the world
54.0 identify women and men in their community who work in science and technology related areas

GCO 2 (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.

2.0 rephrase questions in a testable form
5.0 devise procedures to carry out a fair test and to solve a practical problem
9.0 follow procedures
10.0 select and use tools for measuring
11.0 make observations and collect information that is relevant to the question or problem
14.0 construct and use devices for a specific purpose
17.0 identify and suggest explanations for patterns and discrepancies in data
18.0 draw a conclusion that answers an initial question
22.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations

GCO 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.

55.0 identify natural and artificial sources of light in the environment
56.0 demonstrate that light travels in all directions from a source
57.0 distinguish between objects that emit their own light and those that require an external source of light to be seen
58.0 investigate how a beam of light interacts with a variety of objects
59.0 investigate and predict how to change the location, shape, and size of an object's shadow
60.0 explore how a variety of media may change the direction of light
61.0 demonstrate that white light may be separated into colours
62.0 compare how light interacts with a variety of optical devices

GCO 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.

- appreciate the role and contributions 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
- show interest and curiostiy 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

SCO Continuum

GCO 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.

	Science 4	Science 8
	Light	*Optics*
Light-related outcomes were not previously addressed.	• identify natural and artificial light sources • demonstrate that light travels in all directions • distinguish between emitted and reflected light • investigate light interactions (casting shadows, allowing light to pass, reflect light) • predicting shadow location, size and shape • use media to change the direction of light • demonstrate light dispersion • compare how light interact with various optical devices	• identify and describe properties of visible light • describe the laws and applications of reflection • qualitatively describe the refraction of light • describe different types of electromagnetic radiation (infrared, ultraviolet, X-rays, microwaves, and radio waves) • compare the properties of visible light to other types of electromagnetic radiation

Suggested Unit Plan

Light is the third unit in Science 4, directly following Sound, and is the second consecutive physical science unit.

September	October	November	December	January	February	March	April	May	June

Light

Communicating Using Specific Terminology

Outcomes	**Focus for Learning**
Students will be expected to *25.0 demonstrate that specific terminology is used in science and technology contexts* [GCO 1]	Students are expected to communicate using appropriate terminology in science and technology contexts. They are not, however, expected to memorize definitions. When describing how white light may be separated into colours, for example, students should understand and use the terms prism, dispersion, and spectrum; they should not be expected to define these terms. Specific terminology should be introduced naturally as the need emerges. Students will come to understand their meaning through light-related explorations and investigations. Scientific inquiry and design and problem solving process-related terminology includes • question, problem, solution; • prediction, hypothesis, procedure, materials, tools, instruments; • observations, measurements, record, classify, data, patterns, discrepancies, results, conclusion; • fair test, independent variable, dependent variable, controlled variables; and design, construct, test, evaluate, prototype, constructed device. Light-related terminology includes • light source, light energy, light beam, light ray; • natural light, artificial light, bioluminescence; • reflect, refract, emit, transmit, absorb; • transparent, translucent, opaque, shadow; • white light, ultraviolet light, spectrum, dispersion; and • optical device, ray box, prism, mirrors, lenses, convex, concave. Communicating using appropriate, specific terminology is a constant expectation. As students engage in light-related explorations and investigations their use of scientific and technological terminology should increase. Light is readdressed in the Science 8 *Optics* unit.

Communicating Using Specific Terminology

Sample Teaching and Assessment Strategies

Whenever students are investigating or problem solving, their use of appropriate terminology in communication can be assessed. Assessments may include self, peer, and teacher assessments using terminology checklists in conjunction with direct observations or digital audio recordings of collaborative group work.

Activation

Teachers may

- Pre-assess student use of appropriate light-related terminology with graffiti board activities using question prompts
  - What is light? Where does light come from?
  - What are shadows?
  - How do we see? How did you use light today?
- Create a curiosity centre of light-related items (e.g., children's fiction and non-fiction literature, flashlights, magnifying lenses, light bulbs, mirrors, lenses, prisms, coloured filters, kaleidoscopes, spyglasses, periscopes, microscopes, binoculars, telescopes, eyeglasses, transparent, translucent, opaque objects and materials). Add to the centre as you progress through the unit and have students contribute items.

Students may

- Engage in a book walk of *NL Science 4 Unit 3: Light* to identify light-related terminology to add to the word wall.

Connection

Teachers may

- Incorporate specific light-related terminology into literacy block activities.
- Facilitate a light and shadow walk in and around the school to generate "I Wonder" questions.
- Facilitate a whole class or small group discussion about light and its uses. Discussion should lead to the creation of a graphic organizer (e.g., concept map, K-W-L chart) of the students collective understandings of light.

Students may

- Melt ice cubes using a lamp and a magnifying glass to intensify the light; highlighting that light is a form of energy.
- Create a visual glossary of light-related terminology.
- Record their light-related questions on the class "I Wonder" wall.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (Teacher Resource [TR])

- pp. 14-17

NL Science 4 Unit 3: Light (Student Resource [SR])

- pp. 8-9
- pp. 1-55, 56-58

NL Science 4: Online Teaching Centre

- Science Skills Toolkit

NL Science 4: Online Student Centre

- Science Skills Toolkit

How Do We Use Light?

Outcomes	Focus for Learning
Students will be expected to	
32.0 describe examples, in the home and at school, of tools, techniques, and materials that may be used to respond to their needs [GCO 1]	The science of light has led to the development of numerous light-related technologies (e.g., light bulbs, mirrors, lenses, microscopes, telescopes, lasers, fibre-optic cables, solar cells) that humans use in diverse environments; from everyday life (e.g., light fixtures, mobile device screens, reading glasses) to medicine (e.g., microscopes, lasers, light therapy, fibre optic scopes), dentistry (e.g., curing lights), photography (e.g., lenses, flashes, light meters), visual arts (e.g., laser light shows, theatrical lighting), industry (e.g., laser cutting, UV light disinfection), astronomy (e.g., telescopes), communications (e.g., fibre optics), commerce (e.g., laser bar code scanners), and the military (e.g., night vision goggles, light radar). These technologies developed in response to human needs and wants. We use them to solve problems.
41.0 explore how science and technology have been used to solve problems in the home and at school [GCO 1]	Students should identify examples of light-related technologies used in their home and at school (e.g., computer monitors, flash lights, fluorescent lighting, mobile device screens, power indicator lights, solar powered calculators) and describe the different purposes for which they are used (i.e., What problem does it solve? What human need or want does it meet?). Prescription glasses, for example, are used to correct the vision of near-sighted or far-sighted individuals.
34.0 describe examples of modern technologies that did not exist in the past [GCO 1]	As society's needs and wants change, technology is updated and newer more modern technologies are developed. This is an important aspect of the relationship between technology and society. Students should describe current examples of modern light-related technologies. In the 2010s, for example, LED (i.e., light emitting diode) bulbs replaced incandescent and CFL (i.e., compact fluorescent light) bulbs in many home lighting applications.
54.0 identify women and men in their community who work in science and technology related areas [GCO 1]	Students should recognize that individuals in their community or region, both men and women, work in science and technology related areas. Students should identify individuals who work with light-related technologies. For example • opticians, optometrists, ophthalmologists, lighting engineers; • electricians, plumbers, miners, jewellers, nail technicians, security guards, cashiers, fibre-optic cable installers, nail technicians; • photographers, videographers, biologists, astronomers; and • dentists, dental hygienists, family doctors, medical lab technicians. Teachers should extend treatment to the other Science 4 units (e.g., geologist, audio recording engineer, wildlife protection officer).
	Attitude Encourage students to • appreciate the role and contribution of science and technology in their understanding of the world. • show interest in the activities of individuals working in scientific and technological fields. [GCO 4]

How Do We Use Light?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Display images of out dated, light-related technologies (e.g., candle holders, kerosene lamps, lanterns, camera flash cubes). Ask students to predict their use and how they work.

Connection

Students may

- Conduct a scavenger hunt to identify light-related objects in the classroom and infer the problem solved by each object.
- Reflect on a time when the electrical power was out. What activities had to stop? What other technologies were used for lighting? Write a journal entry or draw a picture about this experience.
- Research uses of light in different environments (e.g., art, dentistry, medicine, retail stores, sports) and communicate findings to classmates.
- Brainstorm light-related careers (e.g., optician). Include careers that use light technologies (e.g., nighttime security guard).

Consolidation

Teachers may

- Invite community members who work in light-related careers to present to the class.

Students may

- Infer the purpose of light sources in a variety of devices (e.g., LED indicator light on smoke detectors, flashing lights, camera flash, strobe lights on fire alarms)
- Create an image time line of lighting sources used by their ancestors to the modern day.
- Develop questions and interview a community elder about light-related technologies that did or did not exist when they were children.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 10-11, 26-29, 64-67

NL Science 4 Unit 3: Light (SR)
- pp. 6-7,16-17, 48-49

NL Science 4: Online Teacher Centre
- IWB Activity 1

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/light.html
- Support organizations (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *City of Ember*

Where Does Light Come From?

Outcomes	Focus for Learning
Students will be expected to 55.0 identify natural and artificial sources of light in the environment [GCO 3]	Light is a form of energy that we can see with our eyes. There are natural sources of light and artificial sources of light. Sources of natural light (i.e., produced by nature) include • the Sun and other stars; • northern lights, lightning, meteors in Earth's atmosphere; • fires, volcanoes; and • bioluminescent organisms (e.g., fireflies and some varieties of deep-sea fish, jellyfish, and fungi). Note that many students may indicate the Moon as a source of natural light. The Moon does not produce its own light. It reflects the light of the Sun. Artificial sources of light (i.e., light produced by human-made devices or technologies) include • light bulbs (e.g., incandescent, fluorescent, halogen, CFL, LED); • light-related devices (e.g., lasers, television, computer and mobile device screens, digital clocks); • fires started by humans (e.g., burning matches, candles, charcoal, lamp oil, wood, fireworks, flares, sparklers); • light sticks and glow-in-the-dark materials; and • stove burners. Students should identify natural and artificial sources of light in the environment. Students may experience difficulty when attempting to classify fires as natural or artificial. For example, a forest fire started by lightning is a natural light source. A campfire lit by a human is an artificial source. **Attitude** Encourage students to show interest and curiosity about objects and events within different environments. [GCO 4] **Sample Performance Indicator** Identify natural and artificial sources of light in digital images of different environments. Classify light sources (e.g., car headlights, forest fires, electric sparks, embers, glow in the dark toys, laser light, rainbows, solar powered lights, signal flares, north star) as natural or artificial and explain your reasoning.

Where Does Light Come From?

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Pre-assess student understanding of the terms natural and artificial (i.e., human-made) using a collection of natural and artificial objects or images. Natural objects could include a leaf, flower, blade of grass, apple, seed, sugar cube, human hair, or fingernail cuttings. Artificial objects could include an artificial plant or flower, artificial turf, artificial sweeteners, artificial nails, hair extensions, or a wig. Ask students to sort objects or images as either natural or artificial.

Connection

Students may
- Identify natural and artificial sources of light in their home, school, or local community through direct observation and represent their findings in a graphic organizer (e.g., T-chart).

Consolidation

Teachers may
- Provide a collection of images of light sources. Ask students to classify them as natural or artificial. Ask which images were easy or difficult to classify and why.

Students may
- Create a collage of natural and artificial light sources.
- Brainstorm potential sources of light to use during a power outage and classify those sources as natural or artificial.
- Communicate how their life would be different without any artificial sources of light.
- Discuss how life would have been different before the invention of electric lamps (e.g., human sleep cycles were regulated by sunrise and sunset).

Extension

Students may
- Research how the northern lights are explained by the scientific and indigenous communities.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp.18-21

NL Science 4 Unit 3: Light (SR)
- pp. 10-13

NL Science 4: Online Teacher Centre
- IWB Activities 2a, 2b, and 3

Suggested

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
    - *Why Rabbit Has a Short Tail (Predicting Strategy Unit)*

Children's Literature
- *Leo the Lightning Bug*, by E. Drachman

How Does Light Help or Harm?

Outcomes	Focus for Learning
Students will be expected to 36.0 consider the positive and negative effects of familiar technologies [GCO 1]	The application of light-related science and technology has both positive and negative effects. Artificial light and technologies are used in many ways to make our lives easier (e.g., vision, safety, security, communication, entertainment, medicine, photography). In some circumstances, however, use of these technologies also has negative effects: • Light bulbs waste electrical energy. Incandescent lights, for example, are less than 5% efficient at converting electrical energy to light energy; 95% of the energy used is lost as heat. By comparison, fluorescent lights are closer to 20% efficient and LEDs are more than 30% efficient. While more efficient, fluorescent bulbs and LEDs still waste electrical energy. • CFL bulbs contain mercury powder which is harmful to the environment. When burnt out, CFLs can not be disposed of with regular household garbage. They should be recycled. • Bright lights and glare may cause visual discomfort or disability. • Light pollution disrupts human sleep patterns. • Light pollution reduces what is visible in the night sky. • Light pollution affects nocturnal animals and migratory birds. Students should identify both the positive and negative effects of using light-related technologies. Refer to pp. 86-87 (*Rocks, Minerals, and Erosion)* and pp. 125-126 (*Sound*) for previous elaborations of this outcome.
37.0 contemplate their own and their family's impact on natural resources [GCO 1]	Students should recognize the impact of their own and their family's lighting usage on natural resources. Most of the artificial light we use is powered by electricity. Depending on where you live in the province, that electricity is produced by hydro, thermal (i.e., oil fired), wind, or diesel generators. Each method has both positive and negative environmental effects. Reducing the use of electricity for artificial lighting will lessen the impact on natural resources. Measures to reduce impacts include • turning off unnecessary lights, turning lights off when exiting a room, directing light to where it is needed; • replacing incandescent bulbs with more efficient bulbs; • installing motion activated lights, dimmer switches, solar powered outdoor lighting, skylights; and • maximizing lighting from natural sources. Refer to pp. 86-87 of the *Rocks, Minerals, and Erosion* unit for previous elaboration of this outcome. **Attitude** Encourage students to realize that the applications of science and technology can have both intended and unintended effects. [GCO 4]

How Does Light Help or Harm?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Students may • Conduct an audit of their home, counting the total number of light bulbs both inside and outside their home. Where possible, indicate the type of light bulb (i.e., incandescent, CFL, LED). Data may be compiled and displayed on charts or graphs. **Connection** Teachers may • Ask students how they think puffins might be affected by light. Students may • Identify the negative effect of light pollution on puffins and research how children in Witless Bay, NL are finding ways to help. • Identify potential negative effects of light pollution on humans, other wildlife, and the environment, through research. • Survey a single light source in a high traffic area of their home over a period of 24 hours to determine the amount of time it is on. • Compare the efficiencies, cost, and life span of incandescent, LED, and compact fluorescent light bulbs. **Consolidation** Students may • Discuss the positive and negative effects of using street lights in their community. • Develop a plan to inform their community about a negative effect of light pollution on humans, wildlife, or the environment. • Develop a school plan to reduce electricity costs due to lighting and present recommendations to the school administration.	**Authorized** *NL Science 4 Unit 3: Light* (TR) • pp. 22-25, 26-29 *NL Science 4 Unit 3: Light* (SR) • pp. 14-15, 16-17 *NL Science 4: Online Teacher Centre* • IWB Activities 4 and 5 **Suggested** Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/light.html • Support organizations (websites) • Puffin patrol (websites) • Energy efficiency (websites)

How Does Light Travel?

Outcomes	Focus for Learning

Outcomes

Students will be expected to

56.0 demonstrate that light travels in all directions from a source
[GCO 3]

18.0 draw a conclusion that answers an initial question
[GCO 2]

Focus for Learning

Students should explore the question, "How does light travel?" and draw a conclusion that answers the initial question.

Provide opportunities for students to observe light produced by unobstructed sources (e.g., a candle, table lamp without a lampshade). Students should note that the light emanating from these sources is visible in all directions. Students should then compare the light produced by unobstructed sources with that produced by a flashlight or a table lamp with a lampshade. These light technologies are designed to block or redirect light rays from travelling in some directions:

- Lampshades block light rays from travelling at eye level.
- Flashlights have a highly reflective concave structure surrounding the bulb that redirects light rays travelling in unwanted directions.

Students should be able to demonstrate that light travels in all directions from a light source. This is one property of light.

Another property that can be demonstrated is that light travels in straight lines. This can be demonstrated using a flashlight and a series of index cards with a hole punched in the centre of each card. Students should stand the cards upright in a line and space them at least 10 cm apart. Shine a flashlight in front of the first card and adjust the position of the remaining cards so that the light shines straight through the holes. Alternatively, the property can be demonstrated using a ray box with the slotted screen inserted.

Properties of light are addressed in more detail in the Science 8 *Optics* unit.

Please refer to pp. 54-55 of the *Integrated Skills* unit for elaboration of skill outcome 18.0.

Attitude

Encourage students to willingly observe, question, explore and investigate. [GCO 4]

Sample Performance Indicator

Sketch how light travels away from a table lamp with and without a lamp shade.

How Does Light Travel?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Teachers may • Provide an illustration of the sun, candle, or a bare incandescent light bulb. Ask students to represent how light travels away from the source. **Connection** Students may • Observe a bare incandescent light bulb or candle from all directions to determine if its light can be viewed. • Explore a collection of light sources (e.g., various types of light bulbs, candles, lanterns, desk or table lamps with and without a shade, flashlights) and observe how light travels away from each source in a darkened environment. • Demonstrate how light travels in straight lines using a ray box with the slotted screen inserted. **Consolidation** Students may • Deconstruct a flashlight to explore why light travels from it as a directed beam of light as opposed to travelling in all directions. • Partially cover the lens of a flashlight with construction paper cut outs and observe the affect on how light travels. • Investigate how light travels in straight lines using a flashlight, a series of index cards with a single hole punched in the centre, and modelling clay to hold them upright. A plastic straw may be used to line up the holes in a straight line.	**Authorized** *NL Science 4 Unit 3: Light* (TR) • pp. 34-39 *NL Science 4 Unit 3: Light* (SR) • pp. 22-25 *NL Science 4: Online Teaching Centre* • IWB Activity 6 • Science Skills Toolkit *NL Science 4: Online Student Centre* • Science Skills Toolkit **Supplementary** Ray box with slotted screen

How Do We See Objects?

Outcomes	Focus for Learning
Students will be expected to	Students should explore the question, "How do we see objects?".

Outcomes

Students will be expected to

57.0 distinguish between objects that emit their own light and those that require an external source of light to be seen
[GCO 3]

Focus for Learning

Students should explore the question, "How do we see objects?".

An object is visible when light rays travel from the object to our eyes. The light rays may be emitted by the object or reflected off the object from an external source of light. A burning candle and a book, for example, are both visible in a lit classroom. The light from the candle is emitted light. The light from the book is reflected from an external source of light. If brought into a dark room, the candle would still be visible. The book, however, would not be visible as there is no external source of light.

Students should distinguish between objects that emit their own light and those that require an external source of light to be seen. Objects that emit their own light are natural or artificial light sources. All other objects require an external source of light to be seen.

Illustrations using arrows to represent emitted or reflected light rays travelling to our eyes from objects may aid student understanding.
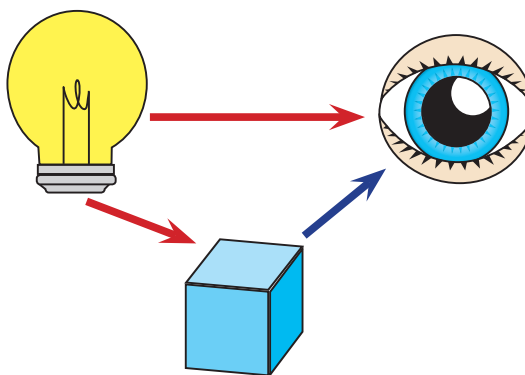
Attitude

Encourage students to appreciate the role of science and technology in their understanding of the world. [GCO 4]

Sample Performance Indicator

Sort objects (e.g., a firefly, water, icicles, the Moon, a mirrored disco ball, lightning, glow sticks) according to whether they emit their own light or require an external source of light to be seen and describe how each object can be seen.

How Do We See Objects?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Teachers may
- Place an object in their hand and ask students to communicate how they are able to see the object. This strategy may uncover student held misconceptions about light (e.g., our eyes emit light).

Connection

Students may
- Investigate if objects emit their own light or require an external light source to be seen. Students should construct a black box (i.e., a closed shoe box with a small eye opening at one end) and place objects inside, one at a time, to see if they are visible. Students should conclude that only objects that emit their own light can be seen. Inserting a small flashlight through a second hole will confirm that objects which do not emit their own light can be seen with an external light source. Observations may be digitally recorded.

Consolidation

Students may
- Create visual representations to illustrate how seeing objects that emit their own light differs from objects that require an external light source.
- Describe how they can see
    - candlelight
    - the teacher in the classroom
    - moonlight reflected in water.

Extension

Students may
- Investigate the science of glow in the dark objects and communicate findings to their peers.
- Research bioluminescent organisms and create a visual display.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 48-53

NL Science 4 Unit 3: Light (SR)
- pp. 34-37

NL Science 4: Online Teacher Centre
- IWB Activity 8

How Does Light Interact with Different Materials?

Outcomes	Focus for Learning

Students will be expected to
 	
58.0 investigate how a beam of light interacts with a variety of objects [GCO 3]
	Students should conduct guided inquiry investigations to determine how different materials interact with a beam of light. Through investigation, students should discover these properties of light:
	
	• Light travels through some objects and materials.
	
	   - Transparent objects and materials transmit light. You can see clearly through them (e.g., glass).
	   - Translucent objects and materials transmit some light, however, some light is scattered in different directions. You can see through them but not clearly (e.g., wax paper).
	   - Opaque objects and materials do not transmit light. You can't see through them and they cast strong shadows (e.g., wood).
	
	• Light reflects off some objects and materials. Shiny, opaque objects, like a mirror, reflect most of the light that strikes them.
	
	• Light may be absorbed by some objects and materials. Dark coloured, opaque objects and materials absorb light. The absorbed light energy changes to heat and warms them up.
	
	Note that objects and materials often display more than one interaction with light. Glass, for example, transmits light rays that strike its surface, however, some light rays are reflected. Dark coloured fabrics absorb light rays becoming warm. Since the fabric is visible, it must also reflect some light rays.

9.0 follow procedures [GCO 2] *11.0 make observations and collect information that is relevant to the question or problem [GCO 2]*	Conducting guided inquiry investigations provides opportunities to address and assess skill outcomes 9.0 and 11.0, as well as other inquiry related skill outcomes (i.e., 3.0, 12.0, 17.0, 18.0, 21.0, 22.0). Refer to the *Integrated Skills* unit for elaboration of these skill outcomes (pp. 36-37, 46-49, 54-55, 58-61). Properties of light and interactions with various objects and materials are addressed in more detail in the Science 8 *Optics* unit. **Attitude** Encourage students to consider their own observations and ideas as well as those of others during investigations and before drawing conclusions. [GCO 4] **Sample Performance Indicator** Classify objects and materials (e.g., magnifying glasses, sunglasses, plastic sandwich bags, mirrors, various rulers, various duo-tang covers, tissue paper, wax paper, gummy bears, wood blocks, books) as transparent, translucent, or opaque. Predict whether objects or materials (e.g., aluminum foil, bristol board, craft sticks, Mira™, nylons, soil, T-shirts) will reflect, absorb, and/or transmit light.

How Does Light Interact with Different Materials?

Sample Teaching and Assessment Strategies

Connection

Students may
- Identify transparent, translucent, and opaque objects in the classroom.

Consolidation

Students may
- Investigate, in small collaborative groups, how various objects and materials interact with light from a flashlight. Do the objects cast shadows, allow light to pass through, and/or reflect light?
- Cover the classroom windows with squares of different materials (e.g., cardboard, wax paper, plastic wrap, parchment paper, garbage bags, iridescent cellophane, construction paper, aluminum foil, coloured plastic tablecloths) to investigate how sunlight interacts with them. How does the material change what you are able to see through the window?
- Investigate how various materials placed over the camera lens on a mobile device affect the pictures taken.
- Devise an investigation to determine if the time require to melt an ice cube under a desk lamp is affected by the type and colour of material the ice is placed upon.
- Investigate how light interacts with a variety of liquids (e.g., apple juice, coffee, corn syrup, Kool-Aid, milk, soda). Liquids can be placed in the optic set container, or similar plastic, transparent, rectangular container. The ray box may be used as the light source.
- Investigate how reflection of light in a mirror compares with reflection in other materials (e.g., smooth and crumpled aluminum foil, wax paper, plastic, white and coloured paper).
- Investigate how reflections change by changing the mirror shape.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 42-45

NL Science 4 Unit 3: Light (SR)
- pp. 28-31

NL Science 4: Online Teacher Centre
- IWB Activities 7a and 7b
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Supplementary

Ray box and optic set

How Can We Change a Shadow?

Outcomes

Students will be expected to

59.0 investigate and predict how to change the location, shape, and size of an object's shadow
[GCO 3]

2.0 rephrase questions in a testable form
[GCO 2]

5.0 devise procedures to carry out a fair test and to solve a practical problem
[GCO 2]

10.0 select and use tools for measuring
[GCO 2]

22.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations
[GCO 2]

Focus for Learning

When an opaque object blocks light rays a shadow is produced. Students should conduct open inquiry investigations related to changing the location, shape, and size of shadows.

To initiate these open inquiry investigations, teachers should cast a shadow using a flashlight and an object and ask students to list things they could change about the set up (e.g., type, size, and brightness of the light source, distance between the light source and object, distance between the object and the wall, location of the light source vertically and horizontally in relation to the object, choice of object, orientation and transparency of object). These factors are possible independent variables. Then, ask students what can be observed or measured about the shadow (e.g., location, shape, size, whether clear or blurry, faint or strong). These are possible dependent variables.

Students should, in small collaborative groups,

- select an independent and dependent variable from the generated lists to propose a testable question (SCO 1.0 and 2.0) to investigate (e.g., How does the distance between the object and the wall affect the size of the shadow?);
- make a prediction and a hypothesis (SCO 3.0);
- devise a procedure to investigate their question that controls all of the non-selected independent variables (SCO 5.0);
- identify and use appropriate tools, instruments, and materials needed to complete their investigation (SCO 6.0 and 10.0);
- carry out their procedure ensuring a fair test (SCO 7.0);
- make and record their observations (SCOs 11.0 and 12.0);
- identify and suggest explanations for patterns in data (SCO 17.0);
- draw a conclusion that answers their initial question (SCO 18.0);
- identify new shadow-related questions to investigate (SCO 21.0);
- communicate with and listen to others while conducting their investigation (SCO 22.0); and
- communicate their procedure and results to others (SCO 23.0).

Refer to the *Integrated Skill* unit for elaboration of these outcomes (pp. 34-37, 40-49, 54-55, 58-61).

Attitude

Encourage students to appreciate the importance of accuracy and honesty. [GCO 4]

Sample Performance Indicator

Predict how to make a bunny hand shadow appear to move to the left on a screen, wiggle his ears, and get larger in size.

How Can We Change a Shadow?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

It is acceptable for students to investigate an independent variable that has no effect on a shadow. In science, confirming that something does not affect a dependent variable is as important as determining that something does.

Activation

Students may
- Explore creating hand shadow puppets.
- View online shadow puppet videos.

Connection

Students may
- Place a golf tee upside down on a desk. Explore how its shadow changes when a flashlight is moved around it.

Consolidation

Students may
- Investigate if the shadow of an object is affected by
  - moving the object closer to or farther from the light source
  - moving the light source closer to or farther from the object
  - moving the light source vertically or horizontally
  - changing the object or its orientation
  - changing the light source or its brightness
  - adding filters (e.g., cellophane, plastic wrap, wax paper)
- Investigate, through repeated observations, how the shadow of an object placed outside in sunlight changes over the course of a school day. Students should predict the location, shape, and size of the shadow at various times and confirm or refute their predictions through subsequent observations. Digital photographs of the shadows will aid further discussion.
- Create a game where one student holds a flashlight, another holds an object, and a third student predicts the location, size, and shape of the shadow. Turn on the flashlight to verify predictions.
- Create and perform a shadow puppet play.

Extension

Students may
- Create a sundial and communicate to peers how it works.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 40-41

NL Science 4 Unit 3: Light (SR)
- pp. 26-27

NL Science 4: Online Teacher Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
  - Investigating Shadows

How Can We Change the Direction of Light?

Outcomes

Students will be expected to

60.0 explore how a variety of media may change the direction of light
[GCO 3]

Focus for Learning

Address this outcome through exploration centres. Students should explore how light may change direction when it strikes various objects and materials (e.g., mirrors and lenses).

Student exploration should include, but not be limited to, the use of ray boxes with plane, convex, and concave mirrors, and double convex and concave lenses.

Through exploration, students should come to discover that:

- Some objects and materials may reflect light. Light striking a mirror, for example, changes direction; it bounces off the mirror. Different mirror shapes reflect light in different directions.

- Transparent objects and materials may bend, or refract, light as it passes through them. When we view objects through transparent materials (e.g., a glass of water) we often see the results of refraction (i.e., objects appear broken, wavy, or distorted). Note that refraction occurs when light enters a material at an angle. Light entering at a right angle (i.e., perpendicular) will not refract.

Students are not expected to provide scientific explanations for reflection or refraction. Reflection and refraction are readdressed in the Science 8 *Optics* unit.

How Can We Change the Direction of Light?

Sample Teaching and Assessment Strategies

Activation

Students may
- View online photographs of mirages and refraction.

Connection

Students may
- At exploration centres
  - observe their reflection in both sides of a metal spoon
  - observe a pencil placed in a glass of water through the sides of the glass
  - view printed text or images through a drop of various liquids placed on an acetate covering sheet
  - place a coin at the bottom of an opaque bowl and back away until hidden by the rim. Ask another student to slowly add water to the bowl until it becomes visible again.
  - view their reflection in various cosmetic mirrors (i.e., plane on one side, concave on the other)
  - view classmates through drinking glasses filled with a variety of transparent, translucent, coloured, and colourless liquids (e.g., water, Kool-Aid, corn syrup, milk)
  - view objects using various magnifying lenses

Consolidation

Students may
- Explore, using a ray box and optic set, how a plane mirror, concave mirror, convex mirror, double concave lens, and double convex lens change the directions of light rays.
- Play a game where students light up targets placed in various classroom locations using light from a flashlight reflected off a mirror.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 46-47, 54-57

NL Science 4 Unit 3: Light (SR)
- pp. 32-33, 38-41

Teaching and Learning Strategies
- www.k12pl.nl.ca/curr/k-6/sci/sci-4/teaching-and-learning-strategies.html
  - Exploring Light

Supplementary

Ray box and optic set

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/light.html
- Light optics (video)
- Science suppliers (websites)

How Does White Light Form Rainbow Colours?

Outcomes	Focus for Learning
Students will be expected to	
61.0 demonstrate that white light may be separated into colours [GCO 3]	Light from the Sun or a fluorescent bulb is white light. It is a mixture of different coloured light rays that, when combined into one beam of light, appears white. Sometimes when white light refracts it separates out into a band of different colours (i.e., the visible light spectrum), which always appear in the same order. This process of separating white light into colours is called dispersion. Rainbows, for example, form when sunlight passes through drops of water. The raindrops disperse the sunlight into the colours of the spectrum.
	Address outcome 61.0 through exploration. Students should demonstrate the dispersion of white light. Student demonstrations should include, but not be limited to, the use of a ray box and prism. Students could change the angle of the beam, the size of the prism, or the material the prism is made from to explore the factors necessary to produce a spectrum. Ask students to record the order in which the colours of the spectrum appear whenever it is observed.
	Students are not expected to provide scientific explanations for the dispersion of light. Light dispersion is readdressed in more detail in the Science 8 *Optics* unit.
17.0 identify and suggest explanations for patterns and discrepancies in data [GCO 2]	Students should compare the records of their explorations to those of others and recognize that the colours of the spectrum always appear in the same pattern or order (i.e., red, orange, yellow, green, blue, indigo, violet). As white light refracts, the different colours of light that make up white light bend different amounts. This difference causes the coloured light rays to separate and spread out into the spectrum.
	Attitude
	Encourage students to demonstrate perseverance and a desire to understand. [GCO 4].
	Sample Performance Indicator
	Manipulate a ray box and prism to produce the visible light spectrum.

How Does White Light Form Rainbow Colours?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Teachers may • Uncover student preconceptions of rainbows by asking students to draw and colour a rainbow and explain how it forms. Students may • View rainbow colours reflected in bubbles or iridescent wrap. **Connection** Students may • Compare their drawing of a rainbow with online images. • Share where they have observed white light being separated into a rainbow (e.g., sun catchers, garden hose spray). • Create a spectrum using a recycled CD or DVD. Lightly score the reflective side of the CD in straight lines using a nail or scissors. Cover the entire reflective side with a single layer of clear packing tape. Remove and discard the packing tape. Shine a flashlight on the CD and manipulate the orientation of the disk until a spectrum is produced. • View the lyrics of the song "Roy G BIV", by They Might Be Giants. **Consolidation** Students may • Explore, in small collaborative groups, how to produce the visible light spectrum by manipulating a ray box, with the single ray screen inserted, and a prism until a spectrum is produced. • Produce a spectrum by filling a shallow pan about half way full with water and placing a mirror in the water, propped up against one side of the pan. Shine a flashlight into the water so that the light shines on the mirror underwater. Hold a sheet of white paper in the air above the pan. Adjust the angle of the flashlight until a spectrum appears on the underside of the paper. • Record the order of colours observed in the visible light spectrum. • View natural and artificial sources (e.g., incandescent, CFL, and LED bulbs) of light using a qualitative analysis spectroscope and note differences in their spectra. Sunlight, for example, produces a rich spectra. The spectra for an LED light will have sharp red, green, and blue lines visible. **Extension** Students may • Research the scientific explanation for the separation of white light into the visible light spectrum.	**Authorized** *NL Science 4 Unit 3: Light* (TR) • pp. 58-61 *NL Science 4 Unit 3: Light* (SR) • pp. 42-45 *NL Science 4: Online Teaching Centre* • Science Skills Toolkit *NL Science 4: Online Student Centre* • Science Skills Toolkit **Supplementary** Ray box and optic set Prism Qualitative analysis spectroscope **Suggested** Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/light. html • Light and colour (video) • Science suppliers (websites)

How Do Optical Devices Interact with Light?

Outcomes	Focus for Learning
Students will be expected to 62.0 compare how light interacts with a variety of optical devices [GCO 3]	Students have investigated how different materials interact with light and explored how various media change the direction of light. Students have observed transmission, absorption, reflection, refraction, and dispersion of light.
	Students should explore how light interacts with various light technologies (e.g., light bulbs, flashlights, eyeglasses, sunglasses, binoculars, magnifying lenses, spyglasses, microscopes, telescopes, cameras, periscopes, overhead projectors, spectroscopes, solar cell, kaleidoscopes, view finders, sun catchers, mirrors, and lenses). Students should observe, explore, and take apart, when possible, optical devices to determine • how and why we use them; • how they work, how they use light, what they do to light; • if they use a light source, mirrors, lenses, or prisms; and • if they transmit, absorb, reflect, refract, and/or disperse light.
14.0 construct and use devices for a specific purpose [GCO 2]	Students, in small collaborative groups, should follow an engineering design and problem solving process to construct a useful optical device (e.g., flashlight, periscope, pinhole camera, solar cooker), demonstrating their knowledge of light properties.
	In addition to skill outcome 14.0, this design and problem solving experience provides an opportunity to address and assess numerous other skill outcomes. Students will • generate design solutions and select one to construct (SCO 4.0); • devise a procedure to construct a prototype (SCO 5.0); • identify the tools, instruments, and materials needed and use them to construct the prototype (SCOs 6.0, 8.0); • test and evaluate the prototype (SCO 20.0); • suggest and make improvements to the prototype and retest until a final solution is reached (SCO 19.0); • communicate the procedure and solution (SCO 23.0); and • evaluate the processes used in solving the problem (SCO 24.0). Refer to the *Integrated Skill* unit for elaboration of these outcomes (pp. 38-45, 50-51, 56-57, 60-63).
	Attitude
	Encourage students to work collaboratively while exploring and investigating. [GCO 4]

How Do Optical Devices Interact with Light?

Sample Teaching and Assessment Strategies

Assess student use of appropriate terminology in conjunction with assessment of these outcomes.

Activation

Students may
- Brainstorm optical devices that use mirrors, lenses, or prisms.

Connection

Teachers may
- Deconstruct an optical device (e.g., an old overhead projector) and describe how various parts interact with light (e.g., bulb emits light, light transmits through the stage glass, lenses magnify and focus light, light reflects off mirrors). Model use of appropriate terminology.

Consolidation

Students may
- Explore optical devices (e.g., light bulbs, flashlights, eyeglasses, sunglasses, binoculars, magnifying lenses, spyglasses, microscopes, telescopes, cameras, periscopes, spectroscopes, solar cell, kaleidoscopes, view finders, sun catchers), deconstructing them when possible, to describe how their various parts interact with light. Exploration should focus on how the device works, what it is used for, if it contains a light source, mirrors, lenses, or prisms, and if the parts emit, transmit, absorb, reflect, refract, and/or disperse light.
- Compare and contrast two or three optical devices selected from the examples in the preceding strategy using Venn diagrams.
- Design on paper a device that would enable a parent in front of a home to view children playing behind the home.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 10-13, 62-63, 64-67

NL Science 4 Unit 3: Light (SR)
- pp. 6-7, 46-47, 48-49

NL Science 4: Online Teaching Centre
- IWB Activities 1 and 9
- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/light. html
- Science suppliers (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *Light, Oh, Light*
- Astroscan telescope (Science 6)
- Magnifiers (Science 6)
- Illuminated magnifiers (Science 6)

How Does Technology Help Us See?

Outcomes	Focus for Learning
Students will be expected to *49.0 describe examples of tools and techniques that extend our senses and enhance our ability to gather data and information about the world* [GCO 1]	Outcome 49.0 could be addressed in conjunction with outcomes 62.0 and 14.0 on the preceding spread. Students should describe several examples of optical devices (i.e., light technologies) that extend our sense of vision and enhance our ability to gather information about the world round us. Descriptions of examples should be limited to generally describing how they work, and for what purpose they are used. Examples could include - artificial lighting to illuminate dark surroundings; - sunglasses or tinted glass to enhance vision in bright conditions; - periscopes to see over, around, or through obstacles; - binoculars to view objects from a distance; - magnifying lenses to produce magnified images of objects; - microscopes to see small objects invisible to the naked eye; - telescopes to gather light from distant objects in space; - fibrescopes to see in hard to reach places; and - plane and curved mirrors (e.g., rear-view and side-view car mirrors, security mirrors, dental mirrors, cosmetic mirrors). STSE outcome 49.0 was previously addressed in the *Sound* unit. Refer to the elaboration provided on pages 113-14.

How Does Technology Help Us See?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation Students may • Wear prescription eyeglasses or sunglasses or fashion glasses with clear plastic tape over the lenses to gain an appreciation for individuals with vision problems. **Connection** Students may • Explore what can be seen with various optical devices (e.g., eyeglasses, sunglasses, monoculars, spyglasses, binoculars, telescopes, magnifying glasses, microscopes, stereoscopes, fibrescopes, periscopes, otoscopes). • Create a T-chart listing optical devices in the left-hand column and indicating how they enhance vision in the right-hand column. **Consolidation** Students may • Identify the most appropriate optical device to use in specific situations (e.g., spotting a moose in an area from a distance, viewing blood cells, viewing craters on the moon, viewing the body structures of a caterpillar, viewing inside their body). • Describe experiences where they used or wished they could use an optical device to extend their vision.	**Suggested** Other Curriculum Resources • Astroscan telescope (Science 6) • Magnifiers (Science 6)

How Does Light Technology Help People?

Outcomes	Focus for Learning
Students will be expected to *43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications* [GCO 1]	Science and technology develop over time and work together in investigating questions and problems and in meeting specific needs. New scientific ideas and discovers lead to new inventions and applications. Students should describe instances where light-related ideas and discoveries have led to the development of new light-related inventions and applications. For example, the discovery and development of a chemical that gives blue LED lights their colour led to the development of white LED light bulbs. Possible contexts to address this outcome include the evolution of • light bulbs (e.g., incandescent, fluorescent, CFL, LED), • eyeglasses, • microscopes, or • lighthouses.
35.0 identify examples of scientific questions and technological problems that are currently being studied [GCO 1]	The contexts used to address outcome 43.0 should be extended to address outcome 35.0. Students should identify light-related scientific questions and technological problems that are currently being studied. For example, the development of • tunable white LED light bulbs that can change from warm to cool white or change colours, and • multi-focal eyeglasses, to replace progressive or bi-focal lenses, that can be adjusted, manually or electronically, to the type of vision needed (i.e., near, intermediate, distance). STSE outcomes 43.0 and 35.0 were previously addressed in the Science 4 *Rocks, Minerals, and Erosion* unit. Refer to the elaborations provided on pp. 84-85 and 94-95.

How Does Light Technology Help People?

Sample Teaching and Assessment Strategies

Resources and Notes

Connection

Students may
- Research the future of eyeglasses or light bulbs.
- Create a time line showing the evolution of light bulbs, eyeglasses, microscopes, or light houses.
- Research sources of light used in local lighthouses in the past. Why would these sources have been used? Why were better sources of light needed? How have jobs related to lighthouses changed over time?

Consolidation

Students may
- Construct a model lighthouse and follow a design and problem solving processes to brighten and focus the light.
- Discuss whether the use of global positioning systems (GPS) and solar lighted buoys could eliminate the need for lighthouses in future.
- Identify examples of scientific questions and technological problems that are currently being studied related to vision correction, home lighting technologies, medical applications, microscopy, and astronomy.

Authorized

NL Science 4 Unit 3: Light (TR)
- pp. 64-67

NL Science 4 Unit 3: Light (SR)
- pp. 48-49

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/light. html
- Lighthouse resources (websites)
- Science suppliers (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *Light, Oh Light* poster *(Synthesizing Strategy Unit)*

Section Three:
Specific Curriculum Outcomes

Unit 4: Habitats and Communities

Focus

Students are familiar with the basic needs of living things and can explore how various organisms satisfy their needs in the habitat in which they are typically found. Students can begin to look for ways in which organisms in one habitat differ from those in another, and consider how some of those differences are helpful to survival. The concept of inter-relatedness can be expanded upon further by looking at populations and the impact of the loss of one population on a community.

This unit has both a scientific inquiry and a design and problem solving focus. The unit emphasizes the development of inquiry skills related to proposing habitat-related questions to investigate, identifying various methods for finding answers, making observations, classifying, and compiling and displaying data. The design and problem solving experience is the construction of an artificial habitat for a small animal. The experience emphasizes the development of skills related to identifying various solutions to problems, constructing devices, suggesting improvements to a design or constructed objects, and identifying new problems that arise from what was learned.

Outcomes Framework

GCO 1 (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.

25.0 demonstrate that specific terminology is used in science and technology contexts
30.0 demonstrate processes for investigating scientific questions and solving technological problems
31.0 compare the results of their investigations to those of others and recognize that results may vary
35.0 identify examples of scientific questions and technological problems that are currently being studied
36.0 consider the positive and negative effects of familiar technologies
37.0 contemplate their own and their family's impact on natural resources
38.0 describe how personal actions help conserve natural resources and care for living things and their habitats
43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
65.0 identify examples of scientific knowledge that have developed from a variety of sources

GCO 2 (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.

1.0 propose questions to investigate and practical problems to solve
3.0 state a prediction and a hypothesis
4.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate
7.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
11.0 make observations and collect information that is relevant to the question or problem
14.0 construct and use devices for a specific purpose
15.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
16.0 compile and display data
17.0 identify and suggest explanations for patterns and discrepancies in data
19.0 suggest improvements to a design or constructed object
21.0 identify new questions or problems that arise from what was learned
23.0 communicate procedures and results

GCO 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.

63.0 identify a variety of local and regional habitats and their associated populations of plants and animals
64.0 investigate and describe how a variety of local animals are able to meet their basic needs in their habitat
66.0 compare the structural adaptations of plants that enable them to thrive in different kinds of places
67.0 compare the structural and behavioural adaptations of animals that help them survive in different kinds of places
68.0 classify organisms according to their role in a food chain
69.0 predict how reduction or removal of a plant or animal population affects the rest of the community
70.0 relate habitat loss to the endangerment or extinction of plants and animals

GCO 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.

- appreciate the role and contributions 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
- show interest and curiosity about objects and events within different environments
- appreciate the importance of accuracy and honesty
- demonstrate perseverance and a desire to understand
- be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment

SCO Continuum

GCO 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.

Science 2	Science 4	Science 6
Animal Growth and Changes	*Habitats and Communities*	*Diversity of Life*
• describe features of natural and human-made environments that support the health and growth of some familiar animals	• identify local habitats and their populations of plants and animals • investigate how local animals meet their needs in their habitat • compare structural and behavioural adaptations of organisms that help them survive in different habitats • classify organisms according to their role in a food chain • predict how reducing or removing a population affects the rest of the community • relate habitat loss to the endangerment or extinction of organisms	• compare the adaptations of closely related animals living in different parts of the world and discuss reasons for any differences • describe how microorganisms meet their basic needs
Science 3		Science 7
Plant Growth and Changes		*Interaction within Ecosystems*
• describe parts of plants and their general function • investigate life needs of plants and describe how they are affected by the conditions in which they grow • describe ways in which plants are important to living things and the environment		• identify the roles of producers, consumers, and decomposers in a local ecosystem • describe conditions essential to the growth and reproduction of microorganisms • describe how energy is supplied to, and how it flows through, a food web • describe interactions between biotic and abiotic factors in an ecosystem • describe signs of ecological succession in a local ecosystem

Suggested Unit Plan

Habitats and Communities is the life science unit within the Science 4 curriculum. It is positioned at the end of the school year to capitalize on opportunities for outdoor learning.

September	October	November	December	January	February	March	April	May	June

Habitats and Communities

Communicating Using Specific Terminology

Outcomes

Students will be expected to

25.0 demonstrate that specific terminology is used in science and technology contexts
[GCO 1]

Focus for Learning

Students are expected to communicate using appropriate terminology in science and technology contexts. They are not, however, expected to memorize definitions. When describing how wolves live and hunt in packs, for example, students should understand and use the term behavioural adaptation; they should not be expected to define this term.

Specific terminology should be introduced as the need emerges. Presenting all the unit terminology at the outset is strongly discouraged.

Scientific inquiry and design and problem solving process-related terminology includes

- question, problem, solution;
- prediction, hypothesis, procedure, materials, tools, instruments;
- observations, measurements, record, classify, data, patterns, discrepancies, results, conclusion;
- fair test, independent variable, dependent variable, controlled variables; and
- design, construct, test, evaluate, prototype, constructed device.

Habitat-related terminology includes

- habitat, environment, habitat loss, climate change;
- adaptation, behavioural adaptation, structural adaptation;
- food chain, producer, consumer, predator, prey;
- nutrient, energy;
- natural resource, conservation, endangered, extinct; and
- organism, species, population, community.

Communicating using appropriate, specific terminology is a constant expectation. As students progress through the unit their use of scientific and technological terminology should increase.

Note that students may have significant prior knowledge of habitat-related terminology and concepts. Teachers should routinely pre-assess student understanding and alter teaching and assessment plans accordingly.

Habitats and communities are readdressed in more detail in the Science 7 *Interactions within Ecosystems* unit.

Attitude

Encourage students to demonstrate perseverance and a desire to understand. [GCO 4]

Communicating Using Specific Terminology

Sample Teaching and Assessment Strategies

Whenever students are investigating or problem solving, their use of appropriate terminology in communication can be assessed. Assessments may include self, peer, and teacher assessments using terminology checklists in conjunction with direct observations or digital audio recordings of collaborative group work.

Activation

Teachers may
- Pre-assess student use of appropriate life science terminology by asking students to construct a "habitat" concept map.
- Facilitate a nature walk to a habitat near the school and generate "I Wonder" questions and record them on the "I Wonder" wall.

Students may
- Close their eyes and think about a special natural place they have visited. Communicate what is seen, heard, smelled, and felt.
- Use alpha-boxes to record new terminology identified in a book walk through *NL Science 4, Unit 4: Habitats and Communities.* Terms can be added to the word wall.

Connection

Teachers may
- Introduce terminology through habitat-related fiction and non-fiction texts (e.g., *Arctic Foxes*, *Blue Whales*) .
- Model the use of appropriate habitat-related terminology and encourage students to adopt them.
- Incorporate specific habitat-related terminology into literacy block activities.

Consolidation

Teachers may
- Present images of local habitats and ask students to describe what they see using habitat-related terminology. What parts do habitats have in common?

Students may
- Create a visual glossary of habitat-related terminology.
- Use technology to record their conversations when observing, exploring and investigating habitats. Recordings may be used for student self-assessment and/or teacher assessment of terminology use.

Resources and Notes

Authorized

NL Science 4 Unit 3: Light (Student Resource [SR])
- pp. 1-55, 56-58

NL Science 4: Online Teaching Centre
- Science Skills Toolkit

NL Science 4: Online Student Centre
- Science Skills Toolkit

Suggested

Children's literature
- *Arctic Foxes*, by V. Franchino
- *Blue Whales*, by R. Bjorklund

What Lives in Local Habitats?

Outcomes	Focus for Learning
Students will be expected to 63.0 identify a variety of local and regional habitats and their associated populations of plants and animals [GCO 3]	A habitat is the place where an organism lives. Limit treatment to the four main types of habitats found in Newfoundland and Labrador (i.e., ocean, freshwater, forest, and arctic). Students should identify local habitats and list examples of the dominant plants (i.e., flora) and animals (i.e., fauna) found in each type of habitat. Oceans • flora - kelp, seaweed, eel grass • fauna - barnacles, mussels, sea stars, crabs, jellyfish, whales, polar bears, seals, gulls, puffin, terns, porpoises, cod fish, shrimp, capelin Freshwater • flora - yellow water lily, cattails • fauna - river otters, beavers, muskrats, Canada geese, ducks, trout, frogs, dragon flies, black flies, water striders, snails Forest (Boreal) • flora - black spruce, balsam fir, juniper, white birch, alder, fire weed, bunch berry, blueberry, pitcher plant, partridge berry • fauna - black bears, caribou, moose, snowshoe hares, meadow voles, mosquitoes, butterflies, weasels, squirrels, coyotes, lynx, wolves Arctic • flora - moss, lichens • fauna - caribou, wolves, arctic foxes, arctic hares, lemmings, polar bears Teachers could address the skill of classifying at this time; classifying organisms according to the habitat they live in and as flora or fauna (SCO 15.0 *Integrated Skills* unit*,* pp. 52-53). Newfoundland and Labrador ecosystems are addressed in the Science 7 *Interactions Within Ecosystems* unit with a focus on biotic (i.e., living) and abiotic (i.e., non-living) factors. **Sample Performance Indicator** Classify images of Newfoundland and Labrador plants and animals according to the habitat that they live in (i.e., ocean, freshwater, forest, arctic).

What Lives in Local Habitats?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Student knowledge of plants and animals may be limited to nonlocal, terrestrial habitats. Throughout the unit ensure that the focus is on Newfoundland and Labrador plants and animals found in either terrestrial or aquatic (i.e., ocean and freshwater) habitats.

Activation

Students may

- View images of local and regional landscapes and classify them according to habitat type (i.e., ocean, freshwater, forest, arctic).

Connection

Students may

- Describe personal experiences where they visited a local habitat. What was the weather like? What plants and animals did you see?

Consolidation

Teachers may

- Provide visual field guides for the environment of Newfoundland and Labrador. Ask students to record in a graphic organizer the dominant plants and animals found in different habitats.
- Assess student knowledge of the plants and animals associated with different habitats using exit cards.
- Affix chart paper in four different locations within the classroom to represent the four habitat types. Divide the class into collaborative groups and ask each group to list all the different plants and animals that live in that habitat. Then conduct a gallery walk. As groups move around the room, they should add new organisms to the lists, place check marks next to those they agree with, and question marks next to those they disagree with.

Students may

- Play a "Who Am I" game; asking yes/no questions of classmates to identify the local plant or animal affixed to their back.
- Create question cards for and play an "I have ... who has" loop game based on the dominant plants and animals found in local habitats.
- Create a single foldable representing the four habitat types and examples of the dominant plants and animals found in each habitat.

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (Teacher Resource [TR])

- pp. 10-15, 44-47, 48-51

NL Science 4 Unit 4: Habitats and Communities (SR)

- pp. 6-9, 32-35, 36-37

NL Science 4: Online Teacher Centre

- IWB Activities 1a, 1b, and 1c

Supplementary

Visual Field Guides for the Environment of Newfoundland and Labrador

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/habitats. html

- Local plants and animals (websites)

Other Curriculum Resources

- *Moving Up with Literacy Place 4* (ELA 4)
  - *The Arctic Tundra: Life on Top of the World (Guided Reading)*
  - *Alone Across the Arctic (Genre Book Club)*

Investigating Local Habitats

Outcomes	Focus for Learning
Students will be expected to	
4.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate [GCO 2]	Students should observe local habitats first-hand and propose questions to investigate based on those observations. In small, collaborative groups, students should select one of the proposed questions or a question from the following list to investigate:

Students should observe local habitats first-hand and propose questions to investigate based on those observations. In small, collaborative groups, students should select one of the proposed questions or a question from the following list to investigate:

- What plants live here?
- Are there different types of plants in different locations? What might be some reasons for this?
- What animals live here? What evidence of animals is there?
- What does this habitat have that allows a specific animal or plant to meet their needs?

Scientists employ various methods to find answers to questions. Students should brainstorm multiple ways to answer their selected question. To find out what animals live in a coastal ocean habitat, for example, students could conduct a field study or survey. They could make direct underwater observations or view animals through an underwater web-cam. Alternatively, they could collect samples of animals found on the beach at low tide or deploy and haul in a beach seine. Students should choose the most appropriate method to find an answer to their question, considering constraints (e.g., safety, time, available tools), and devise a plan to carry out their investigation.

Refer to pp. 38-39 of the *Integrated Skills* unit for elaboration of skill outcome 4.0.

11.0 make observations and collect information that is relevant to the question or problem [GCO 2]

Students should make observations and collect information relevant to their question. To investigate what plants live in an area, for example, students should focus on a manageable area (e.g., the area enclosed by a hula hoop) and collect a small sample or digital image of each different type of plant observed. Findings should be shared with classmates and patterns and discrepancies among plants identified. Students should provide possible explanations for patterns and discrepancies identified (e.g., moss was found in shaded locations).

Conducting habitat-related investigations provides opportunities to address and assess numerous additional skill outcomes

- identify appropriate tools and materials (SCO 6.0);
- carry out procedures (SCO 7.0);
- compile and display data (SCO 16.0);
- draw conclusions (SCO 18.0); and
- communicate procedures and results (SCO 22.0).

Refer to the *Integrated Skills* unit for elaboration of these skill outcomes (pp. 42-45, 48-49, 52-55, 60-61).

Attitude

Encourage students to be sensitive to and develop a sense of responsibility for the welfare of other people, other living things, and the environment. [GCO 4]

Investigating Local Habitats

Sample Teaching and Assessment Strategies

Provide place-based learning opportunities for students to explore local habitats. Students should collaboratively develop guidelines for exploring in ways that show respect for organisms and their habitat.

Activation

Students may
- Explore local habitats and record observations using digital photography, drawings, or watercolour paintings.
- Play "I Spy" in a local habitat.

Connection

Teachers may
- Pose the question "What types of birds visit a local bird feeder?" and discuss with students multiple ways to find an answer.

Students may
- Explore a local habitat and propose questions to investigate and record them on the "I Wonder" wall.

Consolidation

Students may
- Investigate, in small collaborative groups, one of their proposed questions.
- Investigate whether different types of plants are found in different locations within a habitat. Small collaborative groups can be assigned different locations to investigate. Students should collect small, physical samples of the plants in their areas and create a visual display. Findings should be shared with classmates and patterns and discrepancies among displays identified. Explanations for patterns and discrepancies should be inferred. Technology may be used to aid student observations (e.g., hand lens, digital camera, flex camera).

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 10-15

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 6-9

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

Supplementary

Visual Field Guides for the Environment of Newfoundland and Labrador

Why Do Specific Animals Live in Specific Habitats?

Outcomes	Focus for Learning
Students will be expected to 64.0 investigate and describe how a variety of local animals are able to meet their basic needs in their habitat [GCO 3]	Animals have needs they must meet in order to survive (e.g., food, water, shelter, air, space). Animals live in specific habitats where they can meet their needs. In Science 1, students observed similarities and differences in the needs of living things. In Science 4, students should use research inquiry to investigate and describe how various local animals meet their needs within their habitat. Students should, individually or in small collaborative groups, investigate at least one animal from each habitat type (i.e., ocean, freshwater, forest, and arctic) and share their findings with classmates. Student descriptions could be modelled after the following example: • Beavers live in freshwater habitats. They require deep bodies of water which they create by damming rivers. They eat nearby leaves, water lilies, and cattails in summer and tree branches in the winter. Sticks, twigs, and mud are used to construct their shelter. Their lodge has a hole in the ceiling to provide air. Describing how microorganisms meet their needs is addressed in detail in Science 6 *Diversity of Life* unit.
65.0 identify examples of scientific knowledge that have developed from a variety of sources [GCO 1]	Students should recognize that scientific knowledge develops from a variety of sources. Much of what we know about local animals, their needs, habitat, and behaviours, has developed from indigenous knowledge and the local knowledge of hunters, fishers, and naturalists. Biologists use this information to further scientific research. **Attitude** Encourage students to show interest and curiosity about objects and events within different environments. [GCO 4] **Sample Performance Indicator** Create digital pages for a "Habitat" ebook. Include an image of a local animal and a description of how it meets its needs on each page. Combine pages with those created by classmates to form an ebook.

Why Do Specific Animals Live in Specific Habitats?

Sample Teaching and Assessment Strategies

Activation

Students may
- Use a think-pair-share technique to discuss how needs could be met for humans to live on the moon.

Connection

Teachers may
- Display images of unfamiliar, local plants and animals. Ask students to predict how they meet their needs in their habitat.
- Invite local elders, naturalists, hunters, fishers, or wildlife officers to share their knowledge of local animals. Ask them how they acquired this knowledge.
- Facilitate field trips to local habitats or interpretation centres.

Students may
- Share how the needs of a family pet are met in their home.
- Investigate where specific fruits or vegetables they personally consume were grown (e.g., oranges from Israel, kiwi from New Zealand). This information can be used to determine the size of their personal habitat.
- Explore how our knowledge of local edible, medicinal, and poisonous plants developed.

Consolidation

Students may
- Investigate, individually or in small collaborative groups, how specific animals from each local habitat meet their needs.
- Create wanted ads for suitable habitats for local organisms.
- Reflect on the questions:
    - Could an animal survive in more than one habitat?
    - Could different animals share the same habitat?
    - Could a moose survive in an arctic habitat?
    - Could a humpback whale survive in a freshwater lake?

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 16-19

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 10-11

Supplementary

Visual Field Guides for the Environment of Newfoundland and Labrador

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/light. html
- Digital book creators (mobile device applications)
- Regional support organizations (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
    - *Interrupted Journey: Saving Endangered Sea Turtles (Science Book Club)*
    - *The Penguin Book: Birds in Suits (Guided Reading)*
    - *Canadian Owl Guide (Guided Reading)*
- *The Very Hungry Bear* (Science 1 Read aloud)

How Can We Build an Artificial Habitat?

Outcomes

Students will be expected to

30.0 demonstrate processes for investigating scientific questions and solving technological problems
[GCO 1]

1.0 propose questions to investigate and practical problems to solve
[GCO 2]

14.0 construct and use devices for a specific purpose
[GCO 2]

19.0 suggest improvements to a design or constructed object
[GCO 2]

21.0 identify new questions or problems that arise from what was learned
[GCO 2]

Focus for Learning

To address this series of outcomes, students should, in small collaborative groups, investigate the needs of carpenters (i.e., woodlouse), or another small animal (e.g., earthworms, meal worms, slugs, snails, sticklebacks, tadpoles) and design and construct an artificial habitat that meets its basic needs.

Students should propose and investigate questions related to carpenters preferred habitat:

- Do carpenters prefer a light or dark, moist or dry, warm or cool habitat?
- Do carpenters prefer a base substrate of sand, soil, aquarium gravel, or wood chips?
- Do carpenters prefer to shelter under logs or rocks?
- Do carpenters prefer to eat fresh, dry, or rotting leaves?
- Do carpenters prefer a habitat that includes bark, leaf litter, dry grass, or live plants?

Students should devise and carry out procedures using live carpenters to investigate and find answers to their questions. What is learned will likely lead to new questions to investigate. These investigations provide opportunities to address and assess additional skill outcomes (e.g., SCOs 3.0, 4.0, 5.0, 6.0, 7.0, 11.0, 12.0, 16.0, 17.0, 18.0, 22.0).

Using what was learned about carpenters preferred habitat, students should, in small collaborative groups, follow a design and problem solving process to construct an artificial habitat that meets the basic needs of the carpenters (i.e., food, water, shelter, air, space) and their preferred environmental conditions (i.e., lighting, moisture, temperature, substrate). Students should

- generate possible design solutions, select one, identify the tools, instruments, and materials needed, and devise a procedure to construct their artificial habitat (SCOs 4.0, 5.0, 6.0);
- suggest and make improvements to their design (SCO 21.0);
- construct and evaluate their habitat (SCOs 14.0, 20.0);
- suggest and make improvements to their habitat (SCO 21.0);
- identify new problems that arise over time (SCO 21.0);
- communicate how they built their habitat and how it meet the animals needs (SCO 23.0); and
- evaluate the processes used in solving the problem (SCO 24.0).

Refer to the *Integrated Skill* unit for elaboration of these outcomes (pp. 38-43, 50-51, 56-63).

Sample Performance Indicator

- Construct, in small collaborative groups, an artificial habitat for carpenters that meets their needs, incorporating what was learned from investigations. Care for and observe that carpenters over a series of days.

How Can We Build an Artificial Habitat?

Sample Teaching and Assessment Strategies	**Resources and Notes**
Remind students to take care and to show respect when handling and caring for live animals. Instruct students to wash their hands before and after handling the animals. Animals removed from their natural habitat should be returned following completion of the investigation.	**Authorized** *NL Science 4 Unit 4: Habitats and Communities* (TR) • pp. 20-21, 22-23 *NL Science 4 Unit 4: Habitats and Communities* (SR) • pp. 12-13, 14-15
Activation Teachers may • Read aloud *Ordinary Amos and the Amazing Fish* to introduce the concept of artificial habitats.	*NL Science 4: Online Teaching Centre* • IWB Activity 2 • Science Skills Toolkit • Skills and Processes for Scientific Inquiry rubric builder (BLM)
Connection Students may • Recount prior experiences capturing insects or other small animals and constructing homes for them. Students can discuss what happened to these animals and whether the constructed home met all of their needs.	• Skills and Processes for Design and Problem Solving rubric builder (BLM) *NL Science 4: Online Student Centre* • Science Skills Toolkit
Consolidation Students may • Investigate, in small collaborative groups, the habitat preferences of a selected small animal. Share findings with classmates and propose new questions to investigate. Different groups may investigate different animals. • Maintain an artificial habitat over a series of days and make repeated observations of their animals. Observations may be recorded in a chart, observational journal, or as digital images and video. • Suggest and make improvements to their constructed habitat as problems are identified over time.	**Suggested** Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/habitats. html • Science suppliers (websites) Other Curriculum Resources • *Ordinary Amos and the Amazing Fish* (Science 1 Read aloud collection)
Extension Students may • Investigate how zoos create artificial habitats for various animals and debate the positive and negative consequences of keeping animals in zoos.	

How Are Plants Adapted to Their Habitat?

Outcomes

Students will be expected to

66.0 compare the structural adaptations of plants that enable them to thrive in different kinds of places [GCO 3]

Focus for Learning

Organisms live in habitats that meet their needs, but they also depend on adaptations that help them meet their needs within a habitat.

In Science 3, students described plant parts and their general function, investigated plant needs, and described how plants are affected by conditions in which they grow. In Science 4, students are expected to compare the structural adaptations (i.e., physical body parts) that enable plants to survive in different habitats. What structural adaptations enable plants to survive in ocean, freshwater, forest, and arctic habitats? Connections may be made to previous observations of different plants in local habitats.

Example adaptations

- Seaweeds have hold fasts instead of roots that firmly grasp rocks on the ocean floor. Their blades (i.e., leaves) have a wide surface area to capture sunlight for photosynthesis. Many varieties have floats in their blades, hollow sacs filled with air, which keep the blades at or near the ocean's surface.
- Water lilies root themselves in the rich soil at the bottom of the pond or lake. They have extremely long weak stems that reach the water's surface. Their broad, flat leaves float on the surface and absorb sunlight. All their stomata, pore like openings that exchange gases, are found on the upper surface of the leaf.
- Coniferous trees (e.g., spruce, fir, pine) have needles rather than leaves. Needles enable trees to survive in cold habitats with long severe winters and short summers. Needles capture sunlight year round, are not damaged by snow and ice, and have a lower wind resistance than leaves so they are less likely to be uprooted in wind storms.
- Arctic plants grow close together and low to the ground. They have shallow roots and small leaves. Flowering plants flower quickly once summer begins.
- Pitcher plants have pitcher shaped leaves which trap water and insects. The insects are digested as a source of nutrients.

How Are Plants Adapted to Their Habitat?

Sample Teaching and Assessment Strategies	Resources and Notes

Activation
 	
Students may
• Explore local areas to find examples of plants growing in unusual places (e.g., between the cracks in concrete or pavement).
 	
Connection
 	
Students may
• Collect and observe various plant samples from different habitats.
• Use a think-pair-share strategy to consider why the carnivorous nature of pitcher plants is an adaption.
 	
Consolidation
 	
Students may
• Observe and compare
  - kelp hold fasts with roots of various terrestrial plants
  - deciduous tree leaves with needles from coniferous trees
  - coniferous tree cones with seed-bearing fruit
  - maple tree seeds with dandelion seeds
  - stems of coniferous and deciduous trees with those of shrubs and flowering plants
  - various types of mosses with flowering plants
  - leaves of pitcher plants with other forest plants
• Consider what adaptations a plant would need to thrive in various locations within an urban habitat (e.g., between patio paving stones).
	Authorized
	
	NL Science 4 Unit 4: Habitats and Communities (TR)
	• pp. 24-29
	NL Science 4 Unit 4: Habitats and Communities (SR)
	• pp. 16-19
	
	Suggested
	
	Other Curriculum Resources
	• *Moving Up with Literacy Place 4* (ELA 4)
	  - *The Arctic Tundra: Life on Top of the World (Guided Reading)*

How Are Animals Adapted to Their Habitat?

Outcomes	Focus for Learning
Students will be expected to 67.0 compare the structural and behavioural adaptations of animals that help them survive in different kinds of places [GCO 3]	Animals have both structural and behavioural adaptations that enable them to survive in different habitats. Structural adaptations are physical features. Behavioural adaptations are specific activities that help an animal survive. Students should compare the structural and behavioural adaptations of local animals that enable them to survive in their ocean, freshwater, forest, and arctic habitats.

Examples of structural adaptations

- Sea stars have hundreds of sucker-like tube feet on the underside of their arms for locomotion.
- Blubber enables whales to maintain their body temperature in cold habitats.
- Trout are darkly coloured on their back and lighter on the belly for camouflage from predators above and below.
- Salmon have a muscular caudal fin to swim upstream against the current to reach their breeding areas.
- Polar bears have transparent, colourless hair and black skin. Their fur camouflages them against the snow and ice. The transparent hair and black skin maximizing heat absorption.
- Arctic fox, ptarmigan, arctic hares, and snowshoe hares change fur colour seasonally enabling them to remain camouflaged.
- Snowy owls have large eyes with binocular vision (i.e., forward facing) and can rotate their flexible neck 270° to see behind them.
- Black bear teeth include sharp canines and incisors as well as broad flat molars enabling them to eat both plants and animals.
- Lynx have broad well furred paws for walking on snow and sharp retractable claws to catch prey.

Examples of behavioural adaptations

- Whales migrate to colder waters in warm seasons to feed and return to warmer waters in cold seasons to breed.
- Salmon migrate from freshwater to saltwater and then back to freshwater to spawn during their life cycle.
- Beavers slap their broad tail on the surface of freshwater ponds to warn others of possible predators.
- Wolves live and hunt in packs. Working collaboratively enables them to take down prey much larger than an individual wolf could.
- Chipmunks hibernate to survive winter.
- Caribou live in large herds for protection from predators.

Comparing adaptations of closely related animals that live in different parts of the world is addressed in the Science 6 *Diversity of Life* unit.

Sample Performance Indicator

Identify adaptations that enable a local plant (e.g., pitcher plant) or animal (e.g., orca whale) to survive in a habitat and classify adaptations as structural or behavioural.

How Are Animals Adapted to Their Habitat?

Sample Teaching and Assessment Strategies

Adaptation

Teachers may
- Read aloud *What If You Had Animal Feet!?,* or another title from the same series, to illustrate the diversity of structural adaptations that exist among animals.

Connection

Teachers may
- Prompt students to consider how a local animal
    - moves through its habitat
    - obtains food and water
    - finds or builds shelter
    - protects itself from predators
    - protects itself from varying environmental conditions

  Consideration should identify both behavioural and structural adaptations.

Consolidation

Students may
- Create a foldable to illustrate differences between structural and behavioural adaptations.
- Invent an animal which is adapted to an actual or imagined habitat. Animals may be visually represented and presented to classmates.
- Invent a "super" animal with adaptations that enable it to live in any habitat (i.e.,ocean, freshwater, forest, arctic), on the moon, or another planet.

Extension

Students may
- Explore the diversity that exists in bird beaks and foot shapes.

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 24-29

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 16-19

NL Science 4: Online Teacher Centre
- IWB Activity 3

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-4/links/habitats.html
- Adaptation games (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
    - *Killer Whales: Animal Predators (Analyzing Strategy Unit)*
    - *The Arctic Tundra: Life on Top of the World (Guided Reading)*
- What If You Had Animal Feet!? (Science 1 Library collection)
- What If You Had Animal Teeth!? (Science 1 Library collection)

Can We Model Animal Camouflage?

Outcomes

Students will be expected to

3.0 state a prediction and a
       hypothesis
       [GCO 2]

7.0 carry out procedures to
       explore a given problem
       and to ensure a fair test,
       controlling major variables
       [GCO 2]

16.0 compile and display data
       [GCO 2]

17.0 identify and suggest
       explanations for patterns
       and discrepancies in data
       [GCO 2]

23.0 communicate procedures
       and results
       [GCO 2]

31.0 compare the results of their
       investigations to those of
       others and recognize that
       results may vary
       [GCO 1]

Focus for Learning

Address this series of skill and STSE outcomes through a guided inquiry investigation designed to model how camouflage, a structural adaptation, can help an animal survive in its habitat.

Students should:

- Select a natural area where the investigation will be conducted.
- Observe and note the background colours of the area.
- Divide a collection of toothpicks into four groups of equal quantity. Colour each group a different colour using food colouring, vegetable dyes, or non-toxic markers. The colours selected should include at least one that will blend in with the surroundings and others that will stand out.
- Predict which colour(s) of toothpick will be best camouflaged (SCO 3.0).
- Devise and carry out a procedure to search for and collect toothpicks within a time limit, ensuring a fair test (SCO 7.0).
- Carry out multiple trials of the procedure.
- Design and use a chart to record their collected data (SCO 16.0).
- Compare their data with that of other groups investigating in the same area (SCO 31.0).
- Identify and suggest explanations for patterns and discrepancies observed in data (SCO 17.0).
- Determine whether their data supports their predictions and draw a conclusion (SCO 18.0).
- Communicate their findings to classmates (SCO 23.0)

The purpose of the investigation is not to find all the toothpicks. Toothpicks unfound after the time limit represent the organisms that have survived predation. It is the number of toothpicks of each colour that were unfound that should be recorded. If camouflage provides an advantage, toothpicks coloured to match the surroundings should be harder to find, and larger quantities should be unfound.

Refer to the *Integrated Skill* unit for elaboration of these outcomes (pp. 36-37, 44-45, 52-55, 60-61).

Comparing the results of an investigations to those of others is an important part of doing science. The process adds weight (i.e., reliability and accuracy) to a conclusion if the data is confirmed by others. To compare, all groups must uniformly carry out their procedures in a manner that eliminates bias and controls major variables. Should discrepancies in results exist, students should be prompted to provide an explanation.

Attitude

Encourage students to appreciate the importance of accuracy and honesty. [GCO 4]

Can We Model Animal Camouflage?

Sample Teaching and Assessment Strategies	Resources and Notes
Connection	**Authorized**

Connection

Students may
- Use a think-pair-share technique to discuss how camouflage is advantageous to different animals.
- Explore a natural or constructed area and come to school dressed to camouflage themselves within that area.

Consolidation

Students may
- Conduct, in small collaborative groups, the toothpick investigation as described in the focus for learning column. Students should
  - predict which colours of toothpicks will be collected in the greatest numbers and explain their prediction
  - create bar graphs to display their collected data
  - describe how they ensured fair testing.
- Consider the cost, time, and equipment that would be required for scientists to study animal camouflage in the field. What advantages does modelling provide over field studies? Are there any disadvantages?

Extension

Students may
- Colour animal cutouts to camouflage them within specific locations in the classroom. Play games to see how long it takes classmates to find them.

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 24-29

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 18-19

NL Science 4: Online Teaching Centre
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 4: Online Student Centre
- Science Skills Toolkit

How Do Organisms Get Their Food?

Outcomes

Students will be expected to

68.0 classify organisms according to their role in a food chain
[GCO 3]

15.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
[GCO 2]

Focus for Learning

Plants and animals need food to grow and survive. Plants make their own food and are called producers. Animals get their food by eating plants and other animals and are called consumers. Predators are animals that hunt other animals. The animals they hunt are called prey.

The relationships among producers and consumers and predators and prey can be represented in a food chain. Food chains start with a producer. All other organisms in the diagram are consumers. When an animal eats a plant and then another animal eats that animal, energy moves through the habitat. This energy transfer is represented in the diagram by arrows.

balsam fir → red squirrel → pine marten → lynx

Ensure students explore local food chains from ocean, freshwater, forest, and arctic habitats.

Students should classify organisms in food chains as producers or consumers and further classify consumers as predators or prey. Note that some organisms are both predator and prey. Atlantic cod, for example, are predators of capelin and prey of harp seals.

Classifying as primary, secondary, or tertiary consumers, carnivores, herbivores, or omnivores, scavengers or decomposers is not a Science 4 expectation.

For elaboration of outcome 15.0 please refer to pp. 52-53 of the *Integrated Skills* unit.

The roles of producers, consumers and decomposers in local ecosystems are addressed in more detail in the Science 7 *Interactions Within Ecosystems* unit.

Attitude

Encourage students to appreciate the role and contribution of science in their understanding of the world. [GCO 4]

Sample Performance Indicator

Classify organisms in the food chain as producers or consumers, further classify consumers as predators or prey, and provide a rationale their answers.

phytoplankton → krill → capelin → Atlantic puffin → red fox

How Do Organisms Get Their Food?

Sample Teaching and Assessment Strategies

Pre-assess student knowledge of food chain-related terminology and concepts and alter teaching and assessment plans accordingly.

Connection

Teachers may
- Make a connection between the term producer and the produce section at their local grocery store which contains the fruits and vegetables (i.e., plants).
- Present images of local organisms and ask students to classify them as producers or consumers using mini white boards, paddles, or thumbs up and thumbs down.

Students may
- Discuss if an organism can be a predator in one food chain and prey in another.
- Kinesthetically construct food chains on white boards using images of local organisms and arrows affixed to magnets.

Consolidation

Teachers may
- Provide examples of local food chains for students to classify organisms as producers or consumers and predators or prey

Students may
- Create local food chains using the informational text provided in the *Visual Field Guides for the Environment of Newfoundland and Labrador.*

Extension

Students may
- Research plant photosynthesis to identify the materials required by and those produced by producers in this process.

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 34-39

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 24-27

NL Science 4: Online Teacher Centre
- IWB Activity 4
- Science Skills Toolkit

NL Science 4: Online Student Centre
- Science Skills Toolkit

Supplementary

Visual Field Guides for the Environment of Newfoundland and Labrador

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/habitats. html
- Food chain resources (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *The Penguin Book: Birds in Suits (Guided Reading Pack)*
  - *Canadian Owl Guide (Guided Reading Pack)*

How Do Changes to a Population Affect Other Populations?

Outcomes	Focus for Learning
Students will be expected to 69.0 predict how reduction or removal of a plant or animal population affects the rest of the community [GCO 3]	Animals in a habitat rarely rely on only one source of food as depicted in a food chain. A food web is a more accurate representation of the complex feeding relationships that exist within a habitat. Food webs show how different populations of organisms are connected within a community. From these diagrams, scientists predict how changes in one population may affect other populations in the community. Students should predict how reducing or removing a plant or animal population will affect the rest of the community and come to recognize that changes affecting one population can have far reaching affects within the community. If a population of spruce budworms, for example, collapses due to resource depletion • predators that prey on the budworms may increase predation of other food sources, expand their habitat to find new food sources, or experience a decrease in population; and • black spruce trees may experience regrowth of foliage, improved health, and a population increase. These populations, directly affected by the collapse of the spruce budworm population, may in turn, affect other populations to which they connect through the food web. Students are not expected to construct food webs. Describing how energy is supplied to, and how it flows through, a food web, is addressed in the Science 7 *Interactions Within Ecosystems* unit. Students should also explore how local invasive species, whether intentionally (e.g., brown trout, moose, snowshoe hare, starlings) or unintentionally (e.g., coffin box, European green crab, purple loosestrife, various tunicates) introduced, are affecting populations of native plants and animals. Green crab, for example, feed on shellfish and other crustaceans, and have been observed eating small and juvenile fish. There is also concern that green crab may damage eelgrass habitat by cutting the eelgrass roots when digging for prey or making burrows. Eelgrass provides a protective habitat for juvenile fish of many different species. **Sample Performance Indicator** Using the ocean food web depicted on pp. 28-29 within *NL Science 4 Unit 4: Habitats and Communities,* predict how a reduction in the population of capelin will affect other organisms in the ocean community.

How Do Changes to a Population Affect Other Populations?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation	**Authorized**
Teachers may	*NL Science 4 Unit 4: Habitats and Communities* (TR)
• Pre-assess student conceptions of the terms population and community.	• pp. 40-43, 44-47, 48-51
	NL Science 4 Unit 4: Habitats and Communities (SR)
Connection	• pp. 28-31, 32-35, 36-37
Teachers may	*NL Science 4: Online Teacher Centre*
• Model how multiple food chains containing the same plant or animal overlap to form a food web.	• IWB Activity 5
Students may	
• Play predator-prey games to model the relationship between predators and prey. Discussions following games could focus on structural and behavioural adaptations of predators and prey and population dynamics.	
• Discuss what is meant by the term invasive species.	
Consolidation	
Teachers may	
• Kinesthetically arrange students representing various local plants and animals. Connect students using lengths of yarn to represent direct feeding relationships. Depending on the organism, students may be holding several ends of yarn. Teachers should call out authentic situations that could result in reduction or removal of plant or animal population. Students whose organisms are affected by the situation should raise their other hand and then gently tug on the ends of yarn. Students who feel the tug should then raise their hand. Students should come to recognize the interconnectedness of populations within a community and the far reaching affects of habitat change.	
• Call out a situation removing an organism from a food web and ask students to predict how other populations will be affected and record their predictions on an exit card.	
Students may	
• Use a think-pair-share technique to discuss whether the consequences of invasive species introductions are always negative.	
• Predict what impacts the introduction of the coyote has had on the Newfoundland forest community.	

How Does Habitat Loss Affect Plants and Animals?

Outcomes	Focus for Learning
Students will be expected to 70.0 relate habitat loss to the endangerment or extinction of plants and animals [GCO 3]	Habitats continually undergo change. Some of these changes are natural, and others are caused by humans. Natural changes may include forest fires and flooding. Human changes include clearing land for agricultural use, industrialization, and urban development, and building dams on rivers for hydroelectricity. Note that climate change, which is specifically addressed in subsequent outcomes, occurs naturally, but humans actions are causing the climate to change more dramatically. Natural and human-caused changes alter habitats and the populations of plants and animals that live in them. Organism live in habitats where their needs can be met. When habitats change, some organisms may experience difficulty meeting their needs. Widespread habitat change may result in some organisms becoming endangered or extinct. Students should relate habitat loss to the endangerment or extinction of organisms and distinguish between endangered species and extinct species: • Extinct species are no longer living anywhere on Earth (e.g., Labrador duck, great auk, and Newfoundland wolf). • Extirpated species are extinct in an area but exist elsewhere (e.g., bison - unsuccessful introduction, 1964-66). • Endangered species face imminent extinction. • Threatened species are likely to become endangered. • Vulnerable species may become threatened or endangered. The Government of Newfoundland and Labrador Department of Environment and Conservation maintains a current list of vulnerable, threatened, and endangered species in our province. Habitat loss poses the greatest threat to endangered species. To protect endangered species, their ocean, freshwater, forest, and arctic habitats must be protected.

How Does Habitat Loss Affect Plants and Animals?

Sample Teaching and Assessment Strategies

Activation

Students may
- Use a think-pair-share technique to discuss what is meant by the terms extinct and endangered.
- Reflect on the specific needs of an organism and brainstorm reasons why it might become endangered or extinct.

Connection

Students may
- Work in pairs to create a thought web about what habitat loss means.
- Play musical chairs, or similar games, as a model of habitat loss.
- View current lists from the Government of Newfoundland and Labrador Department of Environment of Conservation website of local species at risk.
- Identify protected areas in Newfoundland and Labrador, including marine protected areas.
- Identify organizations committed to protecting local habitats.
- Take before and after pictures of a new building or home construction site, describe the differences, and predict what happened to the organisms that lived there.

Consolidation

Students may
- Research the Labrador duck, great auk, and Newfoundland wolf; extinct organisms of Newfoundland and Labrador.
- Suggest possible reasons for habitat loss in Labrador forests which are home to several populations of endangered woodland caribou.
- Consider how their community has changed from 50 or 100 years ago. What plants and animals have disappeared? What plants and animals have been introduced?

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 56-59

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 42-43

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/habitats. html
- Species at risk resources (websites)

Other Curriculum Resources
- *Moving Up with Literacy Place 4* (ELA 4)
  - *Make Some New Friends (Science Book Club)*
  - *Endangered Sea Animals (Science Book Club)*
  - *Endangered Animals (Science Book Club)*

How Do Our Actions Affect Habitats?

Outcomes	Focus for Learning
Students will be expected to	
37.0 contemplate their own and their family's impact on natural resources [GCO 1]	Human actions can have negative and positive affects on habitats.

Human harvesting of natural resources (e.g., minerals, wood, water, fish and wild game for food, plant and animal products for clothing and medicine) to meet our needs and wants, clearing land for agriculture use, urban development, transportation and energy corridors, damming rivers for hydroelectricity, and the disposal of human waste cause habitat change and habitat loss.

Students should recognize that their own and their family's consumption of natural resources causes habitat loss. Harvesting balsam fir forests, for example, to produce lumber and paper products, and to burn for home heating, results in habitat loss for pine martens (threatened), red crossbills (endangered), and boreal felt lichens (vulnerable). |
| 36.0 consider the positive and negative effects of familiar technologies [GCO 1]

43.0 describe instances where scientific ideas and discoveries have led to new inventions and applications [GCO 1] | Address STSE outcomes 36.0 and 43.0 in the context of a primary resource industry (e.g., forestry, agriculture, fishery, offshore oil and gas industry). Primary resource industries provide the natural materials humans need. Some of the technologies (i.e., tools and practices) used by these industries, however, may have negative effects on habitats.

Agriculture in Newfoundland and Labrador, for example, produces berries, greenhouse products, vegetables (e.g., turnips, cabbage, carrots, potatoes) livestock, dairy, poultry, and eggs. Unsustainable agricultural practices (e.g., land conversion, wasteful water consumption, soil degradation and erosion, use of pesticides and chemical fertilizers) have had negative effects on habitats. To reduce these negative effects, farmers are turning to sustainable agricultural practices (crop rotation, cover crops, drip irrigation, establishing wind breaks, using organic fertilizers, growing drought tolerant plants). Many of these practices were developed and improved by agriculture-related scientific research.

Attitude

Encourage students to realize that the applications of science and technology can have both intended and unintended effects. [GCO 4] |

How Do Our Actions Affect Habitats?

Sample Teaching and Assessment Strategies	Resources and Notes
Activation	**Authorized**
Teachers may	*NL Science 4 Unit 4: Habitats and Communities* (TR)
• Read aloud the *Lorax*, by Dr. Seuss, and discuss the environmental messages it conveys.	• pp. 56-59, 60-63, 64-67
Students may	*NL Science 4 Unit 4: Habitats and Communities* (SR)
• Listen to the songs *The Last of the Great Whales* and *Big Yellow Taxi* and discuss how human actions affect habitats and the populations of organisms that live there.	• pp. 42-43, 44-45, 46-47
	NL Science 4: Online Teacher Centre
	• IWB Activity 6
Connection	
Teachers may	**Suggested**
• Facilitate a discussion to make connections between personal use of natural resources and habitat loss.	Other Curriculum Resources
Students may	• *Moving Up with Literacy Place 4* (ELA 4)
• Create a collage of modern technology used in a selected primary resource industry.	- Recycling, Conservation (Science Book Club)
	- The Big Yellow Taxi (Sounds Like Book Club)
Consolidation	Children's literature
Students may	• The *Lorax*, by Dr. Seuss
• Research and list the positive and negative impacts of using fish finders and cod pots in the fishing industry.	
• Research DDT use in the past and its impact on bird populations.	

How Can We Take Action on Climate Change?

Outcomes	Focus for Learning
Students will be expected to 35.0 *identify examples of scientific questions and technological problems that are currently being studied* [GCO 1]	Climate refers to the average weather conditions for an area over a long period of time. Earth's climate changes naturally, but negative human actions (e.g., burning fossil fuels) are causing greater changes to these patterns. The effects of climate change observed in Newfoundland and Labrador include • increasing average summer and winter air temperatures, • increasing ocean temperatures, • shrinking arctic sea ice, • more frequent extreme weather events, • rising sea-level, • more prevalent flooding and coastal erosion, and • more acidic oceans. Climate change is currently the most significant cause of habitat change and loss; directly affecting the ability of organisms to meet their needs. Consequently, climate change is the focus of most current, habitat-related scientific research. The effects of climate change are most readily observed in Arctic habitats. Rising temperatures, for example, is causing sea ice to shrink rapidly. Polar bears use sea ice as platforms to stalk their prey (i.e., seals). If sea ice continues to shrink, polar bears may become an endangered species. Teachers should readdress outcome 65.0 (refer to pp. 169-170) highlighting the importance of indigenous knowledge to our understanding how Arctic habitats are changing.
38.0 *describe how personal actions help conserve natural resources and care for living things and their habitats* [GCO 1]	Students should provide examples of actions that can be undertaken to reduce the causes and effects of climate change. For example • reduce, reuse, recycle; • purchase energy efficient products; • use renewable sources of energy; • walk, bike, car pool, use public transportation; • compost food waste; • conserve water; and • plant native trees and plants. Many of these actions reduce the emission of greenhouse gases caused by the burning of fossil fuels. Greenhouse gases released into the atmosphere trap solar heat near Earth's surface contributing to climate change.

How Can We Take Action on Climate Change?

Sample Teaching and Assessment Strategies	Resources and Notes

Sample Teaching and Assessment Strategies

Activation

Students may
- View *Turn Back the Tide* climate change videos and posters.

Connection

Teachers may
- Invite local conservation organizations to make presentations about how we can help conserve natural resources and care for living things and their habitats.

Students may
- Research the causes of climate change and local consequences.
- Search online for recent climate change-related news items. Create a bulletin board of climate change headlines.

Connection

Students may
- Create a list of actions they can undertake to reduce the causes and effects of climate change.
- Create a pamphlet on the causes and local consequences of climate change and actions we can undertake to reduce the causes and consequences.
- Select an idea to help a habitat and create a plan to carry it out.

Resources and Notes

Authorized

NL Science 4 Unit 4: Habitats and Communities (TR)
- pp. 68-71

NL Science 4 Unit 4: Habitats and Communities (SR)
- pp. 48-49

Suggested

Resource Links: www.k12pl. nl.ca/curr/k-6/sci-4/links/habitats. html
- Climate change resources (websites)