

Science 6

Curriculum Guide 2018



Education and Early Childhood Development

***Department of Education and Early
Childhood Development
Mission Statement***

***The Department of Education and Early Childhood
Development will improve 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

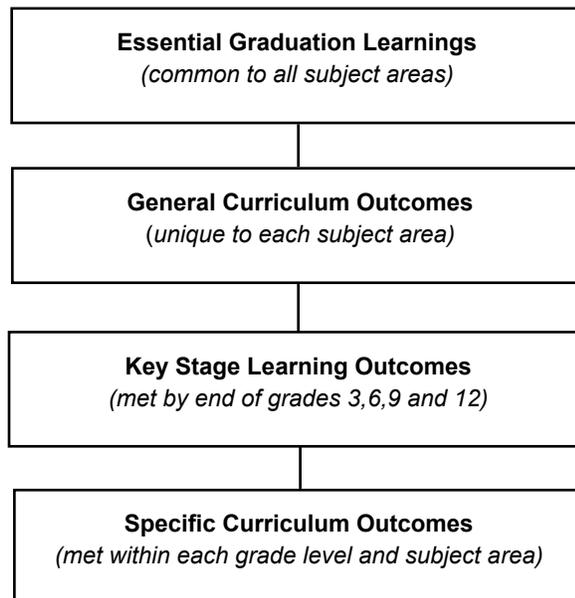
There are multiple factors that impact education: technological developments, increased emphasis on accountability, and globalization. These factors point to the need to consider carefully the education students receive.

The Newfoundland and Labrador Department of Education and Early Childhood Development 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

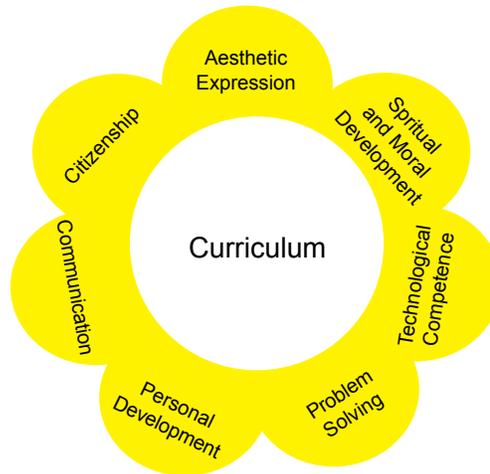
The K-12 curriculum in Newfoundland and Labrador is organized by outcomes and is based on *The Atlantic Canada Framework for Essential Graduation Learning in Schools* (1997). This framework consists of Essential Graduation Learnings (EGLs), General Curriculum Outcomes (GCOs), Key Stage Curriculum Outcomes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



Essential Graduation Learnings

EGLs provide vision for the development of a coherent and relevant curriculum. They 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 K-12 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 use the listening, viewing, speaking, reading and writing modes of language(s), and mathematical and scientific concepts and symbols, to think, learn and communicate effectively.

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.

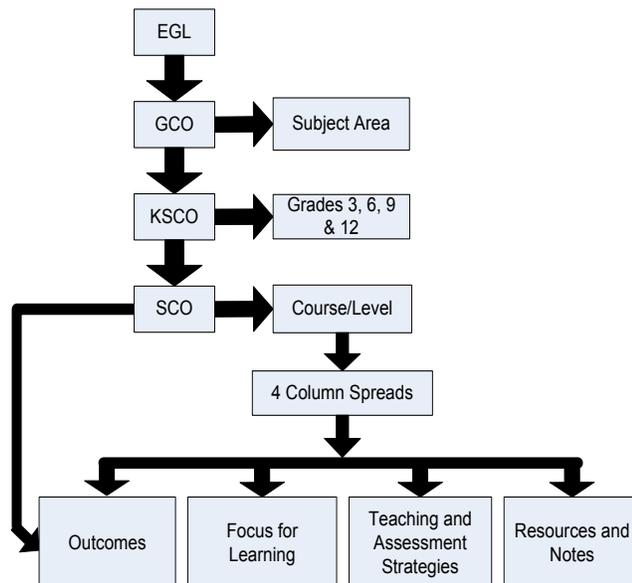
Key Stage Curriculum Outcomes (KSCOs)

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. Several factors 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 all genders and that learning resources include and reflect the interests, achievements, and perspectives of all students. An inclusive classroom values the varied experiences and abilities as well as 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.



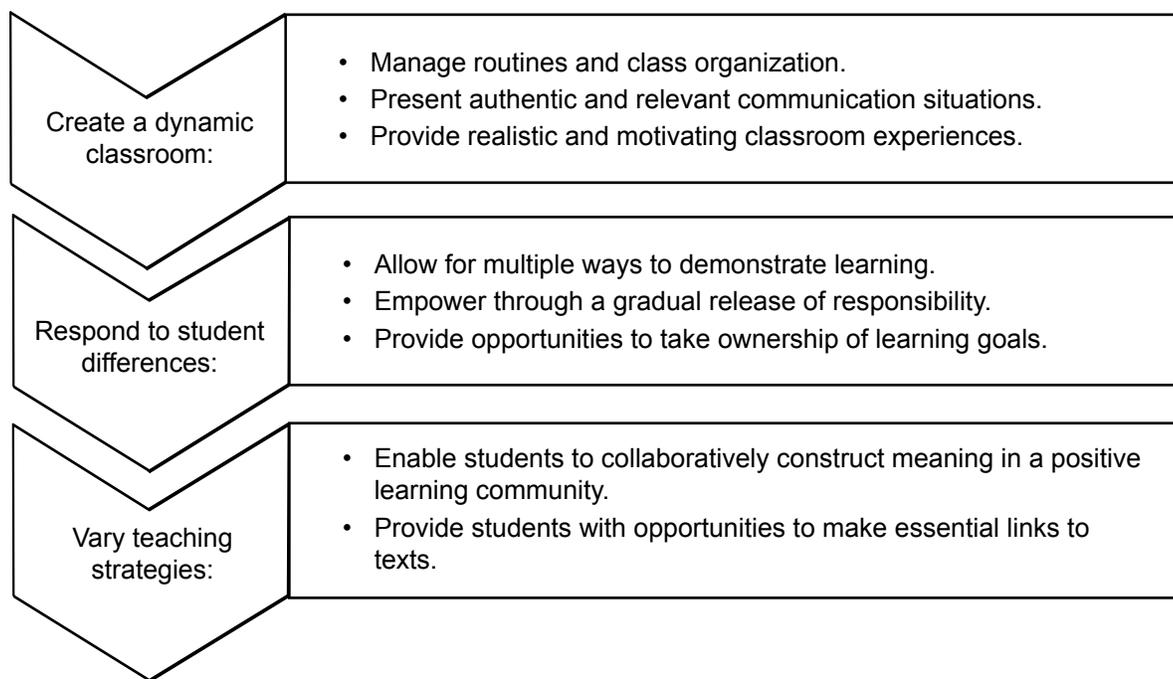
Differentiated Instruction

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, 2008)

Curriculum is designed and implemented to provide learning opportunities for all students according to 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 that provide all students with a safe and supportive place to learn and succeed.

Planning for Differentiation



Differentiating the Content

Differentiating content requires teachers to pre-assess students to identify those who require prerequisite instruction, as well as those who have already mastered the concept and may therefore apply strategies learned to new situations. Another way to differentiate content is to permit students to adjust the pace at which they progress through the material. Some students may require additional time while others will move through at an increased pace and thus create opportunities for enrichment or more in-depth consideration of a topic of particular interest.

Teachers should consider the following examples of differentiating content:

- Meet with small groups to reteach 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, websites, 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., presenting to peers) but the process students use to create the presentation may differ. Some students could work in groups while others meet with the teacher individually. The same assessment criteria can be used for all students.

Teachers should consider flexible grouping 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/or 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.
- Provide activities and resources that encourage students to further explore a topic of particular interest.
- 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 give students options to demonstrate their learning (e.g., create an online presentation, write a letter, or develop a mural). This will lead to an increase in student engagement.

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 and 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 and Early Childhood Development) which impact their learning. The majority of students with exceptionalities access the prescribed curriculum. For details of these exceptionalities see www.gov.nl.ca/edu/k12/studentsupportservices/exceptionalities.html

Supports for these students may include

1. Accommodations
2. Modified Prescribed Courses
3. Alternate Courses
4. Alternate Programs
5. 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.

Teachers may

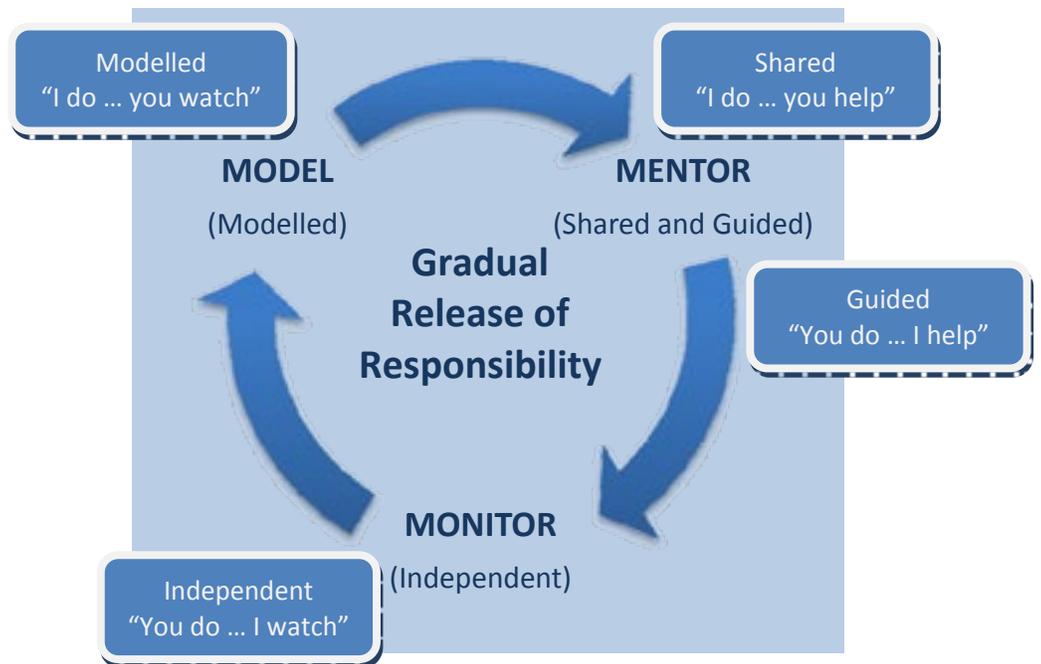
- assign independent study to increase depth of exploration in an area of particular interest;
- compact curriculum to allow for an increased rate of content coverage commensurate with a student's ability or degree of prior knowledge;
- group students with similar abilities to provide the opportunity for students to work with their intellectual peers and elevate discussion and thinking, or delve deeper into a particular topic; and
- tier 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 to 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

“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; and
- 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. Individuals use literacy skills in paper, digital, and live interactions to engage in a variety of activities:

- Analyze critically and solve problems.
- Comprehend and communicate meaning.
- Create a variety of texts.
- Make connections both personally and inter-textually.
- Participate in the socio-cultural world of the community.
- Read and view for enjoyment.
- 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

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

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, or 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:

- 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

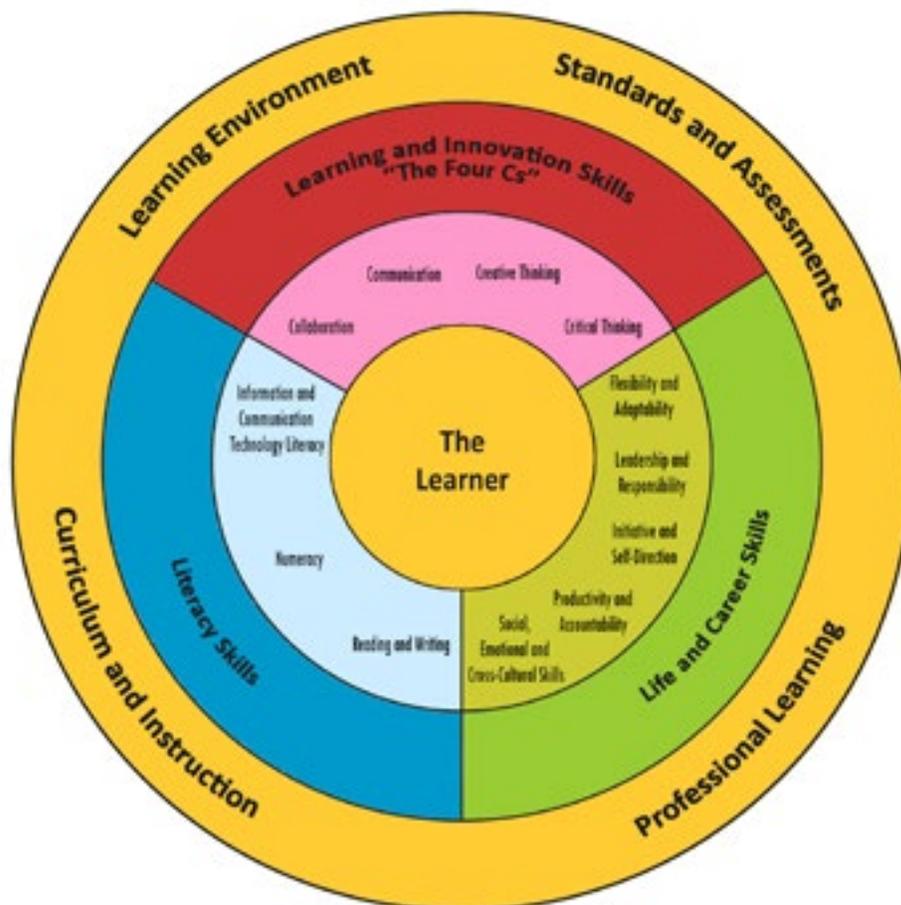
Generation Next is the group of students who have not known a world without personal computers, cell phones, and the Internet. They were born into this technology. They are digital natives.

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 enhance a person's ability to learn, create new ideas, problem solve, and collaborate.
- Life and Career Skills address leadership, and interpersonal and affective domains.
- Literacy Skills develop reading, writing, and numeracy, and enhance the use of information and communication technology.

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.



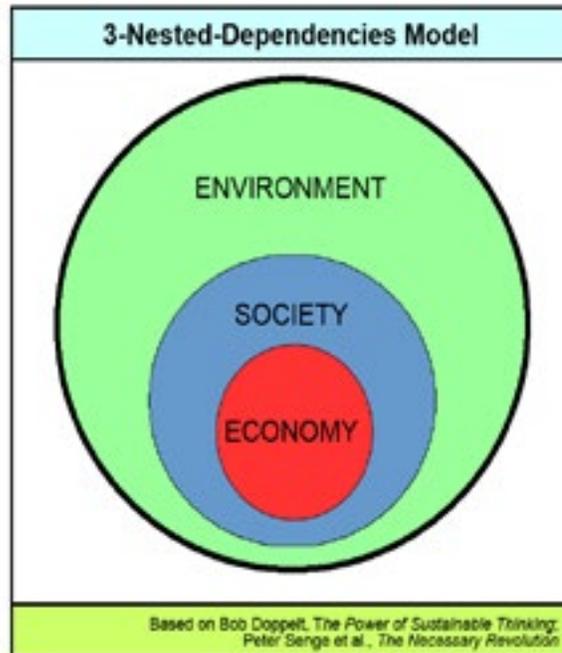
Support for students to develop these abilities and skills is important across curriculum areas and should be integrated into teaching, learning, and assessment strategies. Opportunities for integration of these skills and abilities should be planned with engaging and experiential activities that support 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.



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 that supports environmental integrity and economic viability, resulting in a just society for all generations.

ESD involves teaching *for* rather than teaching *about* sustainable development. In this way 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.

Assessment *for* learning is not about a score or mark; it is an ongoing process of teaching and learning:

- Pre-assessments provide teachers with information about what students already know and can do.
- Self-assessments allow students to set goals for their own learning.
- Assessment *for* learning provides descriptive and specific feedback to students and parents regarding the next stage of learning.
- Data collected during the learning process from a range of tools enables teachers 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 their own progress. It focuses on the role of the student in developing metacognition and enhances engagement in their own learning. Students can

- analyze their learning in relation to learning outcomes,
- assess themselves and understand how to improve performance,
- consider how they can continue to improve their learning, and
- use information gathered to make adaptations to their learning processes and to develop new understandings.

3. Assessment of Learning

Assessment *of* learning involves strategies designed to confirm what students know in terms of curriculum outcomes. It also assists teachers in determining student proficiency and future learning needs. Assessment *of* learning occurs at the end of a learning experience and 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, assessment *of* learning is strengthened. Teachers can

- confirm what students know and can do;
- report evidence to parents/guardians, and other stakeholders, of student achievement in relation to learning outcomes; and
- report on student learning accurately and fairly using 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:

- 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 tools teachers will choose:

Anecdotal Records	Photographic Documentation
Audio/Video Clips	Podcasts
Case Studies	Portfolios
Checklists	Presentations
Conferences	Projects
Debates	Questions
Demonstrations	Quizzes
Exemplars	Role Plays
Graphic Organizers	Rubrics
Journals	Self-assessments
Literacy Profiles	Tests
Observations	Wikis

Assessment Guidelines

Assessments should measure what they intend to measure. It is important that students know the purpose, type, and potential marking scheme of an assessment. The following guidelines should be considered:

- Collect evidence of student learning through a variety of methods; do not rely solely on tests and paper and pencil activities.
- Develop a rationale for using a particular assessment of learning at a specific point in time.
- Provide descriptive and individualized feedback to students.
- Provide students with the opportunity to demonstrate the extent and depth of their learning.
- Set clear targets for student success using learning outcomes and assessment criteria.
- Share assessment criteria with students so that they know the expectations.

Evaluation

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information, and 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, makes judgements about student progress, and 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, and 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 individuals 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.

Course Overview

SCOs are organized into units for each course. 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.

SCOs for Science 6 are organized into five units:

- Integrated Skills,
- Space,
- Flight,
- Electricity, and
- Diversity of Life.

Note, the *Integrated Skills* unit is not intended to be taught as a stand alone unit. As skill outcomes (GCO 2) are encountered in the content units, teachers should refer to the focus for learning elaborations and sample teaching and assessment strategies provided in the *Integrated Skills* unit.

Suggested Yearly Plan

The order in which the units appear in the Science 6 curriculum guide is the recommended sequence.

Unit 1 - Space

Unit 2 - Flight

Unit 3 - Electricity

Unit 4 - Diversity of Life

September	October	November	December	January	February	March	April	May	June
Space			Flight		Electricity			Diversity of Life	

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

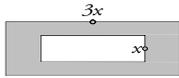
- cautionary notes
- clarity in terms of scope
- common misconceptions
- depth of treatment
- knowledge required to scaffold and challenge student's learning
- references to prior knowledge

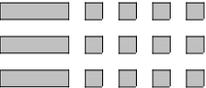
Sample Performance Indicator(s)

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	
<i>GCO 1: Represent algebraic expressions in multiple ways</i>	
<p>Outcomes</p> <p><i>Students will be expected to</i></p> <p>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]</p> <p>1.2 model division of a given polynomial expression by a given monomial concretely or pictorially and record the process symbolically.</p> <p>1.3 apply a personal strategy for multiplication and division of a given polynomial expression</p>	<p>Focus for Learning</p> <p>From previous work with number operations, students should be aware that division is the inverse of multiplication. This can be extended to divide polynomials by monomials. The study of division should begin with division of a monomial by a monomial, progress to a polynomial by a scalar, and then to division of a polynomial by any monomial.</p> <p>Division of a polynomial by a monomial can be visualized using area models with algebra tiles. The most commonly used symbolic method of dividing a polynomial by a monomial at this level is to divide each term of the polynomial by the monomial, and then use the exponent laws to simplify. This method can also be easily modelled using tiles, where students use the sharing model for division.</p> <p>Because there are a variety of methods available to multiply or divide a polynomial by a monomial, students should be given the opportunity to apply their own personal strategies. They should be encouraged to use algebra tiles, area models, rules of exponents, the distributive property and repeated addition, or a combination of any of these methods, to multiply or divide polynomials. Regardless of the method used, students should be encouraged to record their work symbolically. Understanding the different approaches helps students develop flexible thinking.</p> <p>Sample Performance Indicator</p> <p>Write an expression for the missing dimensions of each rectangle and determine the area of the walkway in the following problem:</p> <ul style="list-style-type: none"> • 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 $3x^2 + 6x$. 

SPECIFIC CURRICULUM OUTCOMES	
<i>GCO 1: Represent algebraic expressions in multiple ways</i>	
Sample Teaching and Assessment Strategies	Resources and Notes
<p>Teachers may use the following activities and/or strategies aligned with the corresponding assessment tasks:</p> <p>Modeling division using the sharing model provides a good transition to the symbolic representation. For example, $\frac{3x+12}{3} = \frac{3x}{3} + \frac{12}{3}$. To model this, students start with a collection of three x-tiles and 12 unit tiles and divide them into three groups.</p>  <p>For this example, $x + 4$ tiles will be a part of each group, so the quotient is $x + 4$.</p> <p>Activation</p> <p>Students may</p> <ul style="list-style-type: none"> Model division of a polynomial by a monomial by creating a rectangle using four x^2-tiles and eight x-tiles, where $4x$ is one of the dimensions. <p>Teachers may</p> <ul style="list-style-type: none"> Ask students what the other dimension is and connect this to the symbolic representation. <p>Connection</p> <p>Students may</p> <ul style="list-style-type: none"> Model division of polynomials and determine the quotient <ol style="list-style-type: none"> $(6x^2 + 12x - 3) \div 3$ $(4x^2 - 12x) \div 4x$ <p>Consolidation</p> <p>Students may</p> <ul style="list-style-type: none"> Draw a rectangle with an area of $36a^2 + 12a$ and determine as many different dimensions as possible. <p>Teachers may</p> <ul style="list-style-type: none"> Discuss why there are so many different possible dimensions. <p>Extension</p> <p>Students may</p> <ul style="list-style-type: none"> Determine the area of one face of a cube whose surface area is represented by the polynomial $24s^2$. Determine the length of an edge of the cube. 	<p>Authorized</p> <ul style="list-style-type: none"> <i>Math Makes Sense 9</i> Lesson 5.5: Multiplying and Dividing a Polynomial by a Constant Lesson 5.6: Multiplying and Dividing a Polynomial by a Monomial ProGuide: pp. 35-42, 43-51 CD-ROM: Master 5.23, 5.24 See It Videos and Animations: <ul style="list-style-type: none"> Multiplying and Dividing a Polynomial by a Constant, Dividing Multiplying and Dividing a Polynomial by a Monomial, Dividing SB: pp. 241-248, 249-257 PB: pp. 206-213, 214-219

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.

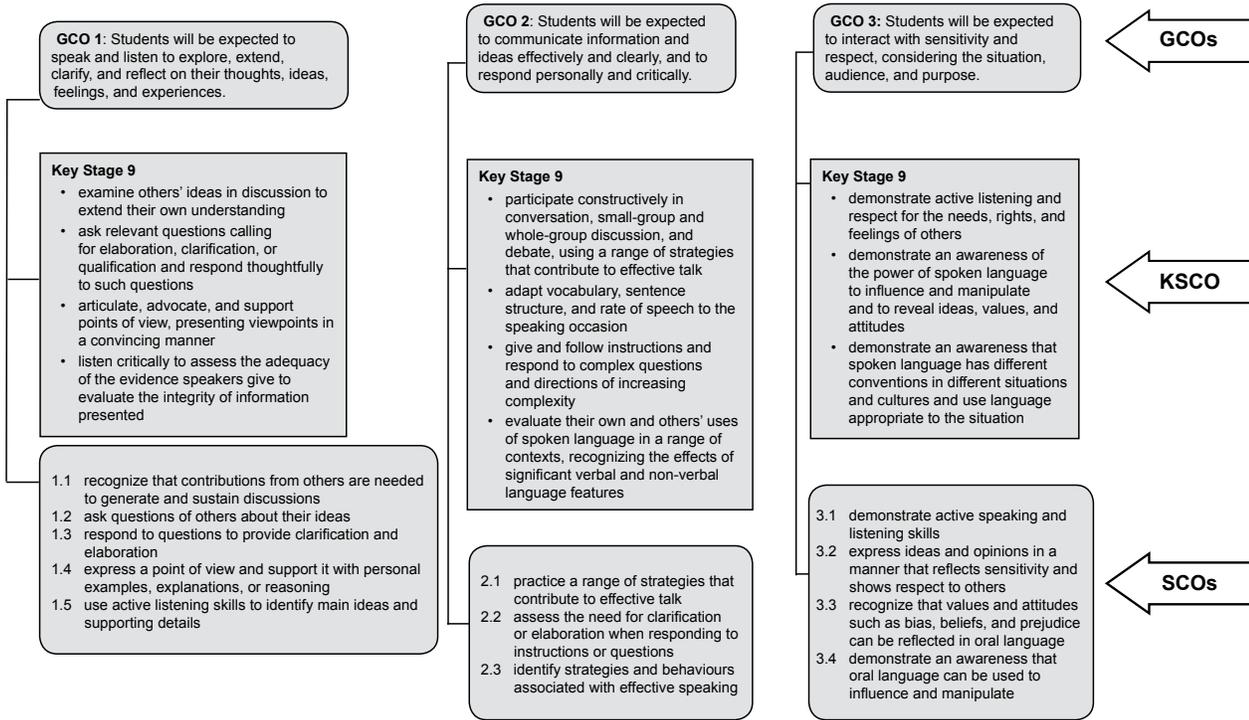
Suggestions for instruction and assessment are organized sequentially:

- **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

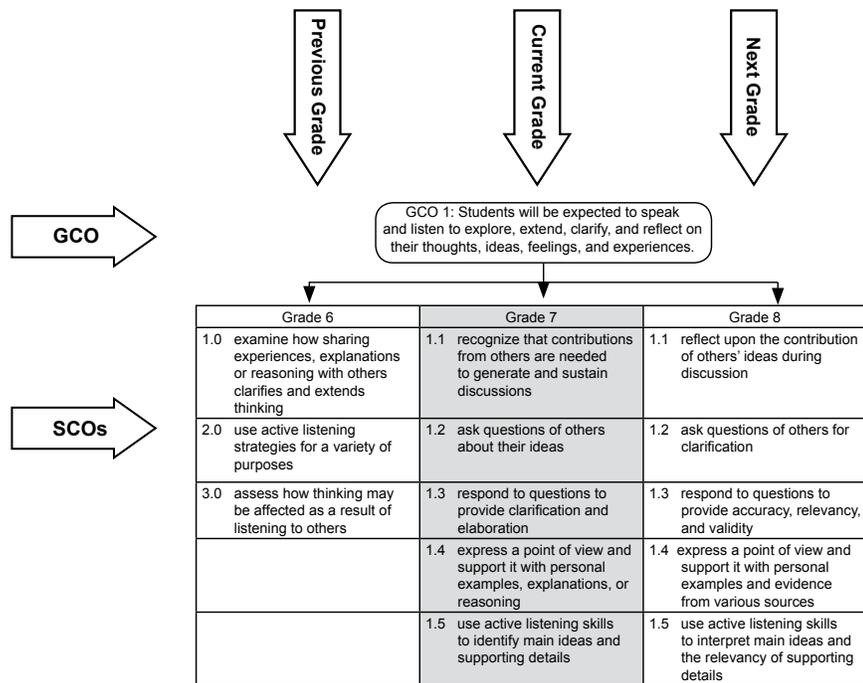
These suggestions provide opportunities for differentiated learning and assessment.

How to use a Strand overview

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



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 define objects and events in investigations
- 5.0 identify and control major variables in investigations
- 6.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate
- 7.0 devise procedures to carry out a fair test and to solve a practical problem
- 8.0 identify appropriate tools, instruments, and materials to complete investigations
- 9.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
- 10.0 select and use tools
- 11.0 follow procedures
- 12.0 make observations and collect information that is relevant to the question or problem
- 13.0 record observations
- 14.0 identify and use a variety of sources and technologies to gather relevant information
- 15.0 use tools and apparatus in a manner that ensures personal safety and the safety of others
- 16.0 construct and use devices for a specific purpose
- 17.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
- 18.0 compile and display data
- 19.0 identify and suggest explanations for patterns and discrepancies in data
- 20.0 evaluate the usefulness of different information sources in answering a question
- 21.0 draw a conclusion that answers an initial question
- 22.0 suggest improvements to a design or constructed object
- 23.0 identify potential applications of findings
- 24.0 identify new questions or problems that arise from what was learned
- 25.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations
- 26.0 communicate procedures and results
- 27.0 ask others for advice or opinions

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
<ul style="list-style-type: none"> pose questions that lead to exploration and investigation identify problems to be solved 	<ul style="list-style-type: none"> propose questions to investigate and practical problems to solve 	<ul style="list-style-type: none"> identify questions to investigate arising from practical problems and issues
	<ul style="list-style-type: none"> rephrase questions in a testable form 	<ul style="list-style-type: none"> rephrase questions in a testable form and clearly define practical problems
<ul style="list-style-type: none"> predict based on an observed pattern 	<ul style="list-style-type: none"> state a prediction and a hypothesis 	<ul style="list-style-type: none"> state a prediction and a hypothesis based on background information or an observed pattern of events
	<ul style="list-style-type: none"> define objects and events in investigations 	<ul style="list-style-type: none"> formulate operational definitions of major variables and other aspects of their investigations
	<ul style="list-style-type: none"> identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate 	<ul style="list-style-type: none"> propose alternative solutions to a given practical problem, select one, and develop a plan
<ul style="list-style-type: none"> identify materials and suggest a plan for how they will be used 	<ul style="list-style-type: none"> identify and control major variables in investigations 	<ul style="list-style-type: none"> design an experiment and identify major variables
<ul style="list-style-type: none"> select and use materials to carry out their own explorations and investigations 	<ul style="list-style-type: none"> identify appropriate tools, instruments and materials to complete investigations 	<ul style="list-style-type: none"> select appropriate methods and tools for collecting data and information and for solving problems
	<ul style="list-style-type: none"> devise procedures to carry out a fair test and to solve a practical problem carry out procedures to explore a given problem and to ensure a fair test, controlling major variables 	<ul style="list-style-type: none"> carry out procedures controlling the major variables
<ul style="list-style-type: none"> use appropriate tools 	<ul style="list-style-type: none"> select and use tools 	<ul style="list-style-type: none"> use instruments effectively and accurately for collecting data
<ul style="list-style-type: none"> follow a simple procedure 	<ul style="list-style-type: none"> follow procedures 	

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
<ul style="list-style-type: none"> make and record observations and measurements 	<ul style="list-style-type: none"> make observations and collect information that is relevant to the question or problem record observations 	<ul style="list-style-type: none"> organize data using a format that is appropriate to the task or experiment
<ul style="list-style-type: none"> use a variety of sources of science information 	<ul style="list-style-type: none"> identify and use a variety of sources and technologies to gather relevant information 	<ul style="list-style-type: none"> select and integrate information from various print and electronic sources or from several parts of the same source
	<ul style="list-style-type: none"> use tools and apparatus in a manner that ensures personal safety and the safety of others 	<ul style="list-style-type: none"> select and use apparatus and materials safely
	<ul style="list-style-type: none"> construct and use devices for a specific purpose 	
<ul style="list-style-type: none"> use personal observations when asked to describe materials and objects sequence or group materials and objects identify the most useful method of sorting 	<ul style="list-style-type: none"> classify according to several attributes and create a chart or diagram that shows the method of classifying 	<ul style="list-style-type: none"> use or construct a classification key
<ul style="list-style-type: none"> construct and label concrete-object graphs, pictographs, or bar graphs 	<ul style="list-style-type: none"> compile and display data 	<ul style="list-style-type: none"> compile and display data, identify the strengths and weaknesses of different methods of collecting and displaying data
<ul style="list-style-type: none"> identify and suggest explanations for patterns and discrepancies in objects and events 	<ul style="list-style-type: none"> identify and suggest explanations for patterns and discrepancies in data 	<ul style="list-style-type: none"> interpret patterns and trends in data, and infer and explain relationships among the variables identify, and suggest explanations for, discrepancies in data
<ul style="list-style-type: none"> distinguish between useful and not useful information when answering a science question 	<ul style="list-style-type: none"> evaluate the usefulness of different information sources in answering a question 	<ul style="list-style-type: none"> apply given criteria for evaluating evidence and sources of information

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
<ul style="list-style-type: none"> propose an answer to an initial question or problem and draw a simple conclusion 	<ul style="list-style-type: none"> draw a conclusion that answers an initial question 	<ul style="list-style-type: none"> state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea
<ul style="list-style-type: none"> compare and evaluate personally constructed objects 	<ul style="list-style-type: none"> suggest improvements to a design or constructed object 	<ul style="list-style-type: none"> evaluate designs and prototypes in terms of functionality, reliability, safety, efficiency, use of materials, and impact on the environment
	<ul style="list-style-type: none"> identify potential applications of findings 	<ul style="list-style-type: none"> identify and evaluate potential applications of findings
<ul style="list-style-type: none"> pose new questions that arise from what was learned 	<ul style="list-style-type: none"> identify new questions or problems that arise from what was learned 	<ul style="list-style-type: none"> identify new questions and problems that arise from what was learned
<ul style="list-style-type: none"> communicate while exploring and investigating communicate procedures and results 	<ul style="list-style-type: none"> communicate questions, ideas, and intentions, and listen to others while conducting investigations communicate procedures and results ask others for advice or opinions 	<ul style="list-style-type: none"> receive, understand, and act on the ideas of others communicate questions, ideas, intentions, plans, and results

Suggested Unit Plan

The *Integrated Skills* unit is not intended to be taught as a stand alone unit. Rather, 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 while engaging in science inquiry investigations, design and problem solving experiences, and decision making processes.

September	October	November	December	January	February	March	April	May	June

Integrated Skills

Initiating and Planning

Outcomes

Students will be expected to

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

2.0 rephrase questions in a testable form [GCO 2]

Focus for Learning

Science begins with a question; engineering begins with a problem. Students are expected to suggest questions to investigate and identify problems to solve. Respectively, these are the first stages of science inquiry and engineering design and problem solving processes.

This skill was previously addressed in Science 4 and 5. It is applied in new contexts (i.e., space, flight, electricity, biodiversity), in Science 6.

Student proposed questions and problems flow from their personal observations, prior knowledge, and experiences. They will experience difficulty coming up with them if simply asked to brainstorm them at the outset. Students should be engaged in meaningful and purposeful experiences to facilitate questioning and problem identification. They should be encouraged to propose questions that can be investigated and practical problems that can be solved.

Encourage students to willingly observe, question, explore, and investigate. Where possible, questions investigated and problems solved should be suggested by students.

To initiate experimental investigations, students are expected to rephrase their 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.

Testable questions are about changing one variable to see the affect on another. They have two parts; a variable to test and a variable to measure or observe:

- What is the effect of ___ on ___?
- What is the relationship between ___ and ___?
- How does changing ___ affect ___?

Students should identify the variable to test as the independent variable and the variable measured or observed as the dependent variable.

Initial Question	Testable Question
How does the weight of a flying device affect flight?	How does adding paper clips to the nose of a paper glider affect the distance it travels?
How does drag affect a paper helicopter ?	What is the effect of rotor length on the amount of time it takes a paper helicopter to fall?
How can we change the strength of an electromagnet?	How does changing the number of coils around a nail affect the number of paper clips it can attract?
Does the shape of a bird's beak determine what it eats?	How does changing the shape of a model beak affect the types of materials it can pick up?

Initiating and Planning

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Discuss “What is Science?”, “What is 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. Provide students with a balloon and various materials, for example, and propose aloud questions to investigate (e.g. I wonder how increasing the number of times you rub a balloon against your hair affects the amount of time it stays attached to a wall? I wonder how rubbing different materials against a balloon will affect how many pieces of confetti it will pick up?)
- Model proposing practical problems from observations. Observe different animals, for example, and wonder aloud as to why birds have wings, fish have fins, or mammals have fur.
- Provide examples of rephrased testable questions. Rephrase “I wonder how drag affects a paper helicopter?” as “What effect would making the rotors longer have on flight”?

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

- Identify problems with lift in a flying device and propose testable questions to investigate.
- Propose questions to investigate about the adaptations of local animals.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 3.0 state a prediction and a hypothesis
[GCO 2]

- 4.0 define objects and events in investigations
[GCO 2]

Focus for Learning

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 might happen in the future. They 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. A hypothesis includes a prediction (i.e., “If..., then...”) and an explanation (i.e., “because...”).

Example:

- If a light bulb is unscrewed in a series circuit, then the other light bulbs will go out because the electrical pathway is broken.
- If air is blown between two balloons, then they will move together because of the higher pressure on the opposite side of the balloons.

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. 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.

Students are expected to define objects and events, within investigations, to facilitate effective communication. Use of consistent definitions among groups allows for the comparison of results when investigating. Students could, for example, define

- the distance a paper glider flies as the distance between the release point and where it first strikes the ground or finally comes to rest, measured in metres with a trundle wheel or by counting floor tiles;
- weight added to a flying device as paper clips or coins;
- terminology used to describe the parts of a flying device (e.g., wings, propellers, rotors); and
- the number of coils to create an electromagnet as 5, 15, and 30 or 10, 20, and 30.

Initiating and Planning

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to make predictions about the effect of adding more coils of wire to an electromagnet, the result of adding weight to a flying device, the effect of drop height on a crater size.

Connection

Teachers may

- Distinguish between guessing and predicting.
- Model making predictions and communicate the reasoning behind each prediction. Use the “If..., then...” format for predictions and the “If..., then... because...” format for hypotheses.
- Intentionally make predictions that will be rejected by evidence 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 experience?
- Ask students how they are defining objects and events in investigations. If investigating the distance a paper glider flies, for example, ask how they are defining distance (i.e., they should determine what the start and end points are and the unit of measure).

Students may

- Use “If..., then...” and “If..., then... because...” formats 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:
 - How does increasing the number of coils in an electromagnet affect its strength?
 - How does weight affect the distance a paper glider will travel?

Consolidation

Students may

- Predict the direction of movement of an object in a Bernoulli’s demonstration.
- Collaboratively define terminology for the parts of a constructed flying device.

Resources and Notes

Authorized

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 5.0 identify and control major variables in investigations [GCO 2]

Focus for Learning

Conditions or factors that could affect the results of an investigation are called variables. Students are expected to identify the independent, dependent, and controlled variables in investigations.

The independent variable is the variable the experimenter chooses to test; it is changed by the experimenter. An experiment is a test to determine if changing the independent variable has an effect on another variable (i.e., dependent variable). The dependent variable is observed or measured by the experimenter during the experiment. All other variables that could affect the result of the experiment must be controlled (i.e., they need to be kept the same for each test).

Example 1

In an experiment modelling how space objects (asteroid, meteoroid or comet) create impact craters, students should identify the size of a marble (space object) as the independent variable (i.e., variable to test) and the size of a crater as the dependent variable (i.e., variable to measure). Students could suggest the following variables to control

- each marble is dropped from the same height,
- each marble starts from resting position,
- same angle of attack for each release point,
- same material the marble is dropped into, and
- same amount and depth of material the marble is dropped into.

Example 2

In an experiment to determine the effect of weight on the distance a paper glider travels, students should identify weight (the number of paper clips or coins added) as the independent variable and distance the paper glider travels as the dependent variable. Students could suggest the following variables to control

- use the same type weight (paper clips or similar objects),
- use the same force to throw the paper glider,
- same angle of attack
- same person throws the paper glider, same person measures the distance
- use the same measuring device (metre stick, measuring tape),
- same measurement technique (release point to first landing or final resting place)
- same testing location.

Identifying variables in investigations was introduced in Science 5.

Initiating and Planning

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Provide testable questions. Ask students to identify the independent (IV) and dependent variable (DV) in each question and at least two controlled variables (CVs).
 - What effect does the release height of a “space object” have on the size of an impact crater? (*IV - release height, DV - size of impact crater, CVs - marble starts at resting position, marble is dropped in same material, same size and mass of marble*)
 - How does rotor length affect the amount of time the paper helicopter stays in the air? (*IV - rotor length, DV - time in air, CVs - same paper used to make helicopters, same basic design followed with differing rotor lengths, same location of each release, and same release height*)
 - Which material (e.g., tissue paper, paper, card stock) creates a more effective airfoil? (*IV - material, DV- height airfoil travels up a string, CVs - same size of airfoil, same amount of tape used to create airfoil, and same location*)
 - Does weight affect the distance a paper glider travels? (*IV - weight, i.e., coins or paper clips, DV - distance, CVs - same location of release, same type of weight, same angle of attack, same force used to throw the paper glider, same measuring device, and same measurement technique*)
 - Does the number of coils on an electromagnet affect its strength? (*IV- number of coils, DV - strength i.e., how many paper clips it can pick up CVs - same type and size of nail, same type and size of paper clips and same type of wire*)

Students may

- Brainstorm controlled variables for investigations.
- Create a foldable to differentiate among the independent, dependent, and controlled variables in investigations. The foldable could be used as an anchor chart for future investigations.

Consolidation

Students may

- Identify and control major variables when investigating
 - the effect of forces on flying devices,
 - how space object size affects depth of an impact crater,
 - how the number of coils affects the strength of an electromagnet.

Resources and Notes

Authorized

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 6.0 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 the moon in the night sky or observing various vertebrates obtaining food in their natural habitat);
- surveys (e.g., survey the types of plants in a given area, survey the types of microorganisms found in a drop of pond water);
- 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 repeated 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

Activation

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 species endangerment or extinction, for example, could be prevented by reducing the amount of habitat destruction that is allowed, restrict hunting of the species or regulate the hunting of their prey. Ask students to consider the costs and benefits of various methods.

Students may

- Brainstorm various ways to find answers to the following:
 - When is the next full moon, solar eclipse, or lunar eclipse?
 - Which invertebrate organisms live in our coastal and ocean habitats? What plants live in a particular area?
- Brainstorm various ways to solve the following:
 - How can we create a Frisbee™ with more lift?
 - How could we improve spacesuits to help astronauts pick up items more effectively?

Consolidation

Students may

- Select an appropriate method to find answers to a question about factors that affect the characteristics of craters.
- Select an appropriate method to reduce the mass of a flying device without affecting its flight.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

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

Focus for Learning

Students are expected to develop procedures to investigate questions and solve practical problems. Students should devise procedures with clear, ordered steps that can be replicated.

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 the size of a space object (marble) affect the size of an impact crater?
Independent Variable	Size of the space object (i.e., variable to test)
Dependent Variable	Size of the impact crater (i.e., variable to measure)
Controlled Variables	<p>Variables that must be kept the same</p> <ul style="list-style-type: none"> • each marble is dropped from the same height, • each marble starts from resting position, • same angle of attack for each release point, • same material that the marble is dropped into, • same amount and depth of material the marble is dropped into.

To be a fair test, identical procedures must be uniformly performed, where only one variable, the independent variable, is changed. Fair testing also requires investigations to be free of bias (i.e., feelings favouring a particular outcome). Personally hoping for a bigger marble to make a bigger impact crater, for example, may introduce bias into an investigation. Students should recognize the potential for bias and devise procedures to eliminate or reduce it (e.g., random sampling, blind testing, repetition, detailed measurement procedures).

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, able to be replicated, 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

Connection

Teachers may

- Ask students to devise procedures for everyday tasks (e.g., sharpening a pencil, measuring air temperature, doing a jumping jack). Request a specific student read aloud their procedure while you attempt to carry it out. Act confused when the procedure is unclear, lacks detail, or fails to include a necessary step. Provide opportunities for the student to orally revise their procedure.
- Orally direct a simple drawing activity, where students are expected to replicate an unseen drawing. Intentionally use unclear instructions. Once completed, show them the original drawing and have them compare it with their own drawing. Repeat the activity for another drawing using clear, detailed instructions.
- Provide unordered procedural steps and ask students to appropriately sequence them.
- 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 major 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
 - redesign an electrical circuit;
 - build a flying device;
 - test the strength of an electromagnet; and
 - choose a variable to test how a space object affects the size of a crater.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 8.0 identify appropriate tools, instruments, and materials to complete investigations [GCO 2]

Focus for Learning

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 the tools, measuring instruments, and materials needed to conduct investigations.

Sometimes the materials, tools, and instruments needed for investigations are provided by the teacher. However, to address this outcome, students should identify and select them.

Tools and instruments used in Science 6 include, but are not limited to

- scientific tools - beaker, graduated cylinder, digital camera, microscope, electroscope, telescope, conductivity meter, dichotomous key, field guide, microscope slide, cover slip, eye dropper;
- measurement tools - electronic scale/balance, metre stick, ruler, trundle wheel, timer, ammeter, voltmeter;
- materials to construct electric circuits - light bulb, wire, electric cell, battery, snap circuit kit, motor, switch, buzzer, alligator clip;
- construction tools - hammer, hacksaw, pliers, scissors, screw driver, clamps, utility knife, wrench, and
- safety materials - safety goggles, gloves.

Students should identify the most appropriate material, tool, or instrument for a task and provide a rationale for their selection.

This outcome can also be addressed in the context of design and problem solving experiences.

Initiating and Planning

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 an inappropriate tool, measuring instrument, or material for a task is selected (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 building a flying device, for example, ask students to select the materials they wish to use from a collection of varied materials.
- 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 tasks.
- 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 appropriate materials, tools, and measuring instruments, when investigating
 - the effect of surface materials on crater size
 - the types of microorganisms found in a drop of pond water,
 - the effect of weight on the distance a paper glider flies, and
 - the conductivity of various materials.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

10.0 select and use tools [GCO 2]

Focus for Learning

Students are expected to carry out investigative and design and problem solving procedures in a manner that ensures fair testing and controls major variables of influence.

Students should recognize the potential for bias (i.e., favouring a particular outcome) when carrying out procedures. When testing paper airplanes, for example, releasing a favoured plane with more force is biased. 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 the accuracy and reliability of results. Students should, when possible, repeat trials at least three times (more is better). 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.

In Science K-3, students selected and 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., beakers, eye droppers, funnels, graduated cylinders, magnets, magnification tools, stethoscope);
- construction tools (e.g., clamps, crowbars, hacksaws, hammers, pliers, screwdriver, screw jack, wrenches, utility knives);
- household tools (e.g., glue gun, scissors, tongs, toothpicks, tweezers); and
- digital tools (e.g., digital cameras, computer programs, and mobile device applications).

Sometimes the tools needed to complete a task are provided by the teacher. To address this outcome, however, students must select the tools they need. They should use these tools safely and correctly. The 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

Activation

Teachers may

- Act out situations where procedures are not fairly carried out and ask students to identify the problem.
- Review the role of controlled variables in experiments.

Connection

Teachers may

- Measure and record the distance a constructed flying device travels, then repeat the measurement at least twice more to highlight the importance of conducting multiple trials.
- Assess whether students carry out procedures to ensure a fair test, using direct observations or digital video.

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 instances where variables were not controlled.
- Provide reasons for their tool choice and describe any difficulties encountered while using the tool.
- Compare the tools used by different groups and evaluate their effectiveness for the task.

Consolidation

Students may

- Carry out procedures to model day and night or the seasons.
- Carry out fair-testing procedures when investigating
 - factors affecting crater size,
 - the effect of rotor length on drag of a paper helicopter,
 - how forces affect flying devices, and
 - the effect of the number of coils on the strength of an electromagnet.
- Select and use tools to conduct an investigation on the conductivity of materials.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

11.0 follow procedures
[GCO 2]

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

Focus for Learning

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 (e.g., fire evacuation procedures).

In Science 4-6, students are expected to make observations and collect information relevant to the question being investigated or the 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. Explicit instruction and practice will be needed, however, to make 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 appropriate, 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., appearance, attraction or repulsion, colour, conductivity, if the bulb lights up, presence or absence of body features, shape, texture).

Connections may be made with collecting information for a descriptive writing piece (English Language Arts 6).

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Students may

- Play “Simon Says” and barrier games to practice following procedures accurately.
- Practice observing and describing objects using appropriate senses.

Connection

Teachers may

- Differentiate between qualitative observations and quantitative measurements.
- Ask students to make quantitative and qualitative observations of a focus object (e.g., arthropod) using personally selected tools and measuring instruments.

Students may

- Complete a 5 senses graphic organizer for a plant leaf.
- Brainstorm relevant measurements, observations, and information that can be collected to answer a question or solve a problem.
- Classify observations as quantitative or qualitative.

Consolidation

Students may

- Follow teacher-provided procedures to
 - explore Bernoulli’s Principle,
 - create static electricity,
 - construct and use an electroscope to detect static charges,
 - construct a simple circuit, and
 - explore the difference between static and current electricity.
- Make observations and collect information relevant to
 - the Moon phases
 - the characteristics of objects in the solar system
 - the effectiveness of a constructed flying device,
 - Bernoulli’s Principle
 - test the conductivity of different materials, and
 - the organisms you can find in a sample of pond water.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

13.0 record observations
[GCO 2]

Focus for Learning

Observations capture a moment in time. To be analyzed and interpreted, observations must be recorded for future use. Records may take various forms

- written descriptions and drawings;
- digital images, video, and audio recordings captured with mobile device technology;
- two column observational notes (i.e., time and observations); and
- charts (tally charts, tables).

Sometimes, teachers direct students to record their observations a specific way and provide them with a recording form. Other times, students should record observations in a format of their choosing and create their own recording form. They should consider the type of measurements, observations, and information being collected and choose an appropriate recording format. Explicit instruction on the use and appropriateness of common formats may be required.

Qualitative observations may be recorded using written descriptions, observational notes, drawings, digital photographs, video, or audio recordings. If exploring what can be observed about microorganisms to indicate that they are living things, for example, students could use observational notes, drawings, or video to record observations. If investigating the phases of the moon, observational notes, drawings, or digital photographs could be used.

Quantitative observations may be recorded as written descriptions, however, more structured recording formats (i.e., tables, charts) are preferred. Tables allow large amounts of data to be neatly organized into columns and rows and facilitate future interpretation and analysis. Students should be encouraged to create their data table before making observations and collecting data. Observations related to the frequency of an object or event should be recorded in a tally chart.

Encourage students to appreciate the importance of accuracy and honesty in recording, whether investigating questions or solving problems.

Connections may be made to outcomes from the Mathematics 6 *Data Relationships* and *Probability* units.

Performing and Recording

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Explicitly instruct students on the use and appropriateness of common recording formats other than written descriptions
 - scientific drawings,
 - tables,
 - tally chart, and
 - two column observation notes.
- Use observations recorded in tally charts and tables, from science investigations, as authentic data in the *Data Relationships* and *Probability* units of Mathematics 6.

Students may

- Consider various methods of recording observations and select one that is appropriate for the measurements, observations, or information being collected. Communicate the reasoning behind the selected format.
- Compare and critically evaluate the effectiveness of recording methods used by different groups.

Consolidation

Students may

- Select and use an appropriate format to record observations related to
 - what is viewed, using a microscope, in a sample of pond water;
 - a group of arthropods;
 - phases of the Moon;
 - examples of Bernoulli's Principle; and
 - how object size affects the size of impact craters.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

15.0 use tools and apparatus in a manner that ensures personal safety and the safety of others [GCO 2]

Focus for Learning

Students should, as part of research inquiry, identify and use a variety of sources and technologies to gather relevant information.

There are many sources of science information

- human resources (e.g., expert interviews, observations)
- media (radio, television broadcasts)
- online resources (e.g., blogs, digital versions of print resources, ebooks, multimedia, web pages); and
- print resources (e.g., almanacs, encyclopedias, field guides, journals, magazines, newspapers, non-fiction books, pamphlets, reports).

Depending on the question being researched, different sources will be used to gather relevant information. Encyclopedias, for example, are used when seeking general, background information. Non-fiction books provide detailed information on specific topics. If enquiring about a current science-related event, magazines, media, and newspaper articles could provide relevant information.

Finding relevant sources of information involves the use of search technologies (i.e., search engines). Explicit instruction in the use of these technologies will help students become better searchers.

Students should be aware of potential dangers of Internet use. Before using an online source to search for information, they should assess its validity.

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.

In Science K-3, students selected and used tools to make observations, manipulate materials, and build simple models. In Science 6 they are expected to use tools and apparatus to complete tasks in a safe manner.

When constructing circuits, students should handle electric cells, batteries, bulbs, and wires safely. They should wear safety glasses and gloves when using tools to construct and build flying devices. To carry a microscope, students should use the arm and when viewing specimens, only use the coarse focus knob on low power. If preparing their own microscope slides to view, they should handle the glass slides, cover slips, and specimens with care.

Routines for safe use of tools and apparatus should be clearly established at the beginning of the year and reviewed whenever students are completing tasks that require the use of tools or apparatus.

Encourage students to follow safety procedures at all times and show concern for their personal safety and that of others.

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide images that include unsafe practices and ask students to identify the potential hazards.
- Show instructional videos on the safe use of various tools and apparatus.

Students may

- Brainstorm sources of science information.

Connection

Teachers may

- Role play unsafe use of a tool or apparatus and ask students to orally identify the unsafe practice and describe how to use it appropriately.
- Review potential sources of science information (e.g., field studies, surveys, modelling, experiments, prototype testing, interviews, questionnaires) and technologies (e.g., magnification tools, measuring tools, mobile device technologies) used to gather relevant information.
- Create a list of safety tips for using tools and apparatus safely.

Students may

- Practice collecting measurements, observations, and information using various magnification tools, measuring tools, and digital technologies.
- Create a poster to instruct others on safe use of a specific tool or apparatus.

Consolidation

Students may

- Identify and use a variety of sources and technologies to gather relevant information about the characteristics of planets in our solar system, endangered species, or vertebrate organisms.
- Demonstrate safe use of tools and apparatus when
 - constructing flying devices,
 - constructing circuits, and
 - using a microscope.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

Focus for Learning

Technologies (i.e., devices) are constructed to help solve specific problems. In Science 6, students are expected to personally construct and use devices for a specific purpose. Opportunities to construct devices exist in each of the four content units (e.g., models of the Sun, Earth and Moon, flying devices, circuits, fossilization models).

Devices should be constructed by students following a plan or procedure that is provided or devised by students as part of an engineering design and problem solving process.

Prior to construction, students should review all plans, procedures, and design sketches, if applicable. They should ensure that they know how to appropriately and safely use all required tools and apparatus. All required materials and tools should be gathered, inspected, and prepared for construction.

Students may encounter problems during construction of their device, particularly if constructing a prototype from a personally devised plan. Problems encountered may require changes to their construction plan (e.g., design changes, use of different tools or materials). Students should recognize that first attempts to solve problems by constructing a device are rarely successful. Typically, repeated (i.e., iterative) changes, modifications, and retesting are required to construct a useful device.

Encourage students to follow safety procedures when constructing devices and show concern for their safety and that of others.

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Students may

- Observe and manipulate unfamiliar devices and infer for what purpose they may be used (e.g., carpenter's pencil, egg yolk separator, garlic press, letter opener, lint brush, shoe horn).

Connection

Teachers may

- Display an anchor chart of an engineering design and problem solving process for students to follow.
- Model the design and problem solving process in solving practical problems encountered in the classroom.
- Create a makerspace within the classroom and provide a wide variety of construction tools and materials for student use.

Students may

- Personally construct devices at the classroom makerspace.

Consolidation

Students may

- Follow provided instructions to personally construct a(n)
 - electroscope,
 - electromagnet,
 - series and parallel circuits,
 - paper airplane, or
 - paper helicopter.
- Follow an engineering design and problem solving process to personally construct a(n)
 - electromagnet with enhanced magnetic abilities;
 - parachute with sufficient drag to protect an attached egg from breaking;
 - Frisbee™;
 - working flashlight;
 - models of the Earth, Sun, and Moon;
 - model spacesuit arm to use in investigations; or
 - model of the fossilization process.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Analyzing and Interpreting

Outcomes

Students will be expected to

17.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
[GCO2]

18.0 compile and display data
[GCO2]

Focus for Learning

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. Animals, for example, may be classified as vertebrates or invertebrates, by physical characteristics (i.e., body covering, number of legs, wings), and how they reproduce (i.e., lay eggs, live birth). Classifying using multiple attributes is a challenging skill that requires explicit instruction and practice.

Classification is a method of analysis and interpretation. Students should create a chart or diagram to show their classification method (e.g., dichotomous key, tree diagram, Venn diagram, Carroll diagram).

This skill pertains to organizing and displaying collected observations, measurements, and information (i.e., data) from inquiry investigations and design and problem solving experiences. Compiling and displaying data makes it easier to identify and communicate patterns and relationships.

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 (e.g., Apple Numbers, Google Sheets, Microsoft Excel). Teachers should limit, if possible, the types of graphs encountered to those addressed in the Mathematics program (i.e., pictograph, bar graph, double bar graph, line graph).

Selecting the most effective format to compile and display data is challenging. The type of graph used, for example, depends on the data being displayed. Bar graphs are used to compare data organized into categories (e.g., the distance a glider travels for each trial). Double bar graphs allow two or more data sets to be displayed on the same graph (e.g., distance travelled by two different gliders). Line graphs are used to represent changes in data, often over time. The growth of a tomato plant, for example, would be represented by a line graph. Double line graphs allow the changes in two different groups to be compared. For line graphs, students should determine if the data points should be connected or not (i.e., is the data discrete or continuous).

Cross curricular connections may be made to Mathematics 6 outcomes in the *Data Relationship* unit.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Model classifying items according to multiple attributes at one time (e.g., sorting Lego™ pieces by colour and size).

Students may

- Recall methods used to classify rocks in Science 4.
- Classify a collection of school supplies according to a student generated classification system.

Connection

Teachers may

- Provide explicit instruction on the use of Venn diagrams, Carroll diagrams, T-charts, and tables when classifying items.
- Introduce items that do not fit neatly within student classification schemes and have them modify their scheme accordingly (e.g., adding a platypus to their classification scheme for birds).
- Review how to use frequency tables, data tables, pictographs, bar graphs, and double bar graphs to display data, by hand or using computer or mobile device applications (e.g., Apple Numbers, Google Sheets, Microsoft Excel).

Students may

- Practice, in non-science contexts, classifying items according to several attributes at one time (e.g., gym equipment, library books, playing cards, trading cards) and create a diagram or chart to show the method of classifying.
- Compile authentic data (e.g., day length on different planets, drop time for various parachute prototypes, tide height at various times of the day, the frequency of visits to a feeder by different species of birds) and discuss appropriate formats to display the data (e.g., frequency table, data table, pictograph, bar graph, or double bar graph), by hand or with the use of a computer.
- Provide reasons for their selected data display format.
- Compare and critically evaluate the effectiveness of formats used by different groups to compile and display data.

Consolidation

Students may

- Classify animals as mammals, reptiles, birds, fish or amphibians.
- Compile and display data collected from investigations to determine
 - the Moon phases
 - the effect of marble size on the size of a crater, and
 - the distance a paper glider will travel.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6 (ELA 6)*
 - Analyzing Strategy Unit

Analyzing and Interpreting

Outcomes

Students will be expected to

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

Focus for Learning

In Science K-3, students identified patterns and discrepancies in objects and events. In Science 6, students are expected to identify and suggest explanations for patterns and discrepancies in data.

Patterns refer to general trends (e.g., the larger the asteroid the larger the impact crater, the more weight you add to a paper glider the less distance it will travel). Patterns are not always immediately obvious. They are easier to identify, however, when data is compiled and visually displayed in tables and graphs. Students should identify patterns, describe relationships in words, and suggest reasonable explanations for them.

Discrepancies refer to unexpected data; observations or measurements 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 procedural and measurement errors, or uncontrolled variables. They are referred to as 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 used may identify possible sources of error and provide plausible explanations for identified differences. Reviewing video recordings of groups carrying out investigative procedures may aid in the identification of potential sources of error.

Cross curricular connections may be made to Mathematics 6 outcomes in the *Data Relationship* unit.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

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 any discrepancies?
 - Is your data similar to that of other groups? If not, why not?
 - How could you improve the accuracy and reliability of your data?

Students may

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

Consolidation

Students may

- Analyze and interpret data to identify patterns and discrepancies when
 - investigating the size of impact craters in relation to the size of a crater,
 - measuring the distance a paper glider travels as more weight is added,
 - investigating the effect of drag on a paper helicopter when one variable is changed, and
 - investigating how the number of coils on an electromagnet affects its magnetic strength.

Resources and Notes

Authorized

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6 (ELA 6)*
 - Analyzing Strategy Unit

Analyzing and Interpreting

Outcomes

Students will be expected to
20.0 evaluate the usefulness of different information sources in answering a question
[GCO 2]

Focus for Learning

Students are expected, as part of research inquiry, to identify and use varied sources to gather relevant information (i.e., SCO 14.0). Additionally, students should evaluate the usefulness of sources (e.g., human resources, media, online resources, print resources) in answering a question.

To determine the usefulness of a source, students should ask questions such as the following:

- Who is the author or developer of the information? What are their qualifications? Are they knowledgeable experts in their field?
- Who is sponsoring the printed resource or website? Are they well known companies, organizations, universities, or government agencies?
- Is the information accurate? Can it be corroborated by other reliable sources?
- Is the information current? Does the resource provide a recent publication date?
- Is the information suitable for use by a Grade 6 student? Does the information make sense? Can it be understood?
- Are sources biased? Do all sides of an issue receive equal treatment? Are there reasons why the information might be biased? Are important facts left out?

Students should be critical consumers of information. While multiple sources may provide information relevant to answering a question, only the most trustworthy sources should be used. Information about the characteristics of objects in the solar system, for example, can be gathered from a wide variety of non-fiction texts and websites. Students should critically evaluate these sources and use only those most trusted.

Cross curricular connections may be made to English Language Arts 6 SCO 17.0 (i.e., evaluate information from a variety of selected sources [GCO 5]).

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present students with a variety of nonfiction texts and websites that could be used to answer questions related to the characteristics of objects in the solar system. Facilitate a discussion to critically evaluate each sources to determine whether it is trustworthy.

Connection

Teachers may

- Create a checklist for evaluating the usefulness of an information source.
- Present various TV commercials to students, and ask students what useful information it presents. Alternatively, students could suggest which questions it could answer, and for which questions it would be a poor source of information.
- Inform students that the class will be receiving a new class pet and they need to learn how to care for it. Ask them to research information sources and evaluate the usefulness of each source.

Students may

- Examine various websites for information about local endangered species and evaluate the usefulness of each information source.

Consolidation

Students may

- Evaluate the usefulness of information sources when researching
 - the characteristics of a planet,
 - a Canadian astronaut,
 - paper airplane designs
 - the history of aviation in Newfoundland and Labrador, and
 - characteristics and adaptation of a specific animal.

Resources and Notes

Authorized

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6 (ELA 6)*
 - Analyzing Strategy Unit

Analyzing and Interpreting

Outcomes

Students will be expected to

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

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

Focus for Learning

In Science K-3, students proposed answers to initial questions and drew simple conclusions based on observations and research. In Science 6, students should draw conclusions following the analysis and interpretation of data.

Conclusions are based on logic and evidence; they answer the initial question. They include a statement indicating if the data supports or rejects the hypothesis. This claim should be justified by providing evidence from the compiled data. If the hypothesis is rejected, students may choose to repeat the investigation to see if any mistakes were made or come up with a new hypothesis to test.

When students communicate their results and conclusions to others they should

- be prepared to defend their conclusion,
- comment on the fairness of the investigation and identify any possible sources of error,
- suggest how the investigation could be improved,
- discuss potential applications of what was learned, and
- identify new questions to investigate.

In Science K-3, students compared and evaluated personally constructed objects with respect to their form and function. In Science 6, students should suggest improvements to a design or constructed object (i.e., technology).

Engineering design and problem solving processes provide opportunities for students to design and construct prototypes. Rarely, is a first attempt successful. Promising prototypes are continuously redesigned, modified, tested and evaluated, in an iterative process to reach an optimal solution.

Prototypes should be evaluated with respect to their function, reliability, aesthetics, safety, and efficient material use. Based on these evaluations, student should recommend design changes and modifications to improve the prototype. Suggestions should be actioned and the prototype should be retested and reevaluated.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Provide a focus object (e.g., paper airplane) and ask students to evaluate it with respect to function, reliability, aesthetics, safety, and efficient use of materials and make suggestions for improvement.
- Provide some examples of flying devices (e.g., types of paper airplanes, Frisbee™, paper helicopters, parachutes, maple seeds) and ask students to evaluate them, select their preferred design, and provide reasons for their choice.
- Use the example of WD-40™ to illustrate the iterative nature of the engineering design and problem solving process; it took 40 attempts to perfect this water displacement technology.

Students may

- Reflect on the following when drawing conclusions:
 - What was the initial question investigated?
 - What was the prediction and hypothesis?
 - Was there a pattern observed in the data? Does it suggest a relationship between the variables?
 - Does the data support or reject the hypothesis?
 - What variables did the procedure control? Are there other variables that were not initially considered?
 - Was the investigation fair? What potential sources of error were identified?
 - How could the procedure be modified for improvement?
 - Why are the results of the investigation important? Who might want to know what was learned?
 - What new questions should be investigated?
- Participate in a gallery walk to view the design sketches, prototypes, or final constructed devices of classmates and provide TAG feedback (i.e., Tell something you like, Ask a question, Give a suggestion).

Consolidation

Students may

- Draw conclusions when exploring what makes an electrical circuit (i.e., wires, battery and a load connected in a pathway)
- Suggest improvements to the design of a(n)
 - electromagnet,
 - model spacesuit arm,
 - flying device, and
 - model to explain eclipses.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6 (ELA 6)*
 - Analyzing Strategy Unit
 - Evaluating Strategy Unit

Analyzing and Interpreting

Outcomes

Students will be expected to

23.0 identify potential applications of findings [GCO 2]

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

Focus for Learning

Students should come to understand that the findings of inquiry investigations have potential applications. Findings may be useful in

- designing new technologies,
- solving practical problems,
- making informed decisions, and
- motivating future scientific investigations.

Students should be asked to identify potential applications whenever communicating the results of investigations and apply those findings to real world scenarios. After determining that faster moving air exerts lower pressure (Bernoulli's Principle), for example, students could be asked:

- Why is this information important?
- What connections can you make between this information and the real world?
- Who might want to know this information?
- How might this information help you or others in your community?
- What technologies have been or could be developed from this information?

In Science K-3, students identified new questions that arose from what was learned. In Science 6, students should identify new questions and problems.

Science begins with a question; engineering begins with a problem.

Investigating science inquiry questions inevitably leads to new questions. As students analyze and interpret data, and draw conclusions to answer initial questions, new questions to investigate will naturally arise.

Similarly, engineering a technological solution to a problem often uncovers, or creates, new problems to solve. As students construct, test, and evaluate prototypes, problems will be encountered. To reach an optimal solution, prototypes must be redesigned and modified to overcome these problems. Once an optimal solution is reached, use of the newly constructed device will naturally lead to the identification of new problems to solve. No technology ever reaches a state of "perfection"; it is continuously redesigned and modified to meet ever changing human needs.

When communicating results of inquiry investigations or a constructed solution to a practical problem, students should routinely be asked to identify what new questions they would like to investigate next or what new problems they would like to attempt to solve.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present stories of accidental discoveries (e.g., Silly Putty™, Teflon™, Penicillin) as examples of unexpected applications of findings.

Connection

Teachers may

- Following completion of inquiry investigations and design and problem solving experiences, ask students to propose new questions or problems to investigate and solve.

Students may

- When communicating the results of inquiry investigations, identify potential applications of their findings and new questions that arise.
- Record new questions to investigate in the More column of a KWLM chart or their personal science learning journal.
- When communicating their constructed solution to a problem, identify new problems that arise from use of the device.

Consolidation

Students may

- Identify potential applications of findings from investigations of Bernoulli's Principle, for example, car spoilers, spray bottles, carburetors, and sailing boats.
- Identify new questions arising from the ways different size aircraft and spacecraft can fly.
- Identify new problems identified through using classification systems used to group living things.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6* (ELA 6)
 - Analyzing Strategy Unit

Communication and Teamwork

Outcomes

Students will be expected to

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

26.0 communicate procedures and results [GCO 2]

Focus for Learning

In Science K-3, students communicated their questions, ideas, and intentions while exploring and investigating. In Science 5, the expectation of “listening to others” as part of effective communication was introduced.

Science and engineering are social enterprises where people work in group settings to investigate questions and solve problems. In these collaborative environments, the ability to listen and communicate so that others understand is an essential skill.

Where 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, using appropriate scientific and technological terminology. They should also actively listen and respond to other members of their group.

Cross curricular connections may be made to English Language Arts outcomes related to the speaking and listening (e.g., use active listening strategies, engage in a range of collaborative discussions).

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 communication related outcomes from the English Language Arts 6 curriculum and the *Data Relationship* unit of Mathematics 6.

Communication and Teamwork

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Have students practice listening skills during a simple activity, for example, one student listens to another and summarizes what they just talked about and try it again with the listener trying to complete a task such as writing a paragraph while listening to the speaker.
- Carry out a procedure to complete a familiar task (e.g. sit in a chair, open a window, sharpen a pencil, turn on an interactive white board) exactly as described by a student. If procedural steps are omitted or lack specificity, carry on in a comical manner to demonstrate failure to complete the task. Provide students opportunities to refine their oral procedures until the task can be completed.

Connection

Teachers may

- Model appropriate communication, using appropriate scientific terminology, and listening skills.
- Encourage students to think aloud; enabling other group members to listen and respond to their questions, ideas, and intentions.
- Assign a manager role within student groups to ensure that members communicate aloud, listen, and respond to each other.
- Digitally record group communication for assessment purposes.

Students may

- Digitally record their group conducting an investigation on how astronauts meet their needs in space through a space suit challenge and then view the video to self assess their communication.

Consolidation

Students may

- Complete peer and self assessments of their communication and listening skills after the space suit challenge.
- Communicate results using appropriate formats when
 - classifying a group of arthropods
 - observing changes in Moon phases over time,
 - investigating how marble size affects the size of impact craters in modelling activities,
 - investigating the affect of added weight on the distance a paper glider travels, and
 - observing difference between series and parallel circuits.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Communication and Teamwork

Outcomes

Students will be expected to
27.0 ask others for advice or
opinions
[GCO 2]

Focus for Learning

In Science 6, students are expected to collaborate with others to investigate questions and find solutions to problems. At times, students may encounter difficulties and be unsure how to proceed (e.g., rephrasing questions in testable forms, defining objects and events in investigations, devising procedures to carry out fair tests, compiling and displaying data, suggesting explanations for patterns and discrepancies in data, suggesting improvements to designs and constructed objects). During these times, students should seek advice or opinions from classmates or other knowledgeable individuals.

Teachers may connect students with knowledgeable adults who might provide expert advice (e.g., engineers, scientists, technologists) by inviting them to the classroom or through the use of technology.

Cross curricular connections may be made to English Language Arts outcomes related to listening critically to the ideas, opinions, and points of view of others. When asking for opinions, students should listen critically to responses and make use of relevant information. Responses may affirm or challenge original ideas and intentions.

Teachers should foster an environment that encourages risk taking; where student are comfortable asking others for and providing constructive advice and opinions.

Encourage students to work collaboratively and to be open minded when receiving advice and opinions from others.

Communication and Teamwork

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate a game of Hedbanz™ or Heads Up™ where students ask questions of others to guess the identity of an object which they can not see (e.g., circuit component, moon phases, planet, vertebrate animal).
- Present “Ask a scientist” videos where experts answer submitted questions.

Students may

- Brainstorm individuals who may be able to provide expert advice or opinion when questions or problems arise.

Connection

Teachers may

- Employ an “Ask 3 Before Me” classroom strategy requiring students to ask questions of classmates before asking the teacher.
- Facilitate opportunities for students to contact experts, through communication technology, to ask for advice or opinions.
- Facilitate opportunities for students to provide TAG feedback (i.e., Tell something you like, Ask a question, Give a suggestion). related to classmates personally devised investigations or constructed devices.

Students may

- Propose questions to ask science-related guest presenters.

Consolidation

Students may

- Ask others for advice and opinions when
 - constructing models of day and night, seasonal cycles, spacesuit arms;
 - constructing flying devices or circuits;
 - creating classification systems and dichotomous keys; and
 - devising fair tests.

Resources and Notes

Authorized

NL Science 6: 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 6: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 6 (ELA 6)*
 - Evaluating Strategy Unit

Section Three:
Specific Curriculum Outcomes

Unit 1: Space

Focus

Space science involves learning about objects in the sky to discover their form, their movements, and their interactions. For students, developing a concept of Earth and space presents a new challenge. It requires extensive experience with models to explore relationships of size, position, and motion of different bodies. In learning about space, students come to appreciate that human ability to observe and study objects in space is greatly enhanced by technology. Students learn that probes and Earth-based devices are contributing to our knowledge of space, and that new capabilities are being developed for monitoring the Earth, for communications, and for further exploration of space.

The *Space* unit emphasizes the relationship between science and technology and has both a science inquiry and design and problem solving focus. Students should have multiple opportunities to design, construct, and use models to demonstrate their understanding of the day/night cycle, the cycle of the seasons, moon phases, eclipses, and tides. Investigating factors that affect the size and appearance of craters provides another opportunity to develop science inquiry skills, specifically those related to fair testing (e.g., identifying and controlling major variables, devising procedures to carry out fair tests). The unit also includes opportunities for student to conduct research inquiry to find answers to questions and to evaluate the usefulness of different information sources.

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.

- 28.0 demonstrate that specific terminology is used in science and technology contexts
- 29.0 describe how evidence must be continually questioned in order to validate scientific knowledge
- 35.0 compare tools, techniques, and scientific ideas used by different people around the world to interpret natural phenomena and meet their needs
- 36.0 demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems
- 37.0 describe scientific and technological achievements that are the result of contributions by people from around the world
- 38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
- 40.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
- 41.0 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.

- 5.0 identify and control major variables in investigations
- 6.0 identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate
- 7.0 devise procedures to carry out a fair test and solve a practical problem
- 10.0 select and use tools
- 13.0 record observations
- 14.0 identify and use a variety of sources and technologies to gather relevant information
- 18.0 compile and display data
- 20.0 evaluate the usefulness of different information sources in answering a question
- 21.0 draw a conclusion that answers an initial question
- 25.0 communicate questions, ideas, and intentions, and listen to others while conducting investigations
- 26.0 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.

- 30.0 describe the physical characteristics of the Sun, planets, and moons
- 31.0 demonstrate how Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons
- 32.0 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for various phenomena
- 33.0 describe the physical characteristics of meteoroids, asteroids, and comets
- 34.0 identify constellations in the night sky
- 39.0 describe how astronauts are able to meet their basic needs in space

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
- recognize that individuals of any cultural background can contribute equally to science
- show interest and curiosity about objects and events within different environments
- 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
- demonstrate perseverance and a desire to understand
- work collaboratively while exploring and investigating
- 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 6	Science 9
<i>Daily and Seasonal Changes</i>	<i>Space</i>	<i>Space Exploration</i>
<ul style="list-style-type: none"> describe changes in heat and light from the Sun describe ways of measuring and recording environmental changes that occur in daily or seasonal cycles investigate and describe changes in living things that occur in seasonal cycles investigate and describe human preparations for seasonal changes 	<ul style="list-style-type: none"> describe the physical characteristics of the Sun, planets, and moons demonstrate how Earth's rotation causes the day and night cycle and Earth's revolution causes the yearly cycle of seasons observe and explain how the relative positions of the Earth, Moon, and Sun are responsible for phenomena describe physical characteristics of meteoroids, asteroids, and comets identify constellations in the night sky describe how astronauts meet their basic needs in space 	<ul style="list-style-type: none"> describe theories on the formation of the solar system describe and classify the major components of the universe describe theories on the origin and evolution of the universe describe and explain the apparent motion of celestial bodies describe the composition and characteristics of components of the solar system describe the effects of solar phenomena on Earth

Suggested Unit Plan

This is the first space science unit students have encountered in the K-12 science program.

September	October	November	December	January	February	March	April	May	June
Space									

Communicating About Space Using Specific Terminology

Outcomes

Students will be expected to

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

Focus for Learning

Science and technology have their own language (i.e., terminology, symbols, diagrams, graphs, and equations). Scientists, engineers, and technologists use this language to collaborate and communicate.

Students should use specific terminology when communicating in science and technology contexts. When describing the movement of planets, for example, students should use the terms rotation, axis, revolution, and orbit. Memorizing definitions is not an expectation.

Terminology should be introduced and defined as the need emerges. Presenting all terms at the outset of the unit is strongly discouraged.

Space-related terminology includes

- solar system, Sun, planet, dwarf-planet, moons, satellite;
- revolution, rotation, axis, orbit, tilt;
- waxing, waning, gibbous, crescent, new Moon, full Moon;
- solar eclipse, lunar eclipse, tides, spring tides, neap tides;
- meteoroid, meteor, meteorite, asteroid, comet, crater; and
- star, constellation, astronomy, astronaut.

Science process- and skill-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 variable; and
- design, construct, test, evaluate, prototype, constructed device.

Whenever students are engaged in investigations or problem solving activities, their use of appropriate terminology in communication should be assessed. Assessments may include

- self, peer, and teacher assessments; and
- the use of terminology checklists in conjunction with direct observations or review of digital audio recordings of collaborative group work.

Communicating About Space Using Specific Terminology

Sample Teaching and Assessment Strategies

As part of this unit, students are expected to record daily sketches of the Moon phases in a Lunar Log (see p. 84). Students should begin this activity at the outset of the unit. It takes 30 days to observe an entire lunar cycle.

Activation

Teachers may

- Pre-assess students' use of appropriate terminology with graffiti board activities using question prompts:
 - What is science? What is engineering? What is technology?
 - What is the science inquiry process? What is the design process?
 - What is space? What is the solar system? What is space exploration?
- Create a class concept map or brainstorming web of space-related terminology.
- Create a science word wall and add new terms as they are introduced. Alternatively, science words can be added to an existing word wall using a different colour font or background.

Students may

- Participate in a book walk through *NL Science 6: Space* to identify space-related terminology.

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 (e.g., provide space-related non-fiction texts for self and shared reading activities).
- Facilitate group work where students are encouraged to think aloud; communicating their ideas, questions and intentions.

Students may

- Use alpha-boxes to record new terminology.
- Create a visual glossary of new terminology using personal illustrations and definitions in their own words.
- Record their space-related questions on a class "I Wonder" wall.

Resources and Notes

Authorized

NL Science 6: Space (Teacher Resource [TR])

- pp. 4-7

NL Science 6: Space (Student Resource [SR])

- pp. 1-55, 56-59

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Space and lunar log resources (websites)

What Makes Up Our Solar System?

Outcomes

Students will be expected to

29.0 describe how evidence must be continually questioned in order to validate scientific knowledge
[GCO 1]

30.0 describe the physical characteristics of the Sun, planets, and moons
[GCO 3]

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

20.0 evaluate the usefulness of different information sources in answering a question
[GCO 2]

Focus for Learning

Pose questions to activate students' prior, space-related knowledge:

- What is a solar system? What celestial bodies are in our solar system? What object is at the centre of our solar system?
- What are planets and moons? How might you describe their movement?

Human understanding of our solar system has changed, and continues to change, as existing evidence is questioned and new evidence is sought and acquired. Students should recognize that continually improving descriptions and explanations of natural phenomena is the nature of science.

Introduce early ideas about the solar system (e.g., geocentrism, flat Earth) and describe how the work of Ptolemy, Copernicus, Galileo, and Kepler has changed human understanding.

Exploring how human understanding of the solar system has changed over time should naturally lead to questions about our current scientific understandings.

Our solar system consists of the Sun, eight planets (with their moons and rings), five known dwarf planets, comets, asteroids, meteoroids, and dust. The Sun (a star) is the centre of our solar system (i.e., heliocentrism). Planets are spherical objects that have cleared other objects from their orbital path around the Sun. Note that Pluto was previously categorized as a planet. In 2006, however, it was reclassified as a dwarf planet. Like planets, dwarf planets orbit the Sun, but they have not cleared their orbital path of other objects, such as asteroids or comets. Moons are natural satellites that orbit some planets. Comets, asteroids, and meteoroids are treated later in the unit.

Students are expected to select either the Sun, one of the eight planets, a dwarf planet, or Earth's moon and use research inquiry to collect data regarding its physical characteristics. Collected information, where applicable, should include

- how big it is (diameter),
- how far it is from the Sun (average distance),
- how fast it moves (orbit speed),
- the length of one year,
- the length of one day,
- what it is made of,
- the number of moons it has, and
- whether it has an atmosphere.

Students should identify and evaluate a variety of possible information sources and use trusted sources to gather relevant information regarding the physical characteristics of their selected solar system component.

Continued

What Makes Up Our Solar System?

Sample Teaching and Assessment Strategies

Student use of appropriate scientific terminology when describing the components of the solar system and their physical characteristics should be assessed.

Activation

Teachers may

- Facilitate a graffiti wall activity for Sun, planets, dwarf planets, and moons.
- Display planet-related non-fiction texts and posters within the classroom.

Students may

- Revisit the “I Wonder” wall, adding questions on index cards. Each time a question is answered, they can annotate it with a check mark and write the answer on the back.

Connection

Teachers may

- Provide images of historical models of the solar system for students to interpret and sequence. Models may include those of Ptolemy, Aristotle, Copernicus, and Brahe, and more recent models that do or do not recognize Pluto as a planet.
- Discuss the recategorization of Pluto as an example of how evidence must be continually questioned (the discovery of Eris [2003] caused astronomers to redefine the term planet and create a new category of objects called dwarf planets).
- Collaboratively develop with students, criteria for evaluating the usefulness of different information sources (e.g., author, publication date).
- Collaboratively create with students, a scale model of the relative distance from the Sun for the inner planets and, if possible, the outer planets.

Students may

- Brainstorm potential information sources that may help answer questions related to the characteristics of planets.
- Compile a list of information sources used to answer the research questions.
- Visit NASA web pages to access information about exploration of planets, dwarf planets, and moons in our solar system.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 8-15

NL Science 6: Space (SR)

- pp. 6-9

NL Science 6: Online Teaching Centre

- What Are Some Characteristics of Objects in the Solar System? (BLM)
- Solar System Chart (BLM)
- Solar System Chart Answer Key (BLM)
- IWB Activity 1
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

Astroscan telescope

Suggested

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

- Solar system resources (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 6* (ELA 6)
 - *Journey to Mars*
 - *When is a Planet not a Planet?*

What Makes Up Our Solar System?

Outcomes

Students will be expected to

30.0 describe the physical characteristics of the Sun, planets, and moons [GCO 3]

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

20.0 evaluate the usefulness of different information sources in answering a question [GCO 2]

Focus for Learning

Individual student research findings should be shared with the class and combined with data from classmates into a class solar system chart (e.g., Solar System Chart, *NL Science 6: Online Teaching Centre*).

Students are expected to analyze and interpret the information compiled in the class solar system chart. They could,

- identify planets with the largest diameters;
- sequence planets from closest to farthest away from the Sun;
- identify gaseous and terrestrial planets;
- compare the relative size of the Sun to planets;
- sequence planets from slowest moving to fastest moving;
- create a bar graph to compare day length on Earth, Mars, Jupiter, Saturn, Uranus, and Neptune;
- create a bar graph to compare year length on Earth, Mars, Jupiter, Saturn, Uranus, and Neptune;
- create a bar graph to compare the number of moons orbiting each of the outer planets;
- relate distance from the Sun to year length; and
- compare the size of Mercury to that of a dwarf planet (Pluto).

Refer to the *Integrated Skills* unit for elaboration of outcomes 14.0 and 20.0.

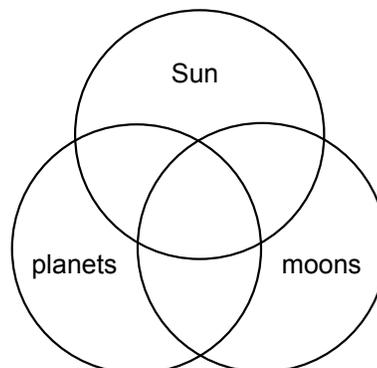
Cross-curricular connections may be made to Social Studies 6 inquiry skills and English Language Arts 6 outcomes related to reading and viewing, and writing and representing.

Attitude

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

Sample Performance Indicator

Use a three circle Venn diagram to compare and contrast the characteristics of the Sun, planets, and moons.



What Makes Up Our Solar System?

Sample Teaching and Assessment Strategies

Consolidation

Teachers may

- Inform students that a new celestial body has been discovered in a neighbouring solar system. Ask students what information would allow them to determine whether the celestial body is a star, planet, dwarf planet, or moon.

Students may

- Complete Frayer models, a foldable, or info-graphic to compare and contrast the Sun, planets, dwarf planets, and moons.
- Collaborate to create a class multimedia presentation representing their collective learning about the physical characteristics of the Sun, eight planets, dwarf planets, and moons in our solar system.
- Provide examples to illustrate how scientific knowledge changes over time.

Extension

Students may

- Write a “day in the life” story about an organism living on one of the planets in our solar system and incorporate information gathered through research inquiry.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 8-15

NL Science 6: Space (SR)

- pp. 6-9

NL Science 6: Online Teaching Centre

- What Are Some Characteristics of Objects in the Solar System? (BLM)
- Solar System Chart (BLM)
- Solar System Chart Answer Key (BLM)
- Day and Year Graphs (BLM)
- IWB Activity 1
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

Astroscan telescope

Suggested

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

- Solar system resources (websites and videos)

What Causes Day, Night, and the Seasons?

Outcomes

Students will be expected to

31.0 demonstrate how Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons
[GCO 3]

10.0 select and use tools
[GCO 2]

Focus for Learning

Earth's day and night are caused by the rotation of Earth on its axis every 24 hours. The surfaces of Earth facing the Sun experience daytime while those facing away experience nighttime.

Earth orbits (i.e., revolves around) the Sun every 365 $\frac{1}{4}$ days on an almost circular, elliptical path. Students may believe that Earth's proximity to the Sun causes the seasons, but this is a common misconception. Earth is closer to the Sun during January and farthest away in July. The yearly cycle of the seasons is caused by Earth's tilt. Earth is tilted on its axis at about 23.5° to its orbital path. The influence of Earth's tilt causes the northern and southern hemispheres to be angled more or less toward and away from the Sun at different times during the year.

Students are expected to engage in an engineering design and problem solving experience to design and construct a model to demonstrate the cycle of day and night and the seasons.

As part of the design and problem solving process, students should

- clarify the problem to be solved and, if needed, conduct research;
- collaboratively brainstorm possible solutions and select one to try;
- devise a construction plan including a list of required tools and materials;
- carry out the construction plan, making changes and modifications as problems are encountered; and
- demonstrate and explain how their model demonstrates the cycle of day and night and the seasons.

Student constructed models are not expected to be to scale. The "Earth", however, should be noticeably larger than the "Moon" and smaller than the "Sun". These models should be kept for use in other modelling-related activities within this unit.

This design and build experience provides an opportunity to address and assess additional skill outcomes from the *Integrated Skills* unit (e.g., 7.0, 8.0, 15.0, 16.0). Students should use appropriate scientific terminology when demonstrating the day and night cycle and the yearly cycle of the seasons.

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

Use your personally constructed model to demonstrate and explain, using specific terminology, how rotation causes Earth's day and how revolution causes the yearly cycle of the seasons.

What Causes Day, Night, and the Seasons?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide examples of everyday objects that rotate (e.g., bicycle wheel, Ferris wheel, spin top) or revolve (e.g., Skip-It™, people on a Ferris wheel, speed skaters skating around a rink).

Students may

- View videos illustrating Earth's day and night and seasonal cycles.

Connection

Teachers may

- Stand in the centre of the classroom and ask students to rotate on their axes and then revolve around you, to demonstrate the difference between the terms.
- Select an object in the room to represent the Sun and ask students to raise an arm to represent Earth's axis. Call out different seasons and ask students to tilt their arm appropriately (i.e., toward the "Sun" for summer, away from the "Sun" for winter).
- Place a globe on a student's desk. Then, ask the student to identify the season, if they were the Sun, based on the tilt of the axis.

Students may

- Create bar graphs, if not previously done, comparing day length and year length for Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.
- Analyze and interpret diagrams depicting how Earth's tilt causes the seasons.

Consolidation

Students may

- Use mobile device technology to record a video of their group demonstrating and orally describing Earth's day and night or seasonal cycle, using their constructed models.
- Physically demonstrate Earth's day and night and seasonal cycle using themselves to represent the Sun and Earth.
- Evaluate and respectfully suggest improvements to the personally constructed models of classmates.

Extension

Students may

- Research and explain solstices and equinoxes.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 16-23

NL Science 6: Space (SR)

- pp. 10-15

NL Science 6: Online Teaching Centre

- Day and Year Graphs (BLM)
- IWB Activity 2
- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Day, night, and season resources (videos)

What Causes the Moon Phases?

Outcomes

Students will be expected to

32.0 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for various phenomena [GCO 3]

32.1 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for the Moon phases

13.0 record observations [GCO 2]

18.0 compile and display data [GCO 2]

Focus for Learning

The relative positions of Earth, the Moon, and the Sun are responsible for various natural phenomena, including the phases of the Moon, eclipses, and tides. These phenomena are addressed separately within this guide.

The appearance of the Moon changes as it orbits Earth. At any given time we are only able to easily see the portion of the Moon that is both facing us and being illuminated by the Sun.

Students are expected to

- complete a Lunar Log (i.e., a daily record of the easily visible portion of the Moon) for a period of 30 days;
- identify and name the eight Moon phases (i.e., full, waning gibbous, waning half, waning crescent, new, waxing crescent, waxing half, waxing gibbous);
- recognize that the Moon phases occur in a cycle (i.e., lunar cycle);
- sequence the Moon phases in the lunar cycle;
- analyze and interpret diagrams explaining the phases of the Moon (e.g., Phases of the Moon BLM); and
- model how the relative positions of Earth, the Moon, and the Sun are responsible for the Moon phases.

Students may use components of their previously constructed models, or other objects to represent Earth, the Moon, and the Sun in activities.

Skill outcomes 13.0 and 18.0 are addressed and may be assessed through completion of the Lunar Log. Refer to the *Integrated Skills* unit for elaboration of these skill outcomes. Students should use appropriate scientific terminology when describing and explaining the Moon phases.

Attitude

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

Sample Performance Indicators

1. Sequence a series of images depicting the eight phases of the Moon and describe the lunar cycle using specific terminology.
2. Demonstrate and explain how a half Moon is visible to a person on Earth using a flashlight and two balls of modelling clay (or similar objects), representing the Moon and Earth, placed on a desk top.

What Causes the Moon Phases?

Sample Teaching and Assessment Strategies

Students should start their Lunar Log at the beginning of the unit.

Activation

Teachers may

- Display images of the Moon in various phases and ask why it looks different in different images.
- Ask students to draw a quick sketch of the Moon and then compare their sketch with those of classmates to note differences in appearance.

Connection

Teachers may

- Provide a Lunar Log template (e.g., calendar with daily circles for students to shade the portion of the Moon not easily visible).

Students may

- Represent or model the different Moon phases (e.g., using cream cookies or modelling clay) and label each phase.
- Create a flip book of the lunar cycle.

Consolidation

Teachers may

- Facilitate a demonstration to explain the Moon phases using a lamp without a shade and a Styrofoam™ ball with a pencil inserted. In a darkened room, direct a student to stand two metres away from the lamp and hold the pencil at arm's length in front of their face. The lamp, Styrofoam™ ball, and their head represent the Sun, the Moon, and Earth respectively. Ask the student to slowly rotate counterclockwise and note changes in the lighted portion of the ball visible to them as they turn.

Students may

- Create a multi-tab foldable of the Moon phases.
- Create a video using physical objects to model and explain how the relative positions of Earth, the Moon, and the Sun determine the Moon phases.

Extension

Students may

- View a lunar calendar and predict the phase of the Moon on their birthday.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 24-29

NL Science 6: Space (SR)

- pp. 16-19

NL Science 6: Online Teaching Centre

- Phases of the Moon BLM
- IWB Activity 3
- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Moon phases (websites and videos)

What Causes Eclipses?

Outcomes

Students will be expected to

32.0 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for various phenomena [GCO 3]

32.2 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for eclipses.

Focus for Learning

Eclipses can occur when Earth is between the Sun and the Moon (i.e., lunar eclipse), and when the Moon is between Earth and the Sun (i.e., solar eclipse).

Students are expected to collaboratively investigate solar and lunar eclipses using models of Earth, the Moon, and the Sun (e.g., Styrofoam™ balls of different sizes and a flashlight). Through modelling, students should discover that

- the Moon, when positioned between Earth and the Sun and perfectly aligned, blocks sunlight from and casts a shadow on Earth (i.e., solar eclipse);
- Earth, when positioned between the Moon and the Sun and perfectly aligned, blocks sunlight from and casts a shadow on the Moon (i.e., lunar eclipse); and
- lunar eclipses can only occur during a full Moon and solar eclipses can only occur during a new Moon.

Students may use components of their previously constructed models or other objects to represent Earth, the Moon, and the Sun in activities.

Students should use appropriate scientific terminology when describing and explaining eclipses.

Attitude

Encourage students to work collaboratively while exploring and investigating. [GCO 4]

Sample Performance Indicator

Use a flashlight held at a distance, and different sized Styrofoam™ balls (or similar objects), representing Earth and the Moon, to model and explain a lunar eclipse.

What Causes Eclipses?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Show images or videos of solar and lunar eclipses and use a Think-Pair-Share strategy to discuss why they occur.
- Ask students to share personal experiences of solar and lunar eclipses.

Connection

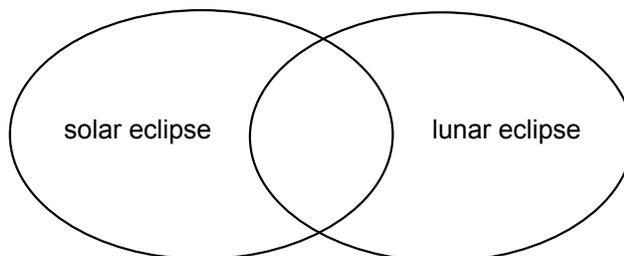
Students may

- Look at a circular object (Sun) on the classroom wall (e.g., clock), close one eye, and place their thumb (Moon) in front of their face (Earth) so that it partially blocks their view of the object. This activity models a solar eclipse.

Consolidation

Students may

- Create a video, using previously constructed models, to demonstrate and explain how the relative positions of Earth, the Moon, and the Sun cause solar and lunar eclipses.
- Use a Venn diagram to compare and contrast solar and lunar eclipses.



- Use coding (e.g., Scratch programming) to create a digital model of solar and lunar eclipses.
- Discuss and explain the difference between a lunar eclipse and a new Moon.
- With the aid of labelled diagrams, explain how the relative positions of Earth, the Moon, and the Sun are responsible for solar and lunar eclipses.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 30-35

NL Science 6: Space (SR)

- pp. 20-21

NL Science 6: Online Teaching Centre

- IWB Activity 4
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Eclipse resources (websites and videos)

What Causes Tides?

Outcomes

Students will be expected to

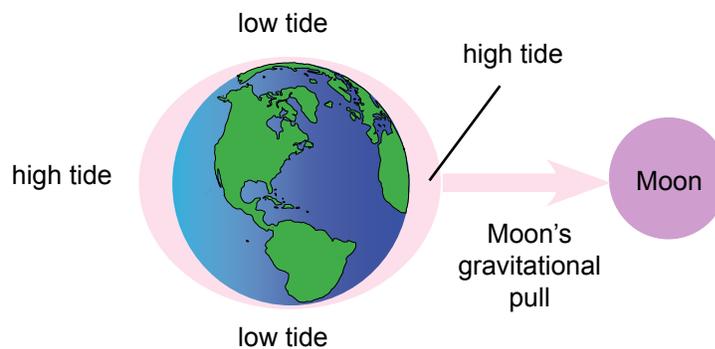
32.0 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for various phenomena [GCO 3]

32.3 observe and explain how the relative positions of Earth, the Moon, and the Sun are responsible for tides

Focus for Learning

Gravity is an attractive force exerted by all masses on each other. Gravitational strength depends on the masses of objects and their separation distance. The enormous mass of the Sun exerts a gravitational force between the Sun and Earth that is 179 times stronger than that between Earth and the Moon. While the Moon exerts a smaller gravitational force on Earth than the Sun, it has a greater effect on tides because of its close proximity. Note, the force of gravity will be explored further in the *Flight* unit.

Earth's rotation, combined with gravitational forces, cause sea levels to "bulge" on the side of Earth closest to the Moon, as well as on the side of Earth opposite the Moon where the Moon's force of attraction is significantly weaker. As Earth rotates, specific positions on Earth "move through" these bulges and experience high tides. The locations halfway between the bulges are where low tides occur.



Students are expected to

- recognize that tides are caused by the gravitational forces of the Moon and the Sun on Earth;
- model and explain how the relative positions of Earth and the Moon cause high and low tides;
- observe patterns in tide graphs and relate to phases of the Moon (i.e., highest high tides [spring tides] correspond approximately with full and new Moons, lowest high tides [neap tides] with half Moons); and
- model and explain how the relative positions of Earth, the Moon, and the Sun cause spring tides (aligned) and neap tides (right angle).

Sample Performance Indicators

1. Place two different sized bottle caps (or similar objects), representing Earth and the Moon, on a desktop. Position an elastic band loosely around Earth to model and explain the positions of high and low tides.
2. Use three different sized bottle caps (or similar objects), representing Earth, the Moon, and the Sun, to model and explain how their relative positions cause spring and neap tides.

What Causes Tides?

Sample Teaching and Assessment Strategies

Student use of appropriate scientific terminology when observing and explaining the tides should be assessed.

Activation

Teachers may

- Present time lapse videos showing changes in tides, such as the Bay of Fundy.

Connection

Teachers may

- Facilitate a discussion to identify individuals in their community or region who might find the information contained in tidal charts and graphs important.

Students may

- Directly observe, where possible, changes in the tide.
- Create a time lapse video of a daily tidal cycle.
- Complete Science in Action! What Causes the Patterns of the Tides? (*NL Science 6: Space*, p. 22) to identify the patterns in tides and relate the patterns to the phases of the Moon. Evidence may be generated to assess skill outcomes 19.0 and 21.0.
- Analyze daily tide charts to identify the timing of high and low tide.

Consolidation

Students may

- Form pairs and discuss
 - the difference between high tides and low tides;
 - how the Moon causes tides;
 - how some relative positions of Earth, the Moon, and the Sun, cause larger tides than usual; and
 - the difference between spring tides and neap tides.
- Create and annotate diagrams to explain how the relative positions of the Moon and Earth create high tides and low tides.
- Create and annotate diagrams to explain how the relative positions of Earth, the Moon, and the Sun, create spring and neap tides.
- Use a Venn diagram to compare and contrast spring tides and neap tides.

Extension

Students may

- Consider the affect on tides if Earth had two moons.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 36-41

NL Science 6: Space (SR)

- pp. 22-23

NL Science 6: Online Teaching Centre

- Tide Graph (BLM)
- Tide Graph Answer (BLM)
- IWB Activity 5
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Tides resources (websites and videos)

What Are Meteoroids, Asteroids, and Comets?

Outcomes

Students will be expected to

33.0 describe the physical characteristics of meteoroids, asteroids, and comets
[GCO 3]

Focus for Learning

Students previously identified that our solar system consists of the Sun, eight planets and their moons and rings, five known dwarf planets, comets, asteroids, and meteoroids. Additionally, they described the physical characteristics of the Sun, the Moon, and planets.

The expectation of SCO 33.0 is for students to describe the physical characteristics of meteoroids, asteroids, and comets. They should describe, where applicable,

- what they are made of,
- their size,
- their orbital path, and
- characteristics of its appearance when viewed from Earth.

Additionally, students should

- distinguish between the terms meteoroid, meteor, and meteorite; and
- relate the formation of impact craters to meteoroids and asteroids colliding with planets and moons.

Student should use appropriate scientific terminology when describing the physical characteristics of meteoroids, asteroids, and comets.

Attitude

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

Sample Performance Indicator

Create a foldable to distinguish between and describe the physical characteristics of meteoroids, asteroids, and comets.

What Are Meteoroids, Asteroids, and Comets?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present images and videos illustrating meteoroids, asteroids, and comets.

Connection

Teachers may

- Present images of impact craters to illustrate the effects of meteoroid and asteroid collisions with planets and moons.

Students may

- Create and populate a chart to record physical characteristics of meteoroids, asteroids, and comets.
- Visit NASA web pages to access information about exploration of small bodies (i.e., meteoroids, asteroids, comets) in our solar system.

Consolidation

Students may

- Create an informational poster or Google slides to describe and distinguish between meteoroids, asteroids, and comets.
- Compare and contrast meteoroids, asteroids, and comets using a triple Venn diagram.

Extension

Students may

- Research well known comets (e.g., Halley's comet, Hale-Bopp comet) and/or exploration of comets by NASA and present findings to the class.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 42- 47, 52-55

NL Science 6: Space (SR)

- pp. 24-25, 28-29

NL Science 6: Online Teaching Centre

NL Science 6: Online Student Centre

Suggested

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

- Meteoroid, asteroid, and comet resources (websites and videos)

What Factors Affect Impact Craters?

Outcomes

Students will be expected to

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

5.0 identify and control major variables in investigations [GCO 2]

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

13.0 *record observations* [GCO 2]

18.0 *compile and display data* [GCO 2]

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

26.0 communicate procedures and results [GCO 2]

Focus for Learning

There are various ways to investigate factors affecting the shape and size of impact craters (e.g., travel through space to directly observe collisions between celestial bodies, experiment by crashing space objects into planets or moons and making observations, create and experiment with model impactors and surfaces). Students should discuss the practicality of different methods and recognize that investigating with models is most appropriate.

Students are expected to create models and carry out a guided inquiry investigation to identify factors affecting crater size and shape. They should

- define crater-related terminology (impactor, rim, floor, ejecta, ray);
- brainstorm possible factors (i.e., variables) that might affect the shape and size of craters (e.g., impactor size and/or mass, impactor speed, angle of impact, surface composition);
- select one variable (i.e., independent variable) to test, formulate the testable question (e.g., What is the effect of impactor speed on the shape and size of craters?), and state a hypothesis;
- determine how the independent variable can be tested using model impactors and surfaces, for example
 - impactor speed - drop the same object (e.g., marble) from varying heights;
 - impactor size - drop different sized objects (e.g., different sized marbles) from the same height;
 - impact angle - drop the same object onto the same surface tilted at different angles; or
 - surface composition - drop the same object, from the same height, onto different surfaces (e.g., flour, potting soil, sand, gravel);
- devise and carry out a procedure, ensuring a fair test, that includes repeated trials (minimum of three), qualitative observations (shape), and quantitative measurements (size);
- compile and display their observations and measurements in appropriate formats;
- analyze and interpret data to identify patterns and trends;
- draw a conclusion based on their findings; and
- communicate to classmates their question, hypothesis, results, and conclusion.

This guided inquiry investigation provides evidence to assess numerous inquiry-related skill outcomes. Refer to the *Integrated Skills* unit for elaboration.

Attitude

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

What Factors Affect Impact Craters?

Sample Teaching and Assessment Strategies

Review the identification of independent, dependent, and controlled variables and the concept of fair testing (first addressed in Science 4). To ensure fairness, investigations should only have one independent variable and other possible variables of influence must be controlled.

If more than one independent variable is involved in an investigation, a valid conclusion cannot be made. This may occur if students select impactor size and/or mass as their independent variable. If they drop different sized marbles, for example, the marbles are likely different masses as well. It is then impossible to conclude whether crater differences are due to marble size, marble mass, or a combination of both. Ideally, objects of different sizes but the same mass, or different masses but the same size, should be used.

Students can define their dependent variable generally (i.e., crater shape and size) or specifically (e.g., crater depth, diameter, ray length). Adding coloured powder (e.g., cocoa, Jell-o™, tempera paint) to the top of other surfaces may aid observation of ejecta and rays.

Connection

Teachers may

- Ensure that a variety of independent variables are investigated within the class.
- Review student procedures prior to their carrying out investigations to ensure they include multiple trials.
- Assign the role of videographer to one member of each group. Ask students to capture and review video of their group carrying out the investigation to evaluate the fairness of their test.

Consolidation

Students may

- Record qualitative observations of crater size and shape using drawings, pictures, slow motion video, and/or written language.
- Record quantitative observations of crater size (e.g., diameter, depth, ray length) in a data table.
- Create a photo collage or video to document the stages of their inquiry investigation.
- Orally present to classmates their investigated question, hypothesis, procedure, and conclusion.
- Identify new questions to investigate, arising from what was learned.

Extension

Students may

- Research well known craters and present findings to the class.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp.

NL Science 6: Space (SR)

- pp. 26-27

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/science-6/teaching-and-learning-strategies.html
- *Investigating Impact Craters*

Suggested

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

- Impact craters (websites and videos)

What Can We See When We Look at the Night Sky?

Outcomes

Students will be expected to

34.0 identify constellations in the night sky
[GCO 3]

35.0 compare tools, techniques, and scientific ideas used by different people around the world to interpret natural phenomena and meet their needs
[GCO 1]

36.0 demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems
[GCO 1]

Focus for Learning

Throughout history, people of all cultures have looked up into the night sky and observed the Moon, stars, planets, meteors, aurora, and lunar eclipses. Through detailed observations, they noted patterns in the apparent motion of some of these objects. The location of stars in the night sky, for example, changes over time.

Constellations are recognizable groups of stars that have been given names. There are 88 recognized constellations. In astronomy, a constellation is used to refer to an area of the sky containing those particular stars. Which constellations are visible in the night sky depends on the time of year and the viewers location on Earth.

Students are expected to identify some common constellations when using planetarium software, or a mobile device application, that represents star positions in real time (constellation star maps may aid identification). Some common constellations visible year round in the northern hemisphere include: Ursa Major, Ursa Minor, Cassiopeia, and Draco. Cygnus is visible in fall. Orion is visible in winter.

Constellations make it easier to recognize and interpret patterns in stars. Different cultures over time (e.g., Celts, Aztecs, Egyptians) traced and recorded the positions of stars. They identified predictable patterns in their apparent movement and used this knowledge to make predictions (e.g., winter is approaching when Orion is visible) and determine the appropriate time to plant and harvest crops. The north star, Polaris, has been used by many cultures for navigation. Similarly, different cultures used the predictability of the lunar phases to create calendars and make predictions. Local harvesting of mussels, for example, traditionally occurred during full Moons when yields were thought to be larger.

Students should recognize that these examples illustrate how each culture creates scientific knowledge to explain natural phenomena and develops tools and techniques to meet their needs.

Exploration of constellations may lead naturally to questions regarding astrology. Astrology is the belief that the relative positions of constellations and other celestial bodies influence human behaviour and events on Earth. When critically evaluated against collected evidence, astrological predictions and explanations are invalidated.

Students should recognize and explain that astrology is not a science and, therefore, not an appropriate way to find an answer to a scientific question. Predicting the likelihood of a volcanic eruption, for example, should be based on appropriate scientific processes, using scientific tools, instruments, and techniques, not the relative positions of constellations and other celestial bodies.

Attitude

Encourage students to recognize that individuals of any cultural background can contribute equally to science. [GCO 4]

What Can We See When We Look at the Night Sky?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present children's versions of ancient Greek myths that involve constellations (e.g., Andromeda, Cassiopeia, Perseus).
- Ask students to identify familiar constellations by name.

Connection

Teachers may

- Provide the star map for a constellation (i.e., stars connected by lines) and ask students to describe what it looks like. Then present the constellation's classical image for interest and comparison.
- Demonstrate how to locate the north star, Polaris (the last star in the handle of the little dipper [Ursa Minor]), using stars in the big dipper (part of Ursa Major) as reference points.

Students may

- Identify differences in constellations visible in the northern and southern hemispheres.
- Make a list of all celestial bodies visible in the night sky without the aid of technology.
- Create their own constellation star maps using black scratch paper or black construction paper and white chalk.
- Make a constellation viewer. Trace a circle, using one end of a paper towel roll, on a square of black construction paper. Draw a constellation inside the circle, poking small holes where the stars are located. Using tape, attach the construction paper square to one end of the paper towel roll. Shine a flashlight into the open end to project the constellation on the ceiling of a darkened room.

Consolidation

Teachers may

- Facilitate a class discussion regarding what is and what is not science, using astronomy and astrology as examples.

Students may

- Discuss why horoscopes are not a scientific way to find answers to questions.

Extension

Students may

- Create a name, star map, and constellation story for a fictitious constellation.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 60-65

NL Science 6: Space (SR)

- pp. 34-37

NL Science 6: Online Teaching Centre

- Constellations (BLMs)
- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

Astroscan telescope

Suggested

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

- Constellation resources (websites and videos)

What Technologies Do We Use to Explore Space?

Outcomes

Students will be expected to

37.0 describe scientific and technological achievements that are the result of contributions by people from around the world [GCO 1]

38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries [GCO 1]

Focus for Learning

Scientists use technology to study space. Students are expected to describe current and past technologies used to study space, including

- Earth and space-based telescopes,
- rockets, space shuttles, and spacecrafts,
- satellites, including the International Space Station (ISS), and
- space probes and rovers (landed spacecraft).

Students should appreciate that these technologies are the result of contributions by people of various cultural backgrounds and space agencies from around the world. The ISS, for example, is a joint effort of several space agencies representing various countries.

Technologies (i.e., products and processes) continue to develop and improve over time. These improvements lead to new scientific discoveries. This is an important aspect of the relationship between science and technology.

Students should describe examples of how improvements to space-related technologies (i.e., telescopes, spacecraft, space probes and rovers) are leading to new discoveries. The Mars Phoenix rover, for example, detected the presence of ice on Mars. The presence of ice had been predicted, but evidence to confirm its presence had not previously been found.

Students should use appropriate scientific terminology when describing space exploration technologies.

Attitude

Encourage students to

- recognize that individuals of any cultural background can contribute equally to science; and
- appreciate the role and contribution of science and technology in their understanding of the world. [GCO 4]

What Technologies Do We Use to Explore Space?

Sample Teaching and Assessment Strategies

Activation

Students may

- Explore the CSA or NASA website to identify current and future space missions.

Connection

Teachers may

- Facilitate a class debate on the advantages and disadvantages of space exploration.
- Provide a collection of informational texts related to space technology and exploration for student use.
- Present a series of images of a planet captured using different technologies (e.g., land-based telescope, Hubble Space Telescope, space probes, space rovers). Ask students to compare what physical characteristics are visible in each image.
- Present videos and animations of current and past space missions.

Students may

- Create a digital or print timeline of space exploration technology.
- Search and identify the countries which have space agencies.
- Search and identify the space agencies or countries contributing to the ISS.

Consolidation

Students may

- Complete “How Can We Learn What a Planet is Made Of?” activity (*NL Science 6: Space*, p.38). Alternatively, teachers may create the planets in advance.
- Create a collage of current technologies used to explore space.

Extension

Students may

- Propose investigations that could be carried out on the ISS.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 66-71

NL Science 6: Space (SR)

- pp. 38-41

NL Science 6: Online Teaching Centre

- IWB Activity 6
- Science Skills Toolkit

NL Science 6: Online Student Centre

Science Skills Toolkit

Supplementary

Astroscan telescope

Suggested

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

- Space technologies (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 6* (ELA 6)
 - *Journey to Mars*

How Do We Meet Our Survival Needs in Space?

Outcomes

Students will be expected to

39.0 describe how astronauts are able to meet their basic needs in space [GCO 3]

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

Focus for Learning

Humans need technology to help them live in space. Astronauts require shelter, food, water, oxygen, waste removal (including carbon dioxide), suitable environmental conditions (e.g., temperature, humidity), and a way to maintain their body health. Students should

- propose questions to research, related to how astronauts meet their basic needs in space (e.g., How do they sleep in space?, What do they eat?, How do they breathe?);
- in pairs or small collaborative groups, research one of the proposed questions; and
- present their findings to classmates.

Use of a cooperative jigsaw strategy is recommended.

Some of the requirements to live in space must also be met by spacesuits, used when astronauts leave a spacecraft.

Students should participate in activities to understand some of the difficulties and limitations of wearing spacesuits. They should

- use materials to collaboratively build a model of a spacesuit's components (e.g., visored helmet, gloves, arms);
- select a task to complete that can be timed (e.g., opening and closing zip top bags, screwing a nut and bolt together by hand, adding a collection of coins to a coin bank, constructing a Lego™ model);
- devise a procedure to compare the time it takes to complete a task while wearing a spacesuit with the time it takes when not wearing the spacesuit (ensure a minimum of three trials for each condition);
- carry out their procedure, ensuring a fair test, and recording measurements in an appropriate format;
- analyze and interpret their results; and
- draw conclusions about the influence of wearing a space suit and practice on the time needed to complete tasks.

In addition to SCO 25.0, this activity provides an opportunity to address and assess numerous science inquiry- and design and problem solving-related skill outcomes. Refer to the *Integrated Skills* unit for elaboration of skill outcomes.

Attitude

Encourage students to show interest in the activities of individuals working in scientific and technological fields. [GCO 4]

How Do We Meet Our Survival Needs in Space?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to identify basic human needs.
- Facilitate a discussion about aspects of the environment in space that would make living in space challenging.
- Ask students to brainstorm what everyday activities would be different if they were an astronaut living on the ISS.

Students may

- View images of astronauts wearing spacesuits.

Connection

Teachers may

- Facilitate a discussion regarding possible materials that could be used to construct a model of a spacesuit (e.g., snowmobile helmet, hockey helmet with visor, hockey gloves, milk cartons, dryer vent hose, duct tape, oven mitts).

Students may

- Use a variety of science information sources (e.g., online videos, books, magazines, websites) to find answers to their questions about how astronauts meet their basic needs in space.

Consolidation

Students may

- Write a journal entry describing a day in the life of an astronaut which incorporates details regarding how they meet their basic needs in space.
- Explain the difficulties experienced when attempting to accomplish a task while wearing a spacesuit. Suggest modifications to the materials or design of components that might help to improve efficiency.
- Create a list of new questions, arising from what was learned, to ask an astronaut about living and working in space.

Extension

Students may

- Research how an astronaut's basic needs are met on the ISS.

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 72-77

NL Science 6: Space (SR)

- pp. 42-45

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Survival needs in space (websites and videos)

Applications of Space Exploration

Outcomes

Students will be expected to

40.0 describe instances where scientific ideas and discoveries have led to new inventions and applications [GCO 1]

41.0 provide examples of Canadians who have contributed to science and technology [GCO 1]

Focus for Learning

SCO 40.0 highlights another aspect of the relationship between science and technology. Scientific ideas and discoveries lead to new technological inventions and applications.

Many new materials and technologies have been developed by scientists to further space exploration. Some of these space technologies are now used on Earth (space spin offs); applied in new ways to solve problems and meet human needs. Students should describe this aspect of the relationship between science and technology and provide examples of space spin offs from personal research. Examples include

- memory and shock absorbent (sports helmets) foam;
- scratch-resistant eyeglass lenses, cell phone cameras;
- LEDs, portable cordless vacuum, advanced water filtration systems;
- emergency reflective blankets, swimsuit and “stay cool” materials;
- robotic surgical devices, artificial limbs, cochlear implants, heart pump, invisible braces; and
- freeze-dried and enriched baby foods.

Note, some information sources identify Tang™, Teflon™, and Velcro™ as space exploration spin-off technologies. These technologies, however, existed on Earth prior to their use in space. Discuss with students the importance of evaluating the validity and reliability of information sources, prior to use.

While positioned at the end of the unit, Canadian contributions to space science and technology may be addressed throughout the unit, in conjunction with other outcomes. Students are expected to provide examples of how Canada has contributed to space exploration. Examples include

- astronauts (e.g., Chris Hadfield, Roberta Bondar, Marc Garneau, Robert Thirsk, Bjarni Tryggvason, Julie Payette);
- the Canadian Space Agency (CSA); and
- Canadian space-related technologies
 - Canadarm1, Canadarm2, Dextre;
 - SciSat and RadarSat;
 - LIDAR and meteorological components of the *Phoenix* Mars lander; and
 - Sensors, imagers, and spectrographs for the James Webb Space Telescope.

Attitude

Encourage students to show interest in the activities of individuals working in scientific and technological fields. [GCO 4]

Applications of Space Exploration

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present examples of space spin off technologies (e.g., freeze dried food, memory foam, LED lights) used on Earth and ask students to infer why each technology was necessary for space exploration.

Students may

- Search the CSA website to identify active Canadian astronauts.

Connection

Teachers may

- Provide a collection of informational texts related to past or future space missions involving Canadian astronauts. Ask students to read and summarize the information for their classmates.

Students may

- Identify and evaluate possible sources of information regarding space spin off technologies. This strategy may provide evidence to assess SCOs 6.0 and 20.0 from the *Integrated Skills* unit.

Consolidation

Students may

- Create a collage depicting space spin off technologies.
- Create a digital or print trading card for a Canadian astronaut using information accessed from the CSA website.

Extension

Students may

- Provide and describe examples of space exploration technologies that might be useful for exploring oceans.
- Create and program a rover, using Lego™ robotics, to accomplish tasks similar to those they would experience on a space mission (e.g., pick up a rock sample, take a picture).

Resources and Notes

Authorized

NL Science 6: Space (TR)

- pp. 78-85

NL Science 6: Space (SR)

- pp. 46-49

NL Science 6: Online Teaching Centre

- IWB Activity 7
- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

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

- Applications of space exploration (websites and videos)

Section Three:
Specific Curriculum Outcomes

Unit 2: Flight

Focus

The capability of flight is shared by a variety of living things and human inventions. For many centuries, humans have marvelled at the ability of living things to attain flight, and they have developed a variety of devices to recreate that ability. Students learn to appreciate the science and technology involved as they investigate how things fly and develop and test a variety of prototype devices. Through their investigations they learn that many different approaches are used, and that each provides a means to achieve lift, movement, and control.

This unit emphasizes the nature of science and technology and has both a design and problem solving and scientific inquiry focus. The unit provides multiple opportunities to construct, test, and improve prototype flying devices and to investigate how modifications to flyers affect lift, distance flown, and control. Inquiry investigations provide opportunities to further develop science related to rephrasing questions in a testable form, defining objects and events, devising and carrying out procedures to ensure a fair test, selecting and using tools, using various sources and technologies to gather relevant information, identifying potential applications of findings, 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.

- 28.0 demonstrate that specific terminology is used in science and technology contexts
- 36.0 demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems
- 38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
- 41.0 provide examples of Canadians who have contributed to science and technology
- 47.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations
- 51.0 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment
- 52.0 provide examples of how science and technology have been used to solve problems around the world

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
- 4.0 define objects and events in investigations
- 7.0 devise procedures to carry out a fair test and to solve a practical problem
- 9.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
- 10.0 select and use tools
- 11.0 follow procedures
- 12.0 make observations and collect information that is relevant to the question or problem
- 14.0 identify and use a variety of sources and technologies to gather relevant information
- 16.0 construct and use devices for a specific purpose
- 19.0 identify and suggest explanations for patterns and discrepancies in data
- 22.0 suggest improvements to a design or constructed object
- 23.0 identify potential applications of findings
- 24.0 identify new questions or problems that arise from what was learned
- 26.0 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.

- 42.0 identify and describe the forces affecting flight
- 43.0 describe the role of lift in overcoming gravity and enabling devices or living things to fly
- 44.0 describe and demonstrate how lift is affected by the shape of a surface
- 45.0 identify situations that involve Bernoulli's principle
- 46.0 describe and demonstrate methods for altering drag in flying devices
- 48.0 describe the means of propulsion for flying devices
- 49.0 describe and justify the differences in design between aircraft and spacecraft
- 50.0 identify characteristics and adaptations that enable birds and insects to fly

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
- recognize that individuals of any cultural background can contribute equally to science
- show interest and curiosity about objects and events within different environments
- 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
- 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 5	Science 6	Science 8
<i>Forces and Simple Machines and Weather</i>	<i>Flight</i>	<i>Fluids</i>
<ul style="list-style-type: none"> investigate different kinds of forces used to move objects or hold them in place observe and describe how various forces can act directly or from a distance to cause objects to move demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object investigate and compare the effect of friction on the movement of an object over various surfaces describe situations demonstrating that air takes up space, has weight, and expands when heated 	<ul style="list-style-type: none"> identify and describe forces affecting flight describe the role of lift in overcoming gravity and enabling things to fly describe and demonstrate how lift is affected by the shape of a surface identify situations involving Bernoulli's Principle describe and demonstrate methods for altering drag in flying devices describe the means of propulsion for flying devices describe and justify the differences in aircraft and spacecraft design identify characteristics and adaptations that enable birds and insects to fly 	<ul style="list-style-type: none"> describe qualitatively the relationship between mass and weight describe the movement of objects in terms of balanced and unbalanced forces define quantitatively the relationship between force, area, and pressure

Suggested Unit Plan

Flight is the first of two consecutive physical science units in the Science 6 curriculum.

September	October	November	December	January	February	March	April	May	June
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Flight

Communicating About Flight

Outcomes

Students will be expected to
28.0 demonstrate that specific terminology is used in science and technology contexts
[GCO 1]

Focus for Learning

In this unit, students will learn about the forces that affect flight in natural and human-made objects and explore how humans have used technology to improve the science of flight.

Throughout the unit, when communicating about flight, students are expected to use specific terminology. Flight-related terminology should be introduced and defined as the need emerges.

Science process-and skill-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.

Flight-related terminology includes

- flyer, glider, force, gravity, weight, drag, lift, thrust;
- aerodynamic, airfoil, Bernoulli's Principle;
- propulsion, propeller, jet engine; and
- aircraft, spacecraft, rocket.

Student use of appropriate, specific terminology is a constant expectation in *Science 6*.

Refer to the initial elaboration of SCO 28.0 provided on pp. 76-77.

Communicating About Flight

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Add flight-related terminology to an existing word wall.
- Create a class concept map or brainstorming web of flight-related terminology.

Students may

- Participate in a book walk through *NL Science 6: Flight* to identify flight-related terminology.

Connection

Teachers may

- Present the video *Flight School 101* from the supplementary resource *Taking Flight* (DVD) to introduce unit terminology and concepts.
- Incorporate specific terminology into literacy block activities (e.g., provide flight-related fiction and non-fiction texts for self and shared reading activities).
- Model appropriate use of scientific and technological terminology when communicating and encourage students to adopt these terms.
- Facilitate collaborative, group investigations and design and problem solving experiences where students think aloud; communicating their ideas, questions, and intentions.

Students may

- Use alpha-boxes to record new terminology.
- Create a visual glossary of flight-related terminology using personal illustrations and definitions.
- Record their flight-related questions on an “I Wonder” wall or in a personal science journal.

Resources and Notes

Authorized

NL Science 6: Flight (Teacher Resource [TR])

- pp. 4-7

NL Science 6: Flight (Student Resource [SR])

- pp. 1-55, 56-58

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

- *Taking Flight* (DVD)

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Flight resources (websites and videos)

How Can We Build a Flying Object?

Outcomes

Students will be expected to

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

10.0 *select and use tools*
[GCO 2]

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

Focus for Learning

To access prior flight-related knowledge and provide a hands-on way to learn about some forces that will be introduced later in the unit, students are expected to personally construct and test a flyer.

Students should, in pairs,

- brainstorm possible types of flyers (e.g., flying disc, paper airplane or glider, paper helicopter, parachute) that can be built out of common materials and select one to construct;
- build and test their flyer (i.e., a prototype);
- make improvements to their flyer and retest; and
- document design changes and record observations after each test.

In addition to SCOs 16.0, 10.0, and 12.0, teachers may choose to address and assess additional skill outcomes (e.g., 1.0, 4.0, 8.0, 13.0, 15.0, 24.0, 25.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

As students progress through the unit and learn about forces affecting flight, they may revisit their flyer and continue to make modifications for improvement. Their final design could be presented at a class Air Show held at the end of the unit.

Attitude

Encourage students to work collaboratively while exploring and investigating. [GCO 4]

How Can We Build a Flying Object?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Review the typical stages of a design process with students (i.e., define the problem, generate possible solutions and select one to try, devise and carry out a plan to construct a prototype, test the prototype, make modifications and retest or abandon in favour of another possible solution, continue to modify and retest prototypes until an optimal solution is reached).

Students may

- Brainstorm examples of natural and human-made objects that fly (e.g., airplanes, hang glider, parachuter, birds, dandelion seeds, drones, Frisbee™).
- Show and share personal objects that fly. They may demonstrate and discuss how it flies.

Connection

Teachers may

- Present exemplars of toy flyers or models and ask students to identify common characteristics among them.

Students may

- Record their observations and measurements from testing in a table.
- Record changes to their flyer design using drawings, digital images, or video.

Consolidation

Students may

- Create a “How to” video or photo collage to illustrate the steps involved in making their flying device.
- Reflect on the modifications made to their prototype flyer and discuss why some changes improved their result when retested.
- Discuss how they might change their flyer if a different criteria was used for assessment (e.g., flying time in the air, distance flown).

Extension

Students may

- Continue to modify and test their flyer for improvement.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 8-9

NL Science 6: Flight (SR)

- pp. 6-7

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Building flying objects (websites and videos)
- Science resource suppliers (websites)

Other curriculum resources

- Prepare for Takeoff!* (ELA 6)

How Does Weight Affect Flight?

Outcomes

Students will be expected to

42.0 identify and describe the forces affecting flight [GCO 3]

2.0 rephrase questions in a testable form [GCO 2]

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

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

Focus for Learning

Forces are pushes or pulls that cause objects to change speed, direction, or shape. A force has both size (i.e., magnitude) and direction.

Students are expected to

- identify and describe the four forces affecting the flight of aircraft (i.e., gravity [weight], lift, drag, thrust); and
- relate gravity and lift, and thrust and drag, as opposing or counteracting forces.

Each force is addressed separately in this unit. At this time, students should engage in a guided inquiry investigation to determine the effect of weight on flight. In pairs, students should

- construct a paper airplane and choose a weighted material to add to increase weight (e.g., coins, modelling clay, paper clips);
- predict where and how adding weight to the paper airplane might affect its flight;
- rephrase “How does weight affect flight?” in a testable form (e.g., How does taping coins to the nose of a paper airplane affect the distance it flies?);
- devise a procedure to carry out a fair test that includes multiple trials for each test;
- ensure that other possible variables of influence are controlled (e.g., use the same plane each time, the same weights, the same launch method and throwing force, the same testing location and measuring tool);
- make and record relevant observations in a table;
- draw a conclusion that answers their testable question; and
- communicate their procedures and results to classmates.

Alternatively, students could construct a paper helicopter or parachute and investigate how adding weight affects its flying time in the air. Note, for these flyers, gravity and drag are the opposing forces.

In addition to SCOs 2.0, 7.0, 9.0, teachers may choose to address and assess additional skill outcomes (e.g., 3.0, 4.0, 5.0, 8.0, 12.0, 13.0, 21.0, 23.0, 25.0, 26.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Student use of appropriate terminology when describing forces and communicating procedures, observations, and results of investigations should be assessed.

Sample Performance Indicators

1. Annotate an image of a dragonfly to identify the four forces affecting its flight and the direction in which they act.
2. Describe how adding weight to an airplane (e.g., additional baggage or passengers) might affect its flight.

How Does Weight Affect Flight?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Revisit the concept of gravity, addressed in the *Space* unit, connect the weight of an object to the force of gravity, and distinguish between mass and weight.

Students may

- Consider the question “Can heavy objects fly?”

Connection

Teachers may

- Present demonstrations or exemplars to facilitate discussion of the forces affecting flight:
 - Throw a paper plane with varying amounts of force (thrust).
 - Drop a flat piece of paper along side a piece crumpled into a ball (gravity and drag).
 - Reflect on trying to run in the shallow end of a swimming pool (drag).
 - Discuss the procedure required to fly a kite (lift).
- Present videos explaining the forces affecting flight.

Students may

- Identify different flying objects and the characteristics that enable them to fly.
- Use mobile devices to record video of their group conducting test trials and review the video to ensure fairness.

Consolidation

Students may

- View a collection of images or exemplars of flying objects (e.g., airship, arrow, boomerang, dandelion seed, dart, drone, duck, kite, football, Frisbee™, hang glider, helicopter, hot air balloon, hovercraft, javelin, shuttlecock, rocket). Compare how they achieve lift and overcome the force of gravity.
- Present how adding weight to their flyer affected its flight and listen to the findings of other classmates. Compare findings and discuss possible explanations for discrepancies or unexpected results.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 10-13

NL Science 6: Flight (SR)

- pp. 8-11

NL Science 6: Online Teaching Centre

- How Does Weight Affect Flight? (BLM)
- IWB Activity 1
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

Supplementary

- *Taking Flight* (DVD)

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Forces affecting flight (websites and videos)

What Creates Lift?

Outcomes

Students will be expected to

- 43.0 describe the role of lift in overcoming gravity and enabling devices or living things to fly
[GCO 3]
- 44.0 describe and demonstrate how lift is affected by the shape of a surface
[GCO 3]
- 23.0 identify potential applications of findings
[GCO 2]

Focus for Learning

Students should explore what creates lift. They should

- describe the role of lift in overcoming gravity;
- understand that heavier objects require more lift to fly;
- recognize that the greater the flow of air, the greater the lift; and
- understand how the shape of an object (i.e., aerodynamics) affects airflow.

In airplanes and birds, wings create most of the lift. The amount of lift depends on the size, shape, and tilt of the wings.

Students are expected to design and build a wing that achieves the most lift (*How Can Wing Designs Increase Lift? NL Science 6: Flight*, pp. 14-15). They should initially build and test the lift achieved by a wedge shaped, rectangular, and curved wing. From their findings, they should conclude that the curved wing achieved the most lift, then continue to redesign the wing to improve results.

Introduce and use the terms aerodynamic and airfoil to describe wing shapes.

This design and build activity provides an opportunity to assess skill outcomes (e.g., following procedures, constructing devices, drawing conclusions, suggest improvements to a design or constructed object). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Following the activity, students should be asked to identify potential real-world applications of aerodynamics and wing size, shape (airfoil), and tilt.

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 Indicators

1. Draw a cross section of a wing design that would achieve significant lift. Annotate the drawing, describing the design features included to achieve lift.
2. The Airbus A380-800 is a double-decked airplane that can accommodate 858 passengers. In designing the wings for this airplane, what factors might engineers have considered?

What Creates Lift?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide images of natural and human-made flying objects. Ask students to identify things they have in common.

Student may

- Play with Frisbees™ to observe lift. Describe their shape.
- Fly kites to observe lift.

Connection

Teachers may

- Ask students to stand with their hands perpendicular to the floor, and wave their hands back and forth, feeling air resistance. Then ask students to turn their hands parallel to the floor and wave again. They should note a reduction in air movement around their hand as their hand is more aerodynamic when held parallel.

Students may

- Describe the shape of an airplane wing.
- Use procedural writing to explain how to fly a kite.

Consolidation

Students may

- Describe the relative strength of lift and gravity affecting an airplane when taking off, in flight, and landing.
- Make modifications to their initial flying device (p. 110) to improve its lift.
- Describe how the design of Frisbees™, planes, kites, and other flyers help them move easily through the air.
- Describe the role of lift in flight and the relationship between weight and lift.
- Describe the role of airflow in producing lift.

Extension

Students may

- Extend the design and build experience to construct, test, and compare airfoils made of different materials (e.g., tissue paper, construction paper, card stock, poster board).

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 14-19

NL Science 6: Flight (SR)

- pp. 12-15

NL Science 6: Online Teaching Centre

- How Can We Test Wing Designs? (BLM)
- How Can Wing Designs Increase Lift? (BLM)
- IWB Activity 2
- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Lift resources (websites and videos)

What Are Some Examples of Bernoulli's Principle?

Outcomes

Students will be expected to

11.0 follow procedures
[GCO 2]

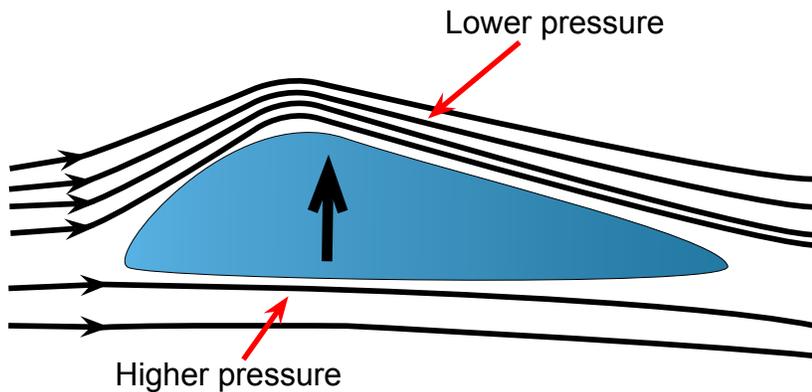
45.0 identify situations that
involve Bernoulli's principle
[GCO 3]

Focus for Learning

Bernoulli's principle states that air and water move faster over curved surfaces than flat surfaces and that the increased speed results in decreased pressure.

Students are expected to follow provided procedures to carry out demonstrations of Bernoulli's principle. Refer to the *Integrated Skills* unit for elaboration of SCO 11.0.

Bernoulli's principle is used to explain how the shape of an airplane wing creates lift. Air travels faster over the curved wing surface and slower under the flat surface of the wing. This creates a difference in air pressure near the two surfaces. Lift results as the higher pressure air under the wing moves upward to replace the lower pressure air.



Students are expected to identify areas of fast and slow moving air, high and low pressure, and the direction of movement for situations demonstrating Bernoulli's principle. They should consider

- lift in an airplane wing,
- propeller propulsion on an airplane,
- lift in a helicopter,
- air blowing over the sail of a sailboat causing forward motion sail boat, and
- ceiling fans.

Helicopter rotor blades, for example, are twisted and angled. As the blades rotate, air flows faster over the top of the blade creating an area of low pressure above. Higher air pressure below the rotor blades creates lift, moving the helicopter upward.

Sample Performance Indicator

Describe how Bernoulli's principle creates lift in a diagram of a seagull wing.

What Are Some Examples of Bernoulli's Principle?

Sample Teaching and Assessment Strategies

Teachers may choose to use a centres approach for students to explore examples of Bernoulli's principle.

Activation

Teachers may

- Present various videos illustrating Bernoulli's principle.

Connection

Students may

- Follow procedures (i.e., oral or written) to observe the effects of Bernoulli's principle:
 - Hold a strip of paper just below their lip, allowing it to hang downward. Blow across the top of the paper and observe.
 - Fold a piece of paper in half and stand it up to form a tent. Blow through the tent with a straw and observe.
 - Suspend two balloons with string from a metre stick. Ensure the balloons are 6 - 10 cm apart. Blow between them with a straw and observe.
 - Put a table tennis ball in a funnel and blow up into it and observe.
 - Place two mugs next to each other, place an empty soda can into a mug and blow air down into the mug with the can and observe.
 - Place a table tennis ball into a stream of air of a hair dryer and observe.
 - Place two table tennis balls on a flat surface about 5 cm apart, blow between them with a straw and observe.

Students should make predictions prior to each activity.

Consolidation

Students may

- Describe how Bernoulli's principle creates lift in a Frisbee™.
- Describe how Bernoulli's principle creates forward motion when wind surfing.
- Ceiling fans rotate in both clockwise and counterclockwise directions. Explain how changing the direction would change air flow in the room.
- Predict what might happen if airplane propellers were installed upside down.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 20-23

NL Science 6: Flight (SR)

- pp. 16-17

NL Science 6: Online Teaching Centre

- IWB Activity 3
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Bernoulli's principle resources (websites and videos)

What Factors Affect Drag?

Outcomes

Students will be expected to

46.0 describe and demonstrate methods for altering drag in flying devices
[GCO 3]

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

26.0 *communicate procedures and results*
[GCO 2]

47.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations
[GCO 1]

Focus for Learning

Drag is the force that acts opposite to the direction of thrust; it slows an object down. Drag is caused by air resistance and the movement of air around an object.

Students are expected to describe methods to increase or decrease drag in flying devices, for example,

- changing shape (more or less aerodynamic),
- increasing or decreasing surface area,
- using different materials (smooth versus rough), and
- increasing or decreasing mass.

They should recognize situations where increasing drag (e.g., parachuting, landing a plane) or decreasing drag (e.g., a plane taking off, race car) is beneficial.

Additionally, students should demonstrate methods to alter drag as a part of a guided, paper helicopter inquiry investigation:

- Construct a paper helicopter from a provided template.
- Collaboratively define parts of the paper helicopter (e.g., rotors, body, tail, flaps, blades).
- Brainstorm possible changes to the paper helicopter that may increase drag and select one to test (independent variable).
- Rephrase the inquiry question “How can we change the amount of drag?” in a testable form (e.g., Does increasing the length of the paper helicopter rotors affect flying time?);
- Make a prediction and a hypothesis.
- Construct a second paper helicopter incorporating the selected change and devise a procedure to carry out a fair test, comparing the flying time of both helicopters.
- Carry out multiple trials of the test, making relevant observations.
- Draw a conclusion as to whether the change affected flying time.
- Communicate their procedures and results to classmates.

It is recommended that student groups investigate different changes.

Students should recognize patterns in the results of their trials as well as account for any discrepancies noted (e.g., the changed paper helicopter fell first three out of four times).

In addition to SCOs 19.0 and 26.0, teachers may choose to address and assess additional skill outcomes (e.g., 3.0, 4.0, 5.0, 7.0, 8.0, 9.0, 12.0, 21.0, 25.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Sample Performance Indicator

Describe ways to increase and decrease drag when riding a bicycle.

What Factors Affect Drag?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to recall a time when they may have put their hand out the window of a moving car. How was it different with their hand horizontal or vertical?
- Facilitate a discussion concerning drag in real-life situations (e.g., swimming, walking through water, riding a bicycle, walking against the wind, speed-related sports, sports clothing).

Connection

Teachers may

- Present a variety of images and ask students to identify if drag is being increased or decreased.

Students may

- Explore running with and without poster board in front of them.
- Brainstorm changes to a football or shuttlecock to increase or decrease drag.
- Discuss whether drag is an important consideration in the design of space craft.
- Create different wing designs out of cardboard to wear on their arms and test to see how various shapes and sizes affect drag.

Consolidation

Students may

- Design and construct a parachute for a Lego™ mini figure to maximize drag.
- Engage in a design challenge to construct a paper helicopter with the longest possible flying time.
- Make modifications to their original flying device (p. 110); altering drag and recording their observations in pictures and/or words.
- Describe how airplane pilots increase drag when landing.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 24-27

NL Science 6: Flight (SR)

- pp. 18-19

NL Science 6: Online Teaching Centre

- IWB Activity 4
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/science-6/teaching-and-learning-strategies.html
- *Paper Helicopter Design Challenge*

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Paper helicopter activity (website)

How Can We Create Thrust?

Outcomes

Students will be expected to

48.0 describe the means of propulsion for flying devices [GCO 3]

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

49.0 describe and justify the differences in design between aircraft and spacecraft [GCO 3]

Focus for Learning

The fourth force acting upon flying devices is thrust. In airplanes, thrust is generated by the engine.

Propeller propulsion pulls a flying device through the air. The rotating propeller blades create a difference in air pressure. Consistent with Bernoulli's principle, the plane moves forward.

Jet propulsion pushes a flying device through the air. High pressure air exits the back of a jet engine pushing the plane forward. Note, most jet engines also include propellers, within the engine, which pull the plane forward as well.

Students should describe the difference between propeller propulsion and jet propulsion.

Students should explore how space flight differs from flying in air. They should recognize that space is almost void of matter and thus offers no resistance to motion. Students should identify new questions to answer about how forces (e.g., gravity, lift, thrust, and drag) affect space flight and problems to solve related to the design of spacecraft.

Students should compare aircraft and spacecraft design to describe, and suggest explanations for differences in their

- shape;
- size;
- parts;
- engine type;
- power source;
- method of take off, launch, and landing; and
- control mechanisms.

Attitude

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

Sample Performance Indicators

1. Using a Venn diagram, compare propeller propulsion with jet propulsion.
2. View images of an aircraft and a spacecraft. Describe differences in design and justify why these differences are required for flight in air or space.

How Can We Create Thrust?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Model jet propulsions using popcorn and a hot air popper. Leave the cover off to observe the resultant thrusts.
- Demonstrate jet propulsion using a balloon filled with air and then released.

Connection

Teachers may

- Demonstrate propeller propulsion using an electric fan placed on a book. Place rollers (e.g., pencils) underneath the book to reduce friction. Turning the fan on should allow the book to move.
- Present closeup images of airplane propeller blades. Ask students to describe their shape and relate to Bernoulli's principle.

Students may

- Describe how thrust is generated for a paper airplane.

Consolidation

Students may

- Create a Venn diagram to compare aircraft and spacecraft.
- Construct and use elastic band airplanes to investigate thrust.
- Complete the activity, [How Can We Launch a Table-Tennis Ball to the Ceiling?](#) (*NL Science 6: Flight*, p. 33), to explore propulsion.
- Create pop rockets using plastic containers with lids, water, and effervescent tablets. They may investigate how changing variables (e.g., container size, amount of water, amount of tablets) affects the height the pop rocket flies.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 32-35

NL Science 6: Flight (SR)

- pp. 22-25

NL Science 6: Online Teaching Centre

- How Can We Make a Propeller Plane or Helicopter (BLM)
- IWB Activities 5 and 6
- Science Skills Toolkit

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Thrust resources (websites and videos)

What Can We Learn from Flight in Nature?

Outcomes

Students will be expected to

50.0 identify characteristics and adaptations that enable birds and insects to fly [GCO 3]

Focus for Learning

Students should identify characteristics and adaptations that enable some birds and insects to fly.

Bird characteristics and adaptations identified may include

- aerodynamic body shape and smooth feathers;
- airfoil-shaped wings with large, lightweight flight feathers;
- some hollow, lightweight bones; and
- large keel sternum to attach powerful flight muscles.

Insect characteristics and adaptations identified may include

- small body size;
- curved, airfoil-shaped wings;
- specialized flight muscles; and
- large wings relative to body size.

Students should describe how these characteristics and adaptations enable flight by relating to their effect on weight, drag, lift, and thrust.

Attitude

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

Sample Performance Indicators

1. Annotate a picture of a bird, identifying specific characteristics and adaptations that enable it to fly.
2. Identify a characteristic or adaptation that enables birds to fly by
 - reducing weight,
 - reducing drag,
 - increasing lift, and
 - increasing thrust.

What Can We Learn from Flight in Nature?

Sample Teaching and Assessment Strategies

This outcome may, alternatively, be addressed at the beginning of the unit.

Activation

Teachers may

- Present videos depicting birds and insects in flight.

Connection

Teachers may

- Present different images of birds and airplanes. Ask students to note similarities and differences in their designs.
- Invite a local bird watcher, ornithologist, or entomologist to present to students about flying organisms.

Students may

- Explore plants' adaptations that allow them to use flight for pollination and seed dispersal.
- Identify characteristics and adaptations that enable bats to fly.
- Classify adaptations as structural or behavioural.

Consolidation

Students may

- Create print or digital posters describing the characteristics and adaptations that enable birds and insects to fly.

Extension

Students may

- Design and create a flyer based on the characteristics of a specific bird or insect. Explain how the flyer's design incorporates the characteristics and adaptations of the bird or insect.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 50-53

NL Science 6: Flight (SR)

- pp. 36-39

NL Science 6: Online Teaching Centre

- IWB Activity 7 Science Skills Toolkit

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Flight in nature (websites and videos)

Other curriculum resources

- *A Collection of Visual Field Guides: The Environment of Newfoundland and Labrador*
 - Birds (Science 4 and 7)

How Far Can Our Paper Airplane Go?

Outcomes

Students will be expected to

36.0 *demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems*
[GCO 1]

4.0 *define objects and events in investigations*
[GCO 2]

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

Focus for Learning

As a culminating activity for the unit, students should apply their learning to design and build a paper airplane that will fly the farthest. Note, students may revisit their initial flyer (p. 110), if appropriate.

Students should

- brainstorm possible paper airplane designs, researching if necessary;
- select a preferred design and construct an initial prototype;
- test the prototype, make changes to the prototype, and retest; and
- construct a final paper airplane, based on the prototype to enter in a class fly-off.

Students should collaboratively develop the class rules for the fly-off. Emphasis should be placed on designing and carrying out a fair test. Students could collaboratively decide

- on limitations in materials used or material size;
- where the airplanes will be tested;
- what the source of thrust will be and how it can be controlled;
- on the initial launch point;
- what measuring instrument and units will be used;
- what is meant by flight distance (e.g., is it the distance from launch point to the point where it hits the ground or its final resting place, is it measured to a specific part of the plane, or the part closest to, or farthest from the launch point);
- how to ensure accuracy and reliability in measurements;
- the number of trials for each airplane;
- what mathematical treatment will be applied to the data collected (e.g., select the best distance of all trails, calculate the mean); and
- how errors in procedure will be handled (e.g., what triggers a do-over and who decides).

In addition to skill outcomes 4.0 and 22.0, evidence may be collected to assess SCOs 8.0, 10.0, 12.0, 15.0, 16.0, 24.0, and 27.0. Refer to the *Integrated Skills* unit for elaboration.

Attitude

Encouraged students to appreciate the importance of accuracy and honesty. [GCO4]

How Far Can Our Paper Airplane Go?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Engage students in a discussion regarding how to maximize distance flown.
- Provide a collection of materials and tools for student use when constructing their paper airplanes.

Students may

- Research paper airplane designs.

Consolidation

Teachers may

- Facilitate a class fly-off to test their personally constructed paper airplanes.
- Ask students to describe problems they encountered in the construction and/or testing of their prototypes and how they overcame them.
- Organize a class air show for students to present their final designs to classmates.

Students may

- Document changes to their prototypes and testing results.
- Participate in a gallery walk to view prototypes of classmates and make suggestions for improvement.
- Discuss issues encountered with the rules of the fly-off. Make suggestions to improve the rules.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 54-55

NL Science 6: Flight (SR)

- pp. 40-41

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Paper airplane resources (websites and videos)
- Science resource suppliers (websites)

How Have Canadians Advanced Flight Technology?

Outcomes

Students will be expected to

51.0 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment
[GCO 1]

41.0 *provide examples of Canadians who have contributed to science and technology*
[GCO 1]

Focus for Learning

SCO 51.0 addresses how advancements in science and technology have changed society and the environment.

Students should

- discuss how development of the airplane has changed the way people work and live;
- discuss the impact of airplane use on the environment; and
- consider how development of drone technology is changing the way people work, live, and interact with the environment.

Encourage students to recognize that individuals from any cultural background can contribute equally to science and technology.

Students should briefly search the history of aviation in Canada and identify examples of Canadians, or Canadian companies, that have contributed to the development of flight technologies.

Additionally, this outcome provides an opportunity to explore the role Newfoundland and Labrador played in flight technology.

Attitude

Encourage students to

- show interest in the activities of individuals working in scientific and technological fields, and
- recognize that individuals of any cultural background can contribute equally to science. [GCO 4]

How Have Canadians Advanced Flight Technology?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present videos illustrating the history of aviation.

Connection

Students may

- Explore student resources on the Canadian Aviation and Space Museum website about Canadian aviation history.
- View real-time websites showing aircraft flying in Newfoundland and Labrador airspace.
- Explore how drones are currently being used to solve problems.
- Explore the impact of air travel on personal carbon footprints.

Consolidation

Students may

- Communicate to others what is learned about a Canadian contribution to flight technology.

Resources and Notes

Authorized

NL Science 6: Flight (TR)

- pp. 56-59

NL Science 6: Flight (SR)

- pp. 42-45

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Canadian aviation resources (websites and videos)

What New Flight Technologies Are Being Developed?

Outcomes

Students will be expected to

52.0 provide examples of how science and technology have been used to solve problems around the world [GCO 1]

38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries [GCO 1]

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

Focus for Learning

Technology is the application of science for practical purposes. Students should provide examples of flight technologies that have been used to solve problems. Airplanes, for example, have been designed for transporting people and goods, recreation, search and rescue, medevac, fighting forest fires, and military purposes. Similarly, helicopters have been designed for various purposes.

Flight technologies continue to evolve. Students should explore new flight technologies currently being developed.

Students should recognize that improving flight technologies, and developing new ones, requires continuous research and testing. Improvements in the tools and techniques of scientific investigations may fuel these advancements. The use of wind tunnels to test scale models is an example.

Students should

- identify wind tunnels as a technology that may be used to gather information about aircraft design,
- collaboratively design and build a wind tunnel, and
- use the wind tunnel to test personally created airfoils.

Refer to the *Integrated Skills* unit for elaboration of SCO 14.0.

What New Flight Technologies Are Being Developed?

Sample Teaching and Assessment Strategies**Connection**

Teachers may

- Present videos of wind tunnel tests.
- Invite an individual in the field of aviation to present to class.

Students may

- View images of different airplane and helicopter designs and predict the purpose for which each was designed.
- Explore how drones are currently being used to solve problems.
- Predict how flight technologies may change as a result of advancements in solar technology and autonomous vehicles.

Consolidation

Students may

- Construct a wind tunnel using, for example, a shoe box and a hair dryer.
- Use appropriate software to design and 3D print airfoils. Then, test the airfoils in the wind tunnel.

Resources and Notes**Authorized**

NL Science 6: Flight (TR)

- pp. 60-63

NL Science 6: Flight (SR)

- pp. 46-49

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Flight and wind tunnel technologies (websites and videos)

Section Three:
Specific Curriculum Outcomes

Unit 3: Electricity

Focus

Students encounter electricity every day of their lives. A basic understanding of how electricity works can help students recognize the need for safer practices when around electricity, begin to realize that they have control over how much electricity they use in the home and at school, and begin to understand the impact energy consumption has on electricity as a resource.

This unit emphasizes the social and environmental contexts of science and technology and has a strong scientific inquiry focus. Investigations to construct circuits, compare series and parallel circuits, identify materials that conduct electricity, and change the strength of an electromagnet provide opportunities to further develop inquiry-related skills.

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.

- 28.0 demonstrate that specific terminology is used in science and technology contexts
- 38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
- 40.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
- 47.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations
- 51.0 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment
- 61.0 describe examples of scientific questions and technological problems that have been addressed differently at different times
- 62.0 describe intended and unintended effects of a scientific or technological development
- 64.0 describe the potential impact of the use by humans of regional natural resources
- 65.0 describe how personal actions help conserve natural resources and protect the environment in their region

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 various methods for finding answers to questions and solutions to problems, and select one that is appropriate
- 7.0 devise procedures to carry out a fair test and to solve a practical problem
- 8.0 identify appropriate tools, instruments and materials to complete investigations
- 11.0 follow procedures
- 15.0 use tools and apparatus in a manner that ensures personal safety and the safety of others
- 21.0 draw a conclusion that answers an initial question
- 26.0 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.

- 53.0 compare the characteristics of static and current electricity
- 54.0 compare a variety of electrical pathways by constructing simple circuits
- 55.0 describe the role of switches in electrical circuits
- 56.0 compare characteristics of series and parallel circuits
- 57.0 compare the conductivity of a variety of solids and liquids
- 58.0 demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects
- 59.0 describe the relationship between electricity and magnetism when using an electromagnet
- 60.0 identify various methods by which electricity can be generated
- 63.0 identify and explain sources of electricity as renewable or non-renewable
- 66.0 identify and explain different factors that could lead to a decrease in electrical energy consumption in the home and at school
- 67.0 identify and explain the dangers of electricity at work or at play

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
- willingly observe, question, explore, and investigate
- demonstrate perseverance and a desire to understand
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions
- 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 using materials
- become aware of potential dangers

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 6	Science 9
<i>Invisible Forces</i>	<i>Electricity</i>	<i>Characteristics of Electricity</i>
<ul style="list-style-type: none"> • identify conditions that affect static electric materials • describe and demonstrate ways to use everyday materials to produce static electric charges, and describe how charged materials interact • describe the effects of static electricity in their daily lives, and identify ways in which static electricity can be used safely or avoided 	<ul style="list-style-type: none"> • compare characteristics of static and current electricity • compare electrical pathways by constructing simple circuits • describe the role of switches in electrical circuits • compare characteristics of series and parallel circuits • compare conductivity of various solids and liquids • demonstrate how electricity can produce light, heat, sound, motion, and magnetic effects • describe the relationship between electricity and magnetism when using an electromagnet • identify methods by which electricity can be generated • identify and explain renewable and non-renewable sources of electricity • identify and explain practices to decrease electrical energy consumption • identify and explain the dangers of electricity 	<ul style="list-style-type: none"> • explain the production of static electrical charges in some common materials • identify properties of static electrical charges • compare qualitatively static electricity and electric current • describe the flow of charge in an electrical circuit • describe series and parallel circuits involving varying resistance, voltage, and current • relate electrical energy to domestic power consumption costs • determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy • describe the transfer and conversion of energy from a generating station to the home

Suggested Unit Plan

Electricity is the second physical science unit in the Science 6 curriculum.

September	October	November	December	January	February	March	April	May	June
					Electricity				

Communicating About Electricity

Outcomes

Students will be expected to
28.0 demonstrate that specific terminology is used in science and technology contexts
[GCO 1]

Focus for Learning

In this unit, students learn about electric charges, static and current electricity, and series and parallel circuits. Students then explore the natural resources we use to generate electricity, their impacts on the environment, and how we can use electricity sustainably.

Throughout the unit, when communicating about electricity, students are expected to use specific terminology. Electricity-related terminology should be introduced and defined as the need emerges.

Science process-and skill-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.

Electricity-related terminology includes

- static electricity, current electricity;
- attract, repel, electric charge, neutral object, electric discharge electroscope;
- source, load, connector, electric cell (battery), switch;
- open circuit, closed circuit, series circuit, parallel circuit;
- conductivity, conductor, insulator;
- electromagnet, generator, turbine, motor; and
- renewable resources, non-renewable resources, sustainable, energy consumption, and energy efficiency.

Student use of appropriate, specific terminology is a constant expectation in *Science 6*.

Refer to the initial elaboration of SCO 28.0 provided on pp. 76-77.

Communicating About Electricity

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students
 - What do you already know about electricity?
 - What experiences have you had with electricity?
 - What would you like to find out about electricity?
- Create a class concept map or brainstorming web of electricity-related terminology.
- Add electricity-related terms to the science word wall as they are introduced.

Connection

Teachers may

- Provide a variety of fiction and non-fiction children's books and magazines related to electricity for students to read and explore.
- Set up a working electric circuit in the classroom, with switches and different loads, and ask students to explain how it works and the function of each part.
- Model the use of appropriate scientific and technological terms and encourage students to adopt them.
- Incorporate specific terminology into literacy block activities.
- Facilitate group investigations, 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.
- Create a visual glossary of specific terminology using personal illustrations and definitions in their own words.
- Record their questions related to electricity on the class "I Wonder Wall" or in a personal science journal.

Resources and Notes

Authorized

NL Science 6: Electricity
(Student Resource [SR])

- pp. 1-55, 56-59

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/science-6/teaching-and-learning-strategies.html
 - *Electricity Resources and Activities*

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Electricity resources (websites and videos)

How Do We Use Electricity?

Outcomes

Students will be expected to

51.0 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment
[GCO 1]

Focus for Learning

Students should

- explore what life in Newfoundland and Labrador was like before electricity;
- recognize how electricity changed, and continues to change, people's lives; and
- develop an awareness of the many ways they use electricity in their daily lives.

Encourage students to ask questions about electricity and share what they already know.

Attitude

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

Sample Performance Indicators

1. Describe what school life was like 150 years ago and how electricity has changed it.
2. Identify ten different ways you use electricity in a typical day.

How Do We Use Electricity?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate a collaborative brainstorming session. Ask students to consider ways their daily life would be different if there was no electricity.
- Role-play how your morning routine would be different without electricity.
- Ask students how they would prepare for a camping trip when there is no source of electricity.
- Ask students to describe how they think people in Newfoundland and Labrador did the following activities 50 years ago:
 - communicated with people who lived far away,
 - travelled from one place to another,
 - cooked and cleaned,
 - spent their leisure time,
 - heated their home,
 - worked in a store or office,
 - farmed, fished, logged, or mined, and
 - learned at school.

Connection

Students may

- Imagine that a blackout has occurred and investigate ways you could still heat and light your house.
- Create a poster comparing aspects of daily life before and after electricity.

Consolidation

Students may

- Use research inquiry to investigate how electricity has changed an aspect of daily life and communicate findings using a format of their choosing (e.g., storyboard/comic strip).

Resources and Notes

Authorized

NL Science 6: Electricity
(Teacher Resource [TR])

- pp. 10-15

NL Science 6: Electricity (SR)

- pp. 6-7

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activity 1
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- How do we use electricity? (websites and videos)

Other curriculum resources

- *Power Up* (ELA 6)

How Are Static and Current Electricity Different?

Outcomes

Students will be expected to

53.0 compare the characteristics of static and current electricity
[GCO 3]

47.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations
[GCO 1]

11.0 follow procedures
[GCO 2]

Focus for Learning

In Science 3, students explored static electricity as an invisible force and observed how charged materials attract and repel objects. In Science 6, students will further explore static electricity and compare its characteristics with that of current electricity.

Students should create static electric charges using a variety of materials and follow procedures to explore their interactions.

Students should come to understand that

- matter contains tiny positive and negative electric charges;
- when objects are rubbed together, negative electric charges move from one object to the other creating an imbalance of positive and negative electric charges on both objects;
- the build up of positive or negative electric charges on the surface of an object is called static electricity;
- objects with more positive electric charges than negative (imbalance) are said to have an overall positive charge;
- objects with more negative electric charges than positive (imbalance) are said to have an overall negative charge;
- objects with an equal number of positive and negative electric charges (balanced) are electrically neutral;
- charged objects with like charges repel (i.e., both objects have positive charges, both objects have negative charges);
- charged objects with opposite charges attract (i.e., one object has a positive charge and the other object has a negative charge);
- charged objects (positive or negative) attract neutral objects; and
- electric discharge occurs when static electricity leaves an object.

The triboelectric series (available in many forms online) ranks the tendency of a material to become positively or negatively charged.

Student exploration of static electricity provides an opportunity to assess skill outcomes 3.0, 11.0, 21.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration.

Note, the concept of an atom is not introduced until Science 9. Use of the term electron (a subatomic particle) to refer to negative electric charges should be avoided.

Sample Performance Indicator

A balloon rubbed against human hair is brought close to another balloon rubbed against polyester. The balloons attract each other.

- Use your understanding of static electricity to explain why the balloons attract.
- Predict and explain what might happen if the polyester material and human hair used to rub the balloons are brought close together.

Continued

How Are Static and Current Electricity Different?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Introduce static electricity by asking students to rub their arm against the back of their plastic chair and observe the hairs on their arm. Ask whether other materials behave in similar ways.
- Ask students where they have observed static electricity.

Connection

Teachers may

- Provide a collection of materials (e.g., aluminum foil, acetate, balloons, cotton fabric, feathers, foam plates, fur, nylon, paper, microfiber cloth, plastic, polyester, silk, wool). Ask students to rub different materials together to create static electricity.
- Present an online triboelectric series chart. When two materials are rubbed together, students should determine which one becomes positive and which becomes negative.
- Discuss dangers and useful applications of static electricity.
- Present videos explaining static electricity.

Students may

- Explore charging balloons and sticking them to the wall (neutral object) and investigate factors affecting the length of time they remain attached.
- Have a soda-can race. Charge a balloon and use it to attract a soda can laid on its side; making it roll without touching.
- Construct a static flyer using a balloon and a plastic produce bag.
- Predict what might happen if two materials close to each other on the triboelectric series are rubbed together and test the prediction.

Consolidation

Students may

- Follow provided procedures; rubbing balloons on strings with different materials and then holding them by their strings and bringing them together to observe whether they attract or repel. Discharge static between trials by tapping against a metal object. Foam plates may be used instead of balloons.
- Create an electroscope and investigate the qualitative strength of various electric charges. If, at times, the electroscope does not appear to be working, suggest possible reasons for this observation (e.g., accidentally discharging static).
- Use their understanding of electric charges to explain interactions observed between charged objects.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 16-25

NL Science 6: Electricity (SR)

- pp. 8-13

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- How are static and current electricity different? (websites and videos)

How Are Static and Current Electricity Different?

Outcomes

Students will be expected to

53.0 compare the characteristics of static and current electricity
[GCO 3]

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

15.0 use tools and apparatus in a manner that ensures personal safety and the safety of others
[GCO 2]

Focus for Learning

Current electricity has not previously been addressed in the science program. Students should come to understand that current electricity

- is the type of electricity used to power devices;
- refers to a continuous flow of negative charges (current);
- comes from sources such as batteries, generators, and power stations; and
- requires an electric circuit (i.e., closed path) to flow.

Note, the terms battery and electric cell are not interchangeable. Familiar AA, AAA, C, and D electric cells are often erroneously referred to as batteries, even though each contains a single 1.5 volt (V) electric cell of varying sizes. Common 9 V batteries contain six individual 1.5 V cells joined together. Be consistent in your use of these terms (e.g., AA cells, 9 V batteries).

Students should explore how current electricity can be used to make a light come on.

Provide students with the materials required to construct an electric circuit (i.e., electric cell or battery, LED or miniature light bulb, copper tape, wires, or wires with alligator clips). Encourage students to plan and try out many different arrangements of parts to make the light come on, and record their observations.

Note, small battery-powered circuits are considered safe when properly constructed and handled. Ensure the voltage of the power source does not exceed the required voltage of the load(s) it is powering. If attempting to turn on a 1.8 V red LED, for example, a 1.5 V cell should be used, not a 9 V battery. Use of safety glasses is recommended when constructing circuits.

In addition to skill outcomes 7.0 and 15.0, evidence may be collected to assess outcomes 8.0, 12.0, 13.0, 21.0, 24.0, 25.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Attitude

Encourage students to

- demonstrate perseverance and a desire to understand,
- show concern for their safety and that of others when planning and carrying out activities and in choosing and using materials, and
- become aware of potential dangers. [GCO 4]

Sample Performance Indicators

1. Compare the characteristics of static and current electricity using a Venn diagram.
2. Demonstrate one arrangement of circuit components that results in the light coming on and one arrangement that does not.

How Are Static and Current Electricity Different?

Sample Teaching and Assessment Strategies

LEDs only allow electric current to flow through them in one direction. If they do not light in a circuit, students should flip them around and try again.

Activation

Teachers may

- Preassess student understanding of current electricity by asking what they already know about it (e.g., Where does it come from?, How does it get to our home and school?, What might it be used for?).
- Demonstrate a static duster and ask students to describe how they think it works. Then demonstrate an electrical device with and without its power source and, similarly, ask students to describe how it works.

Students may

- Identify everyday devices powered by current electricity.

Connection

Teachers may

- Provide students with components of an electric circuit and ask them to try different arrangements to make the light turn on. This could be facilitated during unstructured time.

Students may

- Relate their understanding of current electricity to a current in a body of water.

Consolidation

Students may

- Present various incorrect arrangements of circuit components and ask students to fix the circuit, making the light come on.
- Record, using sketches or digital images, arrangements of circuit components that make the light come on and those that did not make the light come on.
- Compare static and current electricity based on how it is created (source), required materials, whether it moves, and what it is used for.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 16-27

NL Science 6: Electricity (SR)

- pp. 8-15

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit
 - Be Safe, Electricity

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/science-6/teaching-and-learning-strategies.html
 - *Electricity Resources and Activities*

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- How are static and current electricity different? (websites and videos)

What Do We Need to Make an Electric Circuit?

Outcomes

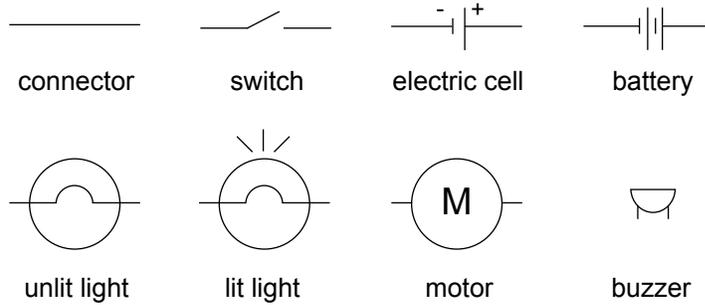
Students will be expected to

54.0 compare a variety of electrical pathways by constructing simple circuits [GCO 3]

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

Focus for Learning

Introduce symbols to represent circuit components as needed.



Students should construct simple circuits using a variety of power sources, connectors, and loads, to determine what is needed to make an electric circuit. They should

- devise procedures to follow and identify appropriate tools and materials to complete their investigation (SCOs 7.0 and 8.0),
- safely use tools and materials to construct electric circuits (SCO 15.0),
- record their observations in circuit diagrams (SCO 13.0), and
- conclude what is needed to make an electric circuit (SCO 21.0).

Students should conclude that to make an electric circuits requires

- a power source (e.g., electric cell, battery);
- connectors (i.e., conductors); and
- one or more loads (e.g., light, motor, buzzer).

For loads to operate, the circuit must be complete. There must be a continuous flow of electricity from the negative terminal of the power source, through the connectors and loads, and back to the positive terminal of the source. If the circuit pathway is broken, the flow of current electricity stops instantly.

Students should be able to accurately draw circuit diagrams of simple circuits and construct circuits from diagrams.

Sample Performance Indicator

Construct an electric circuit that powers two loads and represent it using a circuit diagram.

What Do We Need to Make an Electric Circuit?

Sample Teaching and Assessment Strategies

Components of electric circuits can be sourced locally or purchased from science supply companies. Strings of mini lights can be re-purposed for student use in constructing circuits. Using wire cutters, snip the wire on either side of the bulb, leaving 3-4 cm of wire attached. Using a wire stripping tool, remove 1 cm of the wire insulation from each end to allow contact with alligator clips or other connectors.

Activate

Teachers may

- Introduce the terms source, load, and connector. Ask students to identify examples of each from materials previously used.

Connection

Teachers may

- Provide a variety of components for student use in constructing simple circuits (e.g., electric cells, batteries, wire, wires with alligator clips, copper tape, aluminum foil, light bulbs, LEDs, motors, buzzers) and tools (e.g., wire cutters, wire strippers).

Students may

- Draw a circuit diagram for an arrangement of components from the previous investigation that made the light come on.
- Practice drawing circuit diagrams for constructed circuits.
- Construct a variety of simple circuits using Snap Circuits®.
- Create circuits using online circuit builders.

Consolidation

Teachers may

- Provide diagrams of simple circuits for student to construct.
- Provide diagrams of complete and incomplete circuits. Ask students to predict whether the loads will operate.

Students may

- Predict whether a circuit will power the load or not, when presented with an image of a circuit.
- Explain how to modify an incomplete circuit to make the loads function.
- Construct simple paper circuits as part of a makerspace activity.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 28-31

NL Science 6: Electricity (SR)

- pp. 16-17

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Electric Symbols (BLM)
- IWB Activity 2
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/science-6/teaching-and-learning-strategies.html
- *Electricity Resources and Activities*

Supplementary

- Snap Circuit® kit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Making electric circuits (websites and videos)
- Science resource suppliers (websites)

What Do Switches Do in Electric Circuits?

Outcomes

Students will be expected to

55.0 describe the role of switches in electrical circuits
[GCO 3]

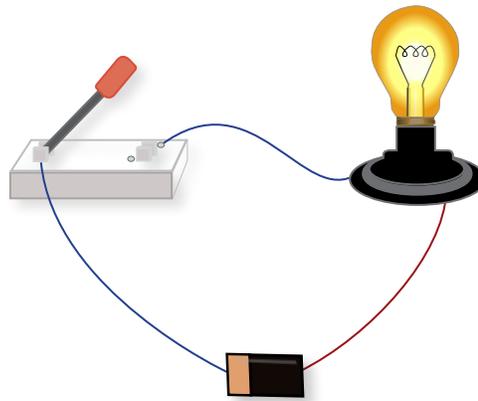
Focus for Learning

Switches are electrical devices that are used to control a circuit. Introduce the electrical symbol for a switch, if not previously addressed.

Students should explore the roll of switches by inserting them, in various locations, into personally constructed circuits. Observations when the switch is open and closed, should be recorded using digital images or circuit diagrams.

Student exploration provides an opportunity to address skill outcomes (e.g., SCOs 8.0, 15.0, 21.0, 26.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Sample Performance Indicators



The simple electric circuit above contains a knife switch.

1. Is the switch open or closed?
2. Describe how the switch controls the flow of electricity.
3. Does the location of the switch in the circuit make any difference?

What Do Switches Do in Electric Circuits?

Sample Teaching and Assessment Strategies

The role of switches could be addressed when addressing SCO 54.0.

Activation

Teacher may

- Provide simple electrical devices (e.g., flashlight, desk lamp) that can be turned on and off for students to disassemble. Ensure the device is unplugged or the battery is removed before disassembly. Ask students to predict and examine how turning off the device works.

Connection

Teachers may

- Introduce examples of different types of switches:
 - toggle (light switch),
 - push button (door bell),
 - pull chain (lights installed on some basements or utility areas),
 - mercury switch (old-fashioned analog thermostats),
 - temperature switch (analog thermostats),
 - dimmer switch,
 - electronic switches (touch sensitive switches), and
 - motion activated switches.
- Describe the function of circuit breaker switches in homes.

Students may

- Brainstorm ways that a circuit might be constructed to be able to turn a load on and off.
- Brainstorm everyday devices that include a switch and identify the type of switch used.

Consolidation

Students may

- Construct circuits with one or more switches and record observations.
- Construct circuits with a switch using Snap Circuits®.
- When the refrigerator door opens, a light inside comes on. Describe how this switch might work.

Extension

Students may

- Research and communicate how a dimmer switch works.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 32-35

NL Science 6: Electricity (SR)

- pp. 18-19

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Electric Symbols (BLM)
- IWB Activity 3
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

- Snap Circuit® kit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Switches and electric circuits (websites and videos)
- Science resource suppliers (websites)

How Are Series and Parallel Circuits Different?

Outcomes

Students will be expected to

56.0 compare characteristics of series and parallel circuits [GCO 3]

26.0 communicate procedures and results [GCO 2]

Focus for Learning

Circuits can be constructed in two main ways. In a series circuit, there is only one pathway the electric current can flow through. In a parallel circuit, there are two or more different pathways through which current can flow (*NL Science 6: Electricity*, p. 20).

Students should

- draw circuit diagrams of simple series and parallel circuits,
- construct series and parallel circuits with different numbers of cells and loads, and
- identify similarities and differences between series and parallel circuits.

To compare the characteristics of series and parallel circuits, students should engage in guided inquiry to determine the effects of similar changes in each type of circuit. They should

- select appropriate materials to construct a series and a parallel circuit using the same components (e.g., two electric cells, connectors, and two lights, motors, or buzzers);
- devise procedures to change the circuit in some way (e.g., add or remove a load from the circuit, insert an open switch in different locations, break the circuit);
- make and record observations (e.g., circuit diagrams, digital images, written language); and
- draw conclusions and communicate what was learned.

When circuit components are combined in series, current flows from the power source, through all loads and switches, and back to the power source through only one pathway. If a switch is opened, all loads go off. If there is a break anywhere in the circuit (e.g., a bulb burns out), all remaining loads go off. If a load is added to the circuit, current must flow through the additional load, reducing the energy available to each load; lights will get dimmer, motors will turn more slowly, buzzer volume will decrease. If a load is removed from the circuit, the energy available to remaining loads increases; lights get brighter, motors spin more rapidly.

When circuit components are combined in parallel, current flows through each pathway. If a switch is opened, it only turns off loads on that parallel pathway. Similarly, if a break occurs (e.g., a bulb burns out), loads on other parallel pathways are unaffected. Each parallel pathway acts independently. Adding or removing a load does not affect the energy available to loads on other pathways. Each bulb, motor, or buzzer continues to operate, unaffected.

Note, during exploration, if loads in parallel are affected by the addition or removal of a load, the power source is insufficient to meet the energy demands and should be increased.

Continued

How Are Series and Parallel Circuits Different?

Sample Teaching and Assessment Strategies

Use of copper tape, instead of wires, when initially constructing parallel circuits may help students visualize the different parallel pathways.

Activation

Teachers may

- Present strings of mini lights that are wired in series and parallel. Allow students to examine how the lights are wired in each string. Plug in the lights and remove one bulb from each string. Ask students to observe the effect this has on the remaining bulbs (they should all go out if wired in series) and explain the observation.

Connection

Teachers may

- Draw a circuit diagram for several cells, a switch, and some loads arranged in series and in parallel.
- Distribute cards indicating circuit type and the number of cells, switches, and loads. Ask students to draw their circuit.

Consolidation

Students may

- Explore circuits wired in series and parallel and explain how they are similar and different.
- Explain some advantages of parallel circuits.
- Explain the differences between series and parallel circuits in a foldable, no-staple booklet.
- A 3 V cell provides power to a LED wired in series. When two more LEDs are added to the series circuit the brightness of the LEDs is dim. Predict how many volts of energy each bulb is receiving. How might you test your prediction (use a voltmeter)?
- Create series and parallel circuits using Snap Circuits®.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 36-41

NL Science 6: Electricity (SR)

- pp. 20-21

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Circuit Cards (BLM)
- IWB Activity 4
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

- Snap Circuit® kit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Series and parallel circuits (websites and videos)

How Are Series and Parallel Circuits Different?

Outcomes

Students will be expected to

56.0 compare characteristics of series and parallel circuits [GCO 3]

26.0 communicate procedures and results [GCO 2]

Focus for Learning

In addition to SCO 26.0, this guided investigation provides an opportunity to assess additional skill outcomes (e.g., 3.0, 4.0, 7.0, 8.0, 12.0, 13.0, 21.0, 23.0, 24.0, 25.0). Refer to the *Integrated Skills* unit for elaboration.

Attitude

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

Sample Performance Indicators

1. If your home was wired in series, what would happen when you turned off your bedroom light?
2. Should speakers at a concert be installed in series or in parallel? Explain the reason for your choice.
3. Using a Venn diagram, identify similarities and differences between series and parallel circuits.

How Are Series and Parallel Circuits Different?

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

NL Science 6: Electricity (TR)

- pp. 36-41

NL Science 6: Electricity (SR)

- pp. 20-21

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Circuit Cards (BLM)
- IWB Activity 4
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

- Snap Circuit® kit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Series and parallel circuits (websites and videos)

Which Materials Conduct Electricity?

Outcomes

Students will be expected to

- 57.0 compare the conductivity of a variety of solids and liquids [GCO 3]
- 6.0 *identify various methods for finding answers to questions and solutions to problems, and select one that is appropriate* [GCO 2]
- 8.0 identify appropriate tools, instruments and materials to complete investigations [GCO 2]

Focus for Learning

Students should describe conductivity as the degree to which a material lets electric current pass through it. They should identify materials that let a lot of electricity pass through them as conductors and those that let very little pass through as insulators.

Students should investigate to determine how well different solids and liquids conduct electricity. They should

- generate possible methods to test conductivity and choose one;
- construct a conductivity tester using appropriate tools and materials;
- select a variety of solids (e.g., glass, plastic, various metals, wood) and liquids (e.g., pickle juice, tap water, salt water, vinegar) to test and justify their choices;
- devise procedures to carry out a fair test of each material;
- make predictions about the conductivity of materials tested;
- carry out their conductivity tests, making and recording relevant observations; and
- compile and display findings, classifying materials tested as good conductors, good insulators, or poor conductors/insulators.

To test for conductivity, students will need to make the test substance act as a connector. The circuit must also include a power source and a device (e.g., LED, light bulb, motor, buzzer) that can be used to determine if the circuit is complete. A material that is a good conductor will allow the device to operate at full capacity. Poor conductors/insulators will only operate the device at reduced capacity (e.g., dimmer light). A good insulator will not complete the circuit, thus the device will not work.

In addition to SCOs 6.0 and 8.0, additional skill outcomes that may be assessed include 3.0, 4.0, 5.0, 7.0, 9.0, 10.0, 12.0, 13.0, 15.0, 16.0, 17.0, 18.0, 19.0, 21.0, 25.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration.

Attitude

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

Sample Performance Indicator

Position the solids and liquids tested on the continuum below to indicate their relative conductivity.



Good Insulator

Good Conductor

Which Materials Conduct Electricity?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Provide a collection of solid and liquid materials for students to use in conductivity testing.
- Suggest that students attach craft sticks, for ease of handling, to connecting wires that will be dipped in liquids to test for conductivity.
- Depending on the setup, ask students how far apart the connecting wires are when testing for conductivity. Controlling the distance for each test is very important to ensure fair testing.

Students may

- Share their ideas on how to use an electric circuit to test whether materials are conductors or insulators.
- View, if necessary, online videos instructing how to make a conductivity tester.
- Compare the conductivity of personally selected materials.
- Perform repeated tests to evaluate each material.
- Collaboratively decide how they will record their predictions and observations (e.g., table, digital images, video).

Consolidation

Students may

- Compare the conductivity of various types of water (e.g., bottled, tap, carbonated, salt).
- Compare the conductivity of various household cleaning products.
- Create a display to classify materials tested as good conductors, good insulators, or poor conductors/insulators.
- Discuss what characteristics make some solids and liquids good conductors and others good insulators.

Extension

Students may

- Investigate how much salt is necessary to make water a good conductor.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 46-47

NL Science 6: Electricity (SR)

- pp. 22-23

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activity 5
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Conductors and insulators (websites and videos)

How Can We Use Electrical Energy to Create Other Forms of Energy?

Outcomes

Students will be expected to

58.0 demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects [GCO 3]

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

Focus for Learning

Students should identify devices that transform electrical energy into more useful energy forms:

- Light bulbs (e.g., incandescent, fluorescent, halogen, LED) transform electrical energy into light energy.
- Baseboard heaters, hair dryers, clothes dryers, stove tops, ovens and toasters transform electrical energy into thermal or heat energy (some of these devices also produce light).
- Devices with motors (e.g., blenders, fans, mixers, washing machines, power tools) transform electrical energy into motion.
- Speakers, buzzers and radios transform electrical energy into sound.
- Electromagnets transform electrical energy into a magnetic energy.

Students should engage in an engineering design and problem solving activity to construct a device that converts electric energy into two or more other forms of energy (i.e., light, heat, sound, motion).

Note, electromagnets are addressed later in the unit and may be excluded from this activity. Students should

- propose possible devices that meet the design criteria and select one to try;
- select appropriate tools, instruments, and materials needed to construct their device;
- devise and carry out a plan to construct a prototype of their device;
- test and evaluate their prototype, making changes and modifications as needed; and
- communicate their final solution to others, demonstrating how the device works and solves the identified problem.

Student constructed solutions will likely include devices such as a light, buzzer, or motor. Bare nichrome wire may be used to produce heat.

In addition to SCO 1.0, outcomes 7.0, 8.0, 12.0, 16.0, 25.0, and 26.0 may be assessed. Refer to the *Integrated Skills* unit for elaboration.

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

Construct a circuit from provided materials to demonstrate how electrical energy can produce light, heat, sound, or motion.

How Can We Use Electrical Energy to Create Other Forms of Energy?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Provide clear, incandescent light bulbs for students to observe the filament that transforms electrical energy to light energy.
- Discuss how some devices transform electrical energy into more than one form of energy (e.g., incandescent light bulbs produce light and heat, oven elements produce heat and light).
- Discuss how electrical and magnetic energy are closely related. Share how a coil of wire, with an electric current flowing through it, can produce a powerful magnetic field.

Students may

- Identify common electrical devices in their homes that transform electricity into other forms.
- Classify household, electrical devices according to the type of energy they produce (i.e., heat, light, sound, motion).
- Create a simple circuit including a power source and a length of bare nichrome wire. Briefly connect the power source and make observations by placing your finger on the bare nichrome wire.

Consolidation

Students may

- Create a circuit diagram of their preferred solution and annotate the diagram to indicate the energy transformations that occur.
- Using Snap Circuits®, construct a circuit that transforms electrical energy into two or more other forms of energy.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 52-55

NL Science 6: Electricity (SR)

- pp. 30-33

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activity 6
- Skills and Processes for Design and Problem Solving rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Supplementary

- Snap Circuit® kit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Build a buzzer (website)
- Science resource suppliers (websites)

How Can We Change the Strength of an Electromagnet?

Outcomes

Students will be expected to

58.0 demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects [GCO 3]

59.0 describe the relationship between electricity and magnetism when using an electromagnet [GCO 3]

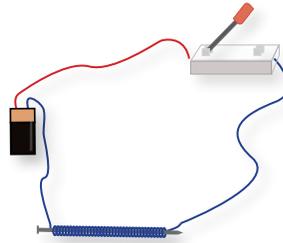
3.0 state a prediction and a hypothesis [GCO 2]

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

40.0 describe instances where scientific ideas and discoveries have led to new inventions and applications [GCO 1]

Focus for Learning

Creating an electromagnet requires a connector wire long enough to make a coil, a large common nail, and an electric cell or battery.



Students should carry out an investigation to determine how different variables affect the strength of the electromagnet. They should

- brainstorm possible ways to change to the electromagnet (e.g., number of electric cells or battery size, wire type, number of coils wrapped around the nail, size or type of nail) and select one variable to test (i.e., independent variable);
- propose a testable question to investigate (e.g., Does increasing the number of coils affect the strength of the electromagnet?);
- state a prediction and a hypothesis;
- operationally define the independent variable (e.g., test the electromagnet using 5, 10, 15, and 20 coils) and dependent variables (e.g., number of paper clips it can pick up);
- identify variables that must be controlled to maintain a fair test;
- devise a procedure to carry out a fair test, including multiple trials;
- make and record observations for each trial; and
- draw a conclusion and communicate to others what was learned.

Evidence from this investigation may be used to assess skill outcomes 3.0, 7.0, 1.0, 2.0, 4.0, 5.0, 9.0, 12.0, 13.0, 15.0, 18.0, 19.0, 21.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration.

Students should describe how understanding that electric current flowing through wire coils produced a magnetic effect led to new inventions and applications (e.g., junkyard electromagnets, maglev trains, microwave ovens, speakers).

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 Indicators

1. Describe how to transform an iron nail into an electromagnet.
2. How can you increase the strength of an electromagnet?

How Can We Change the Strength of an Electromagnet?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Demonstrate the magnetic effects of electric currents by placing a compass next to a complete circuit. The electric current should cause deflection of the compass needle.
- Present and discuss applications of electromagnets (e.g., speakers, maglev trains, junk yard electromagnets).
- Provide a collection of materials for student use when investigating variables affecting the strength of an electromagnet (e.g., 1.5 V electric cells of various sizes [AA, AAA, C, D], button cells, 9 V batteries, insulated and bare wire of varying gauges, common nails of varying sizes, galvanized nails).

Students may

- Make predictions and hypotheses using the “If..., then... because...” template.
- Digitally record the carrying out of their investigation and view the video to ensure the investigation was fairly carried out.
- Choose an appropriate format to communicate to others their question, what they did, and what they found out.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 58-61

NL Science 6: Electricity (SR)

- pp. 34-35

NL Science 6: Online Teaching Centre

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

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Electromagnet resources (websites and videos)
- Science resource suppliers (websites)

How Is Most Electricity Generated?

Outcomes

Students will be expected to

60.0 identify various methods by which electricity can be generated
[GCO 3]

61.0 describe examples of scientific questions and technological problems that have been addressed differently at different times
[GCO 1]

62.0 describe intended and unintended effects of a scientific or technological development
[GCO 1]

Focus for Learning

An electrical generator is one method of producing electricity. Most electrical generators consist of an electromagnet that spins inside coils of wire. The electromagnet is attached by a shaft to a turbine. When the turbine turns, the attached electromagnet spins and generates electricity in the wire coils. Methods used to turn the turbine include

- moving water (i.e., hydroelectric dams, tidal power),
- wind, and
- high-pressure steam (thermal energy) generated by burning fossil fuels or biomass, nuclear reactors, or geothermal sources).

Other methods of electricity generation include

- solar panels transforming solar energy to electricity, and
- electric cells and batteries transforming chemical energy into electricity.

SCO 61.0 illustrates an aspect of the nature of technology. Technology is developed to solve problems and meet human needs. As the needs of societies change, technology changes. Students should describe how the generation of electrical energy has changed over time (e.g., replacing burning coal and oil with greener technologies [hydroelectricity, wind power, solar power]).

Students should recognize that, regardless of method used, the generation of electricity has both intended and unintended effects (e.g., negative environmental effects). Students should briefly research the pros and cons of different electricity generation methods: hydropower, tidal power, wind power, thermal power (fossil fuels, biomass, nuclear), geothermal power, solar power (*NL Science 6: Electricity*, pp. 38-41).

Attitude

Encourage students to realize that the applications of science and technology can have both intended and unintended effects.
[GCO 4]

Sample Performance Indicators

1. Explain how turbines and generators produce electricity.
2. Describe four different sources used to spin a turbine shaft and generate energy.
3. Describe the pros and cons of generating electricity using different methods.

How Is Most Electricity Generated?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Brainstorm with the class various ways electricity is produced.
- Present hand-powered electrical devices (emergency flashlight, emergency radio, lantern) for students to try out. Ask students how they think turning the crank works to create electricity.
- Remind students how an electromagnet works.
- Present videos about how turbines and generators work.

Connection

Students may

- Consider how a generator that uses a magnet is similar to an electromagnet.
- Power a LCD clock or small light using citrus fruit or a potato. Insert a galvanized nail (zinc coated) and a piece of copper into the fruit or potato about 1 cm apart and connect to the device.
- Construct a turbine from a cork and cardstock. Brainstorm possible ways to spin the turbine.
- Research how NL Hydro generates electricity in our province.

Consolidation

Teachers may

- Inform students that a proposed, new coastal community is looking for a source of electricity. Ask them to present developers with three electricity generation options, indicate the pros and cons of each option, and recommend a preferred option.

Students may

- Read pages 38-41 (*NL Science 6: Electricity*) and identify the pros and cons of the electricity generation methods depicted.
- Following research into different electricity generation methods, consider which generation methods might be available in Newfoundland and Labrador, which method is most reliable, and which has the least impact on the environment.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 62-71

NL Science 6: Electricity (SR)

- pp. 36-41

NL Science 6: Online Teaching Centre

- IWB Activity 7

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Electricity generation (websites and videos)
- www.poweryourknowledge.com (NL Hydro)

Other curriculum resources

- *Power Up* (ELA 6)

What Sources of Electricity Are Renewable or Non-Renewable?

Outcomes

Students will be expected to

63.0 identify and explain sources of electricity as renewable or non-renewable
[GCO 3]

64.0 describe the potential impact of the use by humans of regional natural resources
[GCO 1]

65.0 describe how personal actions help conserve natural resources and protect the environment in their region
[GCO 1]

66.0 identify and explain different factors that could lead to a decrease in electrical energy consumption in the home and at school
[GCO 3]

Focus for Learning

Students should

- identify solar, wind, hydroelectric, geothermal, tidal, and biomass as renewable energy sources;
- identify fossil fuels [coal, oil, natural gas] and nuclear power as non-renewable energy sources; and
- recognize that renewable sources cannot be used up, while non-renewable resources eventually run out.

Students should consider the impact on resources (renewable and non-renewable) caused by methods used to generate electricity in Newfoundland and Labrador (i.e., hydroelectric, thermal (fossil fuels), wind, diesel generators).

Students should explore the concept of sustainable energy use and describe actions to reduce consumption of electrical energy at home and at school.

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]

Sample Performance Indicators

1. Describe ways to reduce your personal electricity consumption.
2. Describe how reducing electricity consumption helps conserve natural resources and protects the environment.

What Sources of Electricity Are Renewable or Non-Renewable?

Sample Teaching and Assessment Strategies

Activate

Teachers may

- Invite students to share their prior knowledge about renewable energy.
- Pose the question, “Why is it important for us to conserve energy?”

Connection

Teachers may

- Present digital news articles about current renewable energy initiatives or new electricity generation technologies.
- Present current data on energy use in Canada compared to other countries.

Students may

- Classify electricity generation methods as using renewable or non-renewable resources.
- Read or revisit *Power Up* magazine, an authorized resource for ELA 6.
- Brainstorm ways to conserve electricity at home and at school.

Consolidation

Students may

- Choose an appropriate format to communicate the negative impacts of electricity generation on the natural resources of Newfoundland and Labrador and suggest ways to reduce consumption.
- Create tip sheets of simple ways to conserve electricity at home and at school.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 72-81

NL Science 6: Electricity (SR)

- pp. 38-41

NL Science 6: Online Teaching Centre

- IWB Activity 8

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Renewable and non-renewable sources of electricity (websites)
- Sustainable use (websites and videos)

Other curriculum resources

- *Power Up* (ELA 6)

How Can We Stay Safe Around Electricity?

Outcomes

Students will be expected to

67.0 identify and explain the dangers of electricity at work or at play
[GCO 3]

38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
[GCO 1]

Focus for Learning

Students should identify potential hazards of using electricity and how to stay safe. The focus should be identifying and explaining dangerous situations involving electricity hazards at home and in their community (e.g., frayed wires, electrical devices near water, electrical cords near heaters, low hanging or downed power lines) and explaining what safety precautions should be taken.

Additionally, students should describe the purpose of various technologies invented to keep people safe when using electricity (e.g., outlet plug protectors, surge protectors, circuit breakers, wire insulation, GFCI outlets, three pronged plugs).

Attitude

Encourage students to become aware of potential dangers. [GCO 4]

How Can We Stay Safe Around Electricity?

Sample Teaching and Assessment Strategies

Connection

Students may

- Describe personal safety practices followed when using electrical devices at home.
- Discuss precautions taken when plugging and unplugging devices from electrical outlets.
- Research ways to stay safe when using electricity. Discuss why each safety tip is necessary and what might happen if not followed.

Consolidation

Students may

- Explain why it is important to
 - keep electrical devices away from water,
 - not poke things into an electrical outlet,
 - stay away from low-hanging power lines, and
 - avoid frayed wires.
- Explain the purpose of a surge protector and circuit breaker.
- Design a brochure or poster for “Rules for Electric Safety”.

Resources and Notes

Authorized

NL Science 6: Electricity (TR)

- pp. 82-87

NL Science 6: Electricity (SR)

- pp. 48-49

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Safety resources (websites and videos)

Section Three:
Specific Curriculum Outcomes

Unit 4: Diversity of Life

Focus

Students are able to recognize that living things can be subdivided into smaller groups. As an introduction to the formal biological classification system, students should focus on plants, animals, fungi, and microorganisms. Students should have the opportunity to learn about an increasing variety of living organisms, both familiar and exotic, and should become more precise in identifying similarities and differences among them.

This unit emphasizes the relationships between science and technology and has a scientific inquiry focus. Exploration and investigations provide opportunities to further develop the skills of questioning, classifying, and using information sources and technologies to gather relevant information. Students should have multiple opportunities to classify living things and create charts and diagrams to show their method of classifying. Additionally, they should have opportunities to use microscopes when investigating microorganisms.

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.

- 28.0 demonstrate that specific terminology is used in science and technology contexts
- 29.0 describe how evidence must be continually questioned in order to validate scientific knowledge
- 35.0 compare tools, techniques, and scientific ideas used by different people around the world to interpret natural phenomena and meet their needs
- 38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
- 52.0 provide examples of how science and technology have been used to solve problems around the world
- 64.0 describe the potential impact of the use by humans of regional natural resources
- 65.0 describe how personal actions help conserve natural resources and protect the environment and their region
- 76.0 identify examples of careers in which science and technology play a major role

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
- 6.0 identify various methods for finding answers to given questions and solutions to given problems and select one that is appropriate
- 8.0 identify appropriate tools, instruments, and materials to complete their investigations
- 14.0 identify and use a variety of sources and technologies to gather relevant information
- 17.0 classify according to several attributes and create a chart or diagram that shows the method of classifying
- 20.0 evaluate the usefulness of different information sources in answering a question
- 24.0 identify new questions or problems that arise from what was learned
- 27.0 ask others for advice or opinions

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.

- 68.0 describe the role of a common classification system for living things
- 69.0 distinguish between vertebrates and invertebrates
- 70.0 compare the characteristics of mammals, birds, reptiles, amphibians, and fishes
- 71.0 compare characteristics of common arthropods
- 72.0 examine and describe some living things that cannot be seen with the naked eye
- 73.0 describe how microorganisms meet their basic needs, including obtaining food, water, air, and moving around
- 74.0 compare the adaptations from closely related animals living in different parts of the world and discuss reasons for any differences
- 75.0 identify changes in animals over time, using fossils

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 individuals of any cultural background can contribute equally to science. 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
- 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

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 6	Science 7
<i>Habitats and Communities</i>	<i>Diversity of Life</i>	<i>Interactions within Ecosystems</i>
<ul style="list-style-type: none"> compare external features and behavioural patterns of animals that help them thrive in different habitats compare structural features of plants that enable them to thrive in different habitats relate habitat loss to the endangerment or extinction of plants and animals identify local habitats and their associated populations of plants and animals describe how various animals meet their basic needs in their habitat classify organisms according to their role in the food chain 	<ul style="list-style-type: none"> describe the role of a common classification system for living things distinguish between vertebrates and invertebrates compare characteristics of mammals, birds, reptiles, amphibians, and fishes compare characteristics of common arthropods examine and describe microorganisms describe how microorganisms meet their basic needs compare adaptations of closely related animals from different parts of the world and discuss reasons for any differences identify changes in animals over time, using fossils 	<ul style="list-style-type: none"> explain how biological classification takes into account the diversity of life on Earth identify the roles of producers, consumers, and decomposers in a local ecosystem, and describe both their diversity and their interactions describe conditions essential to the growth and reproduction plants and microorganisms in an ecosystem

Suggested Unit Plan

Diversity of Life is the life science unit within the Science 6 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
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Diversity of Life

Communicating About the Diversity of Living Things

Outcomes

Students will be expected to

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

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

Focus for Learning

In this unit, students learn how to classify things according to the common classification system shared by scientists around the world. Students discover the enormous variety of living things on Earth, including the domains Eukarya, Bacteria, and Archaea. With a focus on the Eukarya domain, students learn the key characteristics of all living things and then those of plants, animals, and fungi. Students practice distinguishing between vertebrates and invertebrates, different classes of vertebrates, and different types of arthropods. They explore how technology, such as microscopes, helps them learn about Earth's microscopic biodiversity.

Throughout the unit, when communicating about living things, students are expected to use specific terminology. When classifying arthropods, for example, students should use terms such as invertebrate, abdomen, antennae, thorax, insect, crustacean, arachnid, and myriapod. Terminology should be introduced as the need emerges.

Science process-and skill-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.

Diversity-related terminology includes

- domain, Archaea, Eukarya, Bacteria, dichotomous key;
- vertebrate, mammal, bird, fish, reptile, amphibian;
- invertebrate, arthropod, insect, arachnid, myriapod, crustacean;
- microorganism, microscopic; and
- adaptation, endangered, extirpated, extinct, fossil.

Student use of appropriate, specific terminology is a constant expectation in *Science 6*.

Refer to the initial elaboration of SCO 28.0 provided on pp. 76-77.

Communicating About the Diversity of Living Things

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students:
 - What does the word diversity make you think of? What kinds of diversity do we have on Earth?
 - What do you know about plants, animals, and fungi?
 - What do you know about vertebrates and invertebrates?
 - What do you know about arthropods?
 - What do you know about microorganisms?
- Create a class concept map or brainstorming web of the diversity of living things-related terminology.
- Add diversity of living things-related terminology to the science word wall, as the need emerges.

Connection

Teachers may

- Provide a variety of fiction and non-fiction children's books and magazines related to this unit for students to read and explore.
- Model the use of appropriate scientific and technological terms when communicating and encourage students to adopt them.
- Incorporate specific terminology into literacy block activities.
- Present video clips of natural environments from around the world to show the diversity of living things on Earth.
- Facilitate group exploration and investigations, where students are encouraged to think aloud: communicating their ideas, questions, and intentions.

Students may

- Use alpha-boxes to record new specific terminology.
- Create a visual glossary of specific terminology using personal illustrations and definitions in their own words.
- Record their questions related to the diversity of living things on the class "I Wonder Wall".

Resources and Notes

Authorized

NL Science 6: Diversity (Teacher Resource [TR])

- pp. 6-9

NL Science 6: Diversity (Student Resource [SR])

- pp. 1-55, 56-59

NL Science 6: Online Teaching Centre

- Science Skills Toolkit

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Diversity of living things (websites and videos)

How Can We Classify Living Things?

Outcomes

Students will be expected to

68.0 describe the role of a common classification system for living things [GCO 3]

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

29.0 *describe how evidence must be continually questioned in order to validate scientific knowledge* [GCO 1]

38.0 *describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries* [GCO 1]

Focus for Learning

Living things share a number of key characteristics, among them the ability to grow and develop, reproduce, respond to stimuli, and adapt to their environment. They process nutrients, use energy to grow and perform tasks, excrete wastes, and maintain homeostasis. They also share a very similar chemical makeup and are made up of cells.

With more than two million different kinds of living things identified, a classification system is needed to organize living things.

Students should recognize that classification systems are human creations. They are developed based on need. Gardeners, for example, might classify plants based on whether or not they are edible. Indigenous people might classify them based on medicinal uses. Foresters might classify trees as deciduous and non-deciduous.

Biologists, classify living things on the basis of relatedness. Recent advancements in genetic technologies are providing new evidence about relationships. This has resulted in many changes to previous classification systems. Students should understand that classification systems change based on new scientific evidence.

Currently, biologists classify living things into three main categories, or domains: Bacteria, Archaea, and Eukarya. These domains are further divided into smaller and smaller categories (i.e., kingdom, phylum, class, order, family, genus, species, subspecies). Eukarya, for example, is divided into several kingdoms, including animals, plants, and fungi.

Note, the three domain system is the most recent commonly accepted classification system. The previous most common system divided living things into five kingdoms (i.e., Monera, Protista, Animals, Plants, Fungi).

Biologists assign each species a two word (binomial) name that includes the genus name and species designation (e.g., *Homo sapien*). Each name is unique and universally accepted by the scientific community.

Students should

- identify key characteristics of living things,
- understand why a common classification system for living things is needed, and
- classify living things using a variety of criteria.

Memorizing the hierarchical structure and categories of the current classification system of living things is not an expectation.

How Can We Classify Living Things?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present an example of a living thing (e.g., plant, classroom pet). Ask students to brainstorm what characteristics distinguish living things from non-living objects.
- Ask students to share prior knowledge of classification systems of living things. Note, be prepared to identify and explain the difference between older classification systems (e.g., five kingdom) and the most current.

Connection

Teachers may

- Ask students to present examples of living and non-living things that have multiple common names (e.g., sofa/couch/chesterfield, mosquito/nipper) and discuss the importance of a common naming system.
- Introduce the idea of viruses and inform that they share some characteristics of living things but not all. Ask students to discuss whether viruses should be considered living things. Note, scientists are divided on this issue and the current most common classification system does not include viruses.
- Present a representation of the three domain classification system (*NL Science 6: Diversity*, p. 8)
- Ask students to describe how libraries, grocery stores, phone books, record stores, or clothing stores are organized.

Students may

- Discuss why a classification system of living things is necessary.

Consolidation

Students may

- Compare the classification of two closely related species (e.g., wolves and dogs) and note categories in which they both belong.
- Brainstorm local living things and record them on sticky notes. Physically group the living things into categories using personally selected criteria.

Extension

Students may

- Research an animal of interest to find out how it is classified.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 10-15

NL Science 6: Diversity (SR)

- pp. 6-9

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Image Bank

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Classification systems (websites and videos)

Note

Existing print and digital resources may not depict the current commonly accepted classification system of living things.

How Can We Classify Plants, Animals, and Fungi?

Outcomes

Students will be expected to

68.0 describe the role of a common classification system for living things [GCO 3]

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

6.0 identify various methods for finding answers to given questions and solutions to given problems and select one that is appropriate [GCO2]

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

27.0 ask others for advice or opinions [GCO 2]

Focus for Learning

Plants, animals, and fungi are living things from the Eukarya domain. They share key characteristics but differ in other ways:

- Animals have cells without cell walls. They have bones or other structures to support them. Animals consume food to live. Most animals move around at some point in their life cycle.
- Plants have cells with cell walls. This allows them to stand upright. Most plants use photosynthesis to make their own food. They usually stay in the same place.
- Fungi have cells with cell walls, so they can stand upright. They cannot make their own food. They obtain nutrients by absorbing it from the soil, or from living and dead things. Fungi usually stay in the same place.

Biologists often construct dichotomous keys to aid in identifying and classifying living things. A dichotomous key uses a series of questions or choices with only two possible answers. The questions or choices are typically based on observable characteristics that define the groups within the classification system being used.

Students should

- construct a simple dichotomous key,
- use dichotomous keys to classify living things,
- observe and ask questions about the characteristics of plants, animals, and fungi in order to classify them, and
- classify plants, animals, and fungi.

When classifying plants, students should use characteristics such as simple or compound leaves, vascular (i.e., having roots and stems) or non-vascular, seed-producing or spore-producing, flowering (angiosperm) or non-flowering (gymnosperm).

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

Attitude

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

Sample Performance Indicators

1. Scientists discover a new living thing. It moves, has cells without walls, and uses photosynthesis to make its own food. Would you classify it as an animal, plant, or fungi? Explain your reasoning.
2. Create a dichotomous key for a small collection of different coins.
3. Classify a dandelion plant using a dichotomous key (*NL Science 6: Diversity*, p. 15).
4. From images or physical specimens, identify common Newfoundland and Labrador plants and animals using the *Collection of Visual Field Guides: The Environment of Newfoundland and Labrador*.

How Can We Classify Plants, Animals, and Fungi?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Facilitate a class trip to a natural area to observe plants, animals, and fungi.
- Provide age appropriate field guides for students to use when attempting to identify local plants, animals, or fungi.
- Present digital images of plants, animals, and fungi and ask students to identify observable characteristics.
- Discuss why a classification system of fungi might be important to people who forage mushrooms for food (Some mushrooms are extremely poisonous).
- Present simple dichotomous keys accessed online.

Students may

- Construct a simple dichotomous key for a collection of eight different items. Then, exchange their keys and items and attempt to use each other's keys to classify the items.
- Identify characteristics of plants that might be useful in creating a dichotomous key.

Consolidation

Teachers may

- Ask students to consider what might happen if each biologist classified and named living things in their own way.
- Ask students what questions they might ask in constructing a dichotomous key to differentiate between animals, plants, and fungi (Does it use photosynthesis? Does it have bones or an exoskeleton? Can it move around?).

Students may

- Compare plants, animals, and fungi in a triple Venn diagram.
- Use a dichotomous key to identify local coniferous trees.
- Use a dichotomous key to identify deciduous trees by leaf shape.
- Construct a simple dichotomous key for a collection of different living things.
- Construct playing cards of different plants, animals, and fungi and create a classification game with them.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 16-27, 42-45

NL Science 6: Diversity (SR)

- pp. 10-15, 26-27

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- Dichotomous Key (BLM)
- IWB Activities 1 and 2
- Image Bank
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Dichotomous keys (websites and videos)

Other curriculum resources

- *A Collection of Visual Field Guides: The Environment of Newfoundland and Labrador* (Science 4 and 7)

How Can We Classify Animals?

Outcomes

Students will be expected to

69.0 distinguish between vertebrates and invertebrates [GCO 3]

70.0 compare the characteristics of mammals, birds, reptiles, amphibians and fishes [GCO 3]

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

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

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

27.0 *ask others for advice or opinions* [GCO 2]

Focus for Learning

Animals can be classified as vertebrates or invertebrates. The vertebrate phylum includes humans, moose, leatherback sea turtles, puffins, and salmon. Vertebrates share a key characteristic; a spinal column, or backbone. Almost all other animals are referred to as invertebrates (e.g., insects, lobster, spiders, snails, mussels, squid, earthworms, sponges, sea stars, sea urchins, jellyfish, corals).

Students should classify animals as vertebrates and invertebrates.

Vertebrates are further classified as fish, amphibians, reptiles, birds, and mammals using distinguishing characteristics. Through research, students should identify the following key characteristics

- cold-blooded versus warm-blooded;
- body covering (e.g., scales, feathers, hair);
- breathing organ (e.g., gills, lungs, skin);
- reproductive differences (e.g., eggs with shells versus eggs without shells, egg laying location, egg laying versus live birth, presence of mammary glands); and
- habitat.

For the purposes of Science 6, vertebrate categories may be referred to as classes. It should be noted, however, that the most recent commonly accepted classification system no longer considers birds a separate class; they are a sub-group of reptiles.

Students should

- identify the distinguishing characteristics of mammals, birds, reptiles, amphibians, and fish;
- classify vertebrate animals as mammals, birds, reptiles, amphibians, and fish; and
- recognize that the diversity of living things often results in exceptions that do not fit neatly into established categories (e.g., a platypus is an egg-laying mammal).

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

Sample Performance Indicators

1. Classify the following animals as vertebrates or invertebrates: caribou, cod, dragonfly, earthworm, lobster, gull, sea star, squid.
2. Scientists discover a new vertebrate animal on a remote island. What questions might you ask to determine if the animal is a reptile, bird, or mammal?
3. Classify the following as fish, amphibians, reptiles, birds or mammals: American coyote, American robin, arctic hare, capelin, crocodile, garter snake, green frog, harp seal, killer whale, leatherback sea turtle, little brown bat, osprey, and rainbow trout.
4. Select two classes of vertebrates and compare them in a Venn diagram.

How Can We Classify Animals?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Physically sort animal names written on sticky notes into two groups, vertebrates and invertebrates, without informing students. Ask them to figure out what characteristic you are using to classify them. This activity may be extended to further sort vertebrate animals into classes.
- Present images of animal skeletons and point out the skull and backbone.
- Ask students to feel the vertebrae at the top of their own spinal column.

Students may

- Compare and contrast a coyote and a crab.

Connection

Teachers may

- Divide the class into groups of five and facilitate a cooperative jigsaw activity to investigate mammals, birds, reptiles, amphibians, and fish.

Students may

- Participate in a book walk through non-fiction literature about animals. With a partner, identify the vertebrate animals and further classify them as mammals, birds, reptiles, amphibians, and fish.
- Physically sort a collection of plastic animals into vertebrate and invertebrate phyla, and vertebrates into classes.
- Create a digital collage of vertebrate and invertebrate animals.

Consolidation

Teachers may

- Facilitate a game of animal “Who am I?”; asking questions about characteristics to determine the animal’s identify.

Students may

- Use the dichotomous key presented on page 29 of *NL Science 6: Diversity* to classify common vertebrate animals.
- Classify a deck of created animal cards as vertebrates or invertebrates and vertebrates as mammals, birds, reptiles, amphibians, and fish.
- Research to identify examples of mammals, birds, reptiles, amphibians, and fish that live in Newfoundland and Labrador.
- Create animal trading cards that include biological name, classification, and distinguishing characteristics.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 28-37

NL Science 6: Diversity (SR)

- pp. 16-21

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activities 3 and 4
- Image Bank
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Vertebrate and invertebrate resources (websites and videos)

Other curriculum resources

- *A Collection of Visual Field Guides: The Environment of Newfoundland and Labrador* (Science 4 and 7)

Note

Existing print and digital resources may not depict the current commonly accepted classification system of living things.

How Can We Identify Arthropods?

Outcomes

Students will be expected to

71.0 compare characteristics of common arthropods [GCO 3]

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

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

27.0 ask others for advice or opinions [GCO 2]

Focus for Learning

More than 95% of all animals are invertebrates. Arthropods are the largest category of invertebrates. Key distinguishing characteristics shared by all arthropods include

- a hard exoskeleton,
- a segmented body, and
- jointed antennae and limbs and antennae.

Arthropods are classified as insects, crustaceans, arachnids and myriapods.

- Insects have three body parts (i.e., head, abdomen, and thorax), six legs, and one set of antennae. Most insects have wings.
- Crustaceans have two pairs of antennae and up to 20 body segments. They live in or near water and some have different kinds of legs.
- Arachnids have two body parts, eight legs, and no antennae or wings.
- Myriapods have one set of antennae and many body segments with one or two pairs of legs per segment.

Students should

- compare the characteristics of common arthropods (e.g., beetles, butterflies, dragonflies, mosquitoes, grasshoppers, spiders, scorpions, ticks, stink bugs, millipedes, centipedes, shrimp, lobsters, crabs), and
- classify common arthropods as insects, crustaceans, arachnids, or myriapods.

Note, students often erroneously refer to spiders as an insect.

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

Attitude

Encourage students to work collaboratively while exploring and investigating. [GCO 4]

Sample Performance Indicator

View the common arthropods on pages 24–25 of *NL Science 6: Diversity*. Using the descriptions on page 23, classify them as insects, crustaceans, arachnids, or myriapods. Additional research may be necessary.

How Can We Identify Arthropods?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present images of several arthropods and ask students to classify them as vertebrates or invertebrates and explain their reasoning.

Connection

Teachers may

- Present images of a variety of arthropods and ask students to identify similarities and differences among them.
- Define arthropod and share with students their key distinguishing characteristics.

Students may

- Identify images of arthropods from a collection of invertebrate images.
- Create cards for a common arthropod “Who am I?” game. Cards should include four clues, from general to specific, based on the characteristics of the arthropod.

Consolidation

Students may

- Create a quick reference guide to use when classifying arthropods that includes characteristics such as the number of legs, antennae, body segments, and wings.
- Classify common arthropods using classification keys sourced online.
- Use modelling clay, or other materials, to build models of fictitious arthropods. Models may be shared with classmates and classified as insects, crustaceans, arachnids, or myriapods.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 38-41

NL Science 6: Diversity (SR)

- pp. 22-25

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activity 5
- Image Bank

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Arthropod resources and classification keys (websites and videos)

Other curriculum resources

- *A Collection of Visual Field Guides: The Environment of Newfoundland and Labrador* (Science 4 and 7)

Are Microorganisms Important for Biodiversity?

Outcomes

Students will be expected to

72.0 examine and describe some living things that cannot be seen with the naked eye
[GCO 3]

8.0 *identify appropriate tools, instruments, and materials to complete their investigations*
[GCO 2]

73.0 describe how microorganisms meet their basic needs, including obtaining food, water, air, and moving around
[GCO 3]

Focus for Learning

Students should recognize that most living things on Earth are microscopic (i.e., too small to be seen with the naked eye). Bacteria, Archaea, and most members of the Eukarya domain are microscopic.

Microscopic living things are called microorganisms.

Students should collect and examine microorganisms from a local pond environment. They are abundant around the pond edge, upon the surface of aquatic vegetation and on decomposing organic matter on the bottom. Students should prepare slides from collected water samples for viewing with a light microscope.

Focusing a microscope is a challenging skill that requires direct instruction and practice. Students should be able to focus the microscope, safely change magnification, and refocus.

Using high power (i.e., 100X magnification), it is unlikely that students will observe bacteria, archaea, or viruses, which are too small for a typical light microscope. They are most likely to observe microorganisms from the eukarya domain called protists. Common protists include amoeba, euglena, giardia, paramecium, and plasmodium.

In addition to SCO 8.0, teachers may address and assess skill outcomes 1.0, 6.0, 14.0, and 24.0. Refer to the *Integrated Skills* unit for elaboration of these skill outcomes.

Students should understand that similar to larger living things, microorganisms exhibit characteristics of life. Protists, for example, grow and develop, reproduce, and respond and adapt to their environment. They obtain energy in a variety of ways. Some produce their own energy through photosynthesis. Others obtain energy by ingesting food or decomposing organic matter. Many protists move through their aquatic environment by means of flagella (long, slender, whip-like structure) or cilia (short, vibrating hair-like structures).

Based on observations of prepared slides, digital images, or illustrations, predict how common microorganisms meet their needs.

Attitude

Encourage students to

- appreciate the role and contribution of science and technology in their understanding of the world, and
- demonstrate perseverance and a desire to understand. [GCO 4]

Sample Performance Indicator

View prepared slides, electron micrograph images, or illustrations of microorganisms (e.g., microscopic algae, bacteria, amoeba, euglena, giardia, paramecium). Predict and describe how each microorganism might meet its needs in their environment.

Are Microorganisms Important for Biodiversity?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present images of microorganisms taken with light and electron microscopes. Ask questions to prompt students to discuss prior knowledge about microorganisms (e.g., What do you think these images show?, What kind of technology might have been used to obtain these photos?, What are microorganisms? Where might we find microorganisms?).

Connection

Teachers may

- Provide instruction on how to use a microscope. Students should always begin focusing on low power and use the coarse and fine adjustment knobs to bring the object into focus. Then, increase magnification by switching to medium power and refocus with the fine adjustment knob (Caution, never use the coarse adjustment knob with medium or high power), and repeat for high power.
- Provide opportunities for students to practice using the microscope to focus on objects.
- Attach a flexible camera to the eyepiece of a microscope and project the image for the class to observe. Alternatively, pictures can be taken through the eyepiece using mobile device cameras.
- Instruct students on how to prepare slides using drops of the collected pond water.
- Introduce yeast as microscopic fungi. Ask students to share prior knowledge of yeast and discuss how it might meet its needs in the environment.

Students may

- Add sugar and warm water to dry yeast and after 5-10 minutes prepare slides using the activated yeast. View the prepared slides under the microscope and describe any characteristics of life observed.

Consolidation

Students may

- Research a common microorganism and find out how it meets its needs and communicate their findings.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 50-59

NL Science 6: Diversity (SR)

- pp. 32-35

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- How to Use a Microscope (BLM)
- How to Prepare a Slide (BLM)
- Image Bank
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Microorganism resources (websites and videos)

How Does the Diversity of Microorganisms Affect Us?

Outcomes

Students will be expected to

35.0 compare tools, techniques, and scientific ideas used by different people around the world to interpret natural phenomena and meet their needs
[GCO 1]

52.0 provide examples of how science and technology have been used to solve problems around the world
[GCO 1]

Focus for Learning

Students should use research inquiry to explore how microorganisms affect humans in both positive and negative ways. Teachers may assess SCOs 1.0, 14.0, and 27.0.

Stemming from their research, students should describe examples of how science and technology, related to microorganisms, has been used to meet needs and solve problems. Examples include

- food production (e.g., use of bacteria to produce yogurt and cheese, use of yeast in baking);
- development of food preservation methods to prevent or limit the ability of microorganisms to spoil foods (refrigeration, freezing, drying, preserving with salt, sugar, vinegar, or other chemicals);
- encouraging microorganisms growth to compost organic waste;
- development of technological products and processes to fight disease causing microorganisms (e.g., personal hygiene practices, sanitation techniques, water treatment, sterilization techniques, anti-bacterial products, antibiotics, vaccines);
- encouraging microorganisms on and in our bodies that aid with digestion and protection (e.g., eating yogurt, probiotics, fecal transplants); and
- researching the ability of some microorganisms to feed on petroleum products as a potential way to clean up oil spills.

Students should recognize that the application of science and technology to meet needs and solve problems sometimes leads to unintended consequences. Prolific use of antibacterial household products and antibiotics, for example, has led to the development of antibiotic-resistant strains of bacteria.

In Science 5, students explored the role of “germs” in causing infections and creating vaccines.

Attitude

Encourage students to

- realize that the applications of science and technology can have both intended and unintended effects, and
- recognize that individuals of any cultural background can contribute equally to science. [GCO 4]

Sample Performance Indicators

1. Describe examples of how microorganisms are helpful and harmful to humans.
2. What are some ways you can protect yourself from harmful microorganisms?
3. A common side effect of antibiotics is digestive upset. Discuss why antibiotics might cause digestive upset and how microorganisms might help normalize digestive functioning again.

How Does the Diversity of Microorganisms Affect Us?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Present commercials and print ads for foods and technological products that encourage growth of helpful microorganisms and discourage growth of harmful microorganisms (e.g., probiotic yogurt, antibiotic ointment). Ask students to discuss how these technologies help humans.
- Ask students to recall prior studies of infections caused by “germs” and the use of vaccines to prepare the body to fight the infection, and relate to helpful and harmful microorganisms.
- Ask students to discuss prior knowledge about what makes food spoil.
- Discuss how the prolific use of antibacterial cleaning products may put us at risk by leading to the development of resistant bacterial strains.

Students may

- Compile a list of common diseases caused by microorganisms.
- Review appropriate hand-washing and food preparation techniques.

Consolidation

Students may

- Collaboratively research positive and negative impacts of microorganisms on humans.
- Create an informational ad explaining a specific food preservation technique (i.e., technological product or process) and how it prevents or limits the ability of microorganisms to spoil food.
- Respond to the statement, *microorganisms are harmful and should be eliminated*.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 60-65

NL Science 6: Diversity (SR)

- pp. 36-37

NL Science 6: Online Teaching Centre

- Image Bank

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Microorganism resources (websites and videos)

Do Related Species That Live In Different Environments Have Similar Or Different Adaptations?

Outcomes

Students will be expected to

74.0 compare the adaptations from closely related animals living in different parts of the world and discuss reasons for any differences [GCO 3]

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

20.0 *evaluate the usefulness of different information sources in answering a question* [GCO 2]

Focus for Learning

In Science 4, students identified features that enable living things to thrive in their environment as adaptations and distinguished between structural and behavioural adaptations. In Science 6, students are expected to compare adaptations of closely related animals living in different environments.

Students should

- select two related species that live in different environments (e.g., Labrador wolf and Australian dingo, moose and elk, black bear and Asian black bear);
- identify and evaluate potential sources of science information;
- research how closely related the species are, the environments in which they live, and their structural and behavioural adaptations;
- compile and display findings in an appropriate format; and
- compare their adaptations suggesting reasons for any differences.

As part of this research activity, skill outcomes 8.0, 14.0, 17.0, and 24.0 may be addressed, in addition to SCOs 1.0 and 20.0. Refer to the *Integrated Skills* unit for elaboration.

Students should learn how species adapt over time. Note, be aware that discussion of the process of adaptation may challenge the religious beliefs of some students. If it becomes an issue, be sensitive in your response and present challenging information in a neutral way.

Sample Performance Indicators

1. View images of several different species of foxes in their natural environments and compare differences in the size of their ears. Predict and discuss why large ears may be a helpful adaptation in one environment while small ears are helpful in another.
2. Explain why arctic hare and snowshoe hare, both Newfoundland and Labrador organisms, might have different adaptations.
3. How is the diversity of living things related to the diversity of environments on Earth?

Do Related Species That Live In Different Environments Have Similar Or Different Adaptations?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students how camouflage, a structural adaptation, might help a predator or prey species to be more successful in their environment.

Connection

Teachers may

- Present a collection of images representing the diversity of environments on Earth and discuss how it relates to the diversity of living things.
- Present images of birds with different shaped beaks. Ask students to predict what type of food each bird might eat based on its beak shape. Further, ask if the birds might be able to survive if placed in different environments.

Students may

- Conduct an online search to identify the adaptations of a specific animal. Communicate those adaptations by annotating an image of the animal.
- Identify behavioural and structural adaptations of local terrestrial and aquatic animals and describe how they might help members of the species to survive in their environment.
- Conduct online searches for images of closely related mammals (e.g., species of seals, deer, bears, foxes, hares, whales, wild dogs or cats).

Consolidation

Students may

- Imagine that a local animal is moved to a new environment (e.g., an African polar bear). Predict what adaptations it might require to be able to survive there.
- Describe the process by which the large antlers of a moose may have evolved over time.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 66-75

NL Science 6: Diversity (SR)

- pp. 38-41

NL Science 6: Online Teaching Centre

- Science Skills Toolkit
- IWB Activity 6
- Image Bank
- Skills and Processes for Scientific Inquiry rubric builder (BLM)

NL Science 6: Online Student Centre

- Science Skills Toolkit

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Adaptation resources (websites and videos)

How Can We Protect Biodiversity?

Outcomes

Students will be expected to

*64.0 describe the potential impact of the use by humans of regional natural resources
[GCO 1]*

*65.0 describe how personal actions help conserve natural resources and protect the environment and their region
[GCO 1]*

Focus for Learning

Many species of living things are under threat; their population sizes decreasing to dangerous levels. Species are put at risk when there is a dramatic change in their environment (e.g., climate change, habitat loss, arrival of an invasive species, over harvesting, pollution, and disease). Humans are the cause of most dramatic environmental changes.

Species at risk are ranked based on the health of their populations, and receive one of the following designations:

- vulnerable/special concern,
- threatened, or
- endangered.

If steps are not taken to protect endangered populations, species may become extinct or extirpated (i.e., locally extinct); reducing biodiversity.

Students should

- explain the difference between endangered, extirpated, and extinct;
- identify examples of local species at risk;
- identify human behaviours that increase the rate at which species are becoming endangered, extirpated, or extinct; and
- identify personal actions that help protect local environments and biodiversity.

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]

Sample Performance Indicator

Describe personal actions you can take to help protect biodiversity.

How Can We Protect Biodiversity?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Present a list of species at risk in Newfoundland and Labrador and ask students to discuss possible reasons why they are endangered.
- Facilitate a discussion about human resource use and the impacts of climate change, habitat loss, pollution, and over harvesting on biodiversity.
- Identify protected areas in Newfoundland and Labrador (i.e., wilderness reserves, ecological reserves, provincial and national parks, marine protected areas).

Students may

- Conduct an online search to identify personal actions that help protect local environments and biodiversity.
- Conduct an online search to identify local, regional, and national organizations committed to protecting biodiversity.

Consolidation

Teachers may

- Discuss with students why the process of adaptation cannot help species survive dramatic environmental changes.
- Facilitate a presentation to students (virtual or in person) by a member of an organization committed to protecting biodiversity.

Students may

- Discuss how action to protect environments help protect biodiversity.
- Plan and carry out a plan to communicate the importance of protecting biodiversity to their community.
- Write letters to local and other governments about the importance of protecting biodiversity.
- Participate in citizen science action projects related to protecting biodiversity.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 76-79

NL Science 6: Diversity (SR)

- pp. 42-43

NL Science 6: Online Teaching Centre

- Image Bank

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Species at risk resources (websites and videos)
- Protecting biodiversity resources (websites and videos)

How Can We Study Biodiversity in the Past?

Outcomes

Students will be expected to

75.0 identify changes in animals over time, using fossils
[GCO 3]

76.0 identify examples of careers in which science and technology play a major role
[GCO 1]

29.0 describe how evidence must be continually questioned in order to validate scientific knowledge
[GCO 1]

38.0 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries
[GCO 1]

Focus for Learning

In Science 4, students learned that rocks contain clues about Earth's history, including fossils. In Science 6, students learn that fossils offer a window into the biodiversity of Earth's past.

Students should

- describe how fossils form;
- understand that fossils tell us about Earth's past biodiversity;
- recognize that the fossil record shows that most living things in the past looked different from living things today and many species have become extinct; and
- describe different methods and technologies used to study fossils.

The study of fossils by early paleontologists was limited to observations of a fossil's exterior and estimating relative age based on its position in rock layers (i.e., fossils in deeper layers were older than fossils found in shallower layers). The development of new technologies, and their use by paleontologists, has led to new discoveries about fossils and theories about the history of life on Earth.

Today, radiometric dating methods, based on the natural decay of certain elements, as commonly used as reliable clocks to determine the absolute age of fossils. These methods can be very precise, determining ages ranging from a few thousand years to more than four billion years. Sequencing fossils from oldest to youngest shows a gradual increase in the complexity of living things that lived on Earth.

Other technologies, such as x-ray tomography, computer modelling, and 3D printing, enable paleontologists to make new observations about the interior of a fossil without destroying it and to reconstruct models of the fossil or what the living thing might have looked like.

Newfoundland and Labrador has a rich fossil history. These fossils (e.g., Mistaken Point fossils) play a significant role in our current understanding of the history of life on Earth. Students should be exposed to this rich history.

Attitude

Students are encouraged to show interest in the activities of individuals working in scientific and technological fields.
[GCO 4]

Sample Performance Indicators

1. What does Earth's fossil record teach us about biodiversity in the past?
2. Describe two different methods or technologies used to study fossils.

How Can We Study Biodiversity in the Past?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide physical samples, or images, of fossils for students to observe. Ask students to share their prior knowledge of fossils.
 - What are fossils?
 - How do fossils form?
 - How are fossils found?
 - How are they studied?

Students may

- Compile a list of inquiry questions they have about fossils.

Connection

Teachers may

- Review how fossils form and distinguish between casts and moulds.
- Identify paleontologists as scientists who study fossils and describe different methods and technologies they use to study fossils.
- Demonstrate the formation of fossils in sedimentary rock layers by alternating layers of sediment (e.g., brown sugar, flour, sand) in a small transparent container with animals (e.g., Goldfish crackers, gummy candy) inserted between layers. Inform students that fossils in lower layers are older than those above.

Students may

- Model fossil formation (i.e., moulds) by pressing objects into modelling clay.
- View images of fossils and describe the visible structures.

Consolidation

Teachers may

- Present images of Earth's fossil record sourced online and ask students to analyze and interpret them; communicating what is learned about the history of life on Earth.

Students may

- Compare mammoth or mastodon fossils with elephant skeletons and identify differences.
- Conduct an online search to identify technologies currently used by paleontologists to study fossils.

Resources and Notes

Authorized

NL Science 6: Diversity (TR)

- pp. 80-85

NL Science 6: Diversity (SR)

- pp. 44-49

NL Science 6: Online Teaching Centre

- IWB Activity 7
- Image Bank

Suggested

Resource links: www.k12pl.nl.ca/curr/k-6/sci/science-6.html

- Fossil record resources (websites and videos)

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