

Science 5

Curriculum Guide 2017



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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Alicia Oldford
Bonne Bay Academy

Allison Edwards
Bishop Field School

Allison Hammond
Mary Queen of Peace Elementary

Andrew Power
Paradise Elementary

Anne Marie Brown
CC Loughlin Elementary

Carla Lambert
MacDonald Drive Elementary

Carla McIsaac
Mary Queen of the World Elementary

Carrie Collins
Villanova Junior High

Cynthia Fillier
Beachy Cove Elementary

Darrell Stacey
Sprucewood Academy

Denise Pitts
Octagon Pond Elementary

Elaina Johnson
Catalina Elementary School

Jill Snook
Virginia Park Elementary

Karen Adams
Goulds Elementary

Kim Keating
Holy Trinity Elementary

Naomi Young
Gander Academy

Nicole Blanchard
Amos Comenius Memorial

Patricia Edwards
CC Loughlin School

Ruth Power-Blackmore
Larkhall Academy

Stacie Pardy
J.R. Smallwood Middle School

Tracy Drake
All Hallows Elementary

Todd Woodland
Department of Education and Early Childhood
Development

Section One: Newfoundland and Labrador Curriculum

Introduction

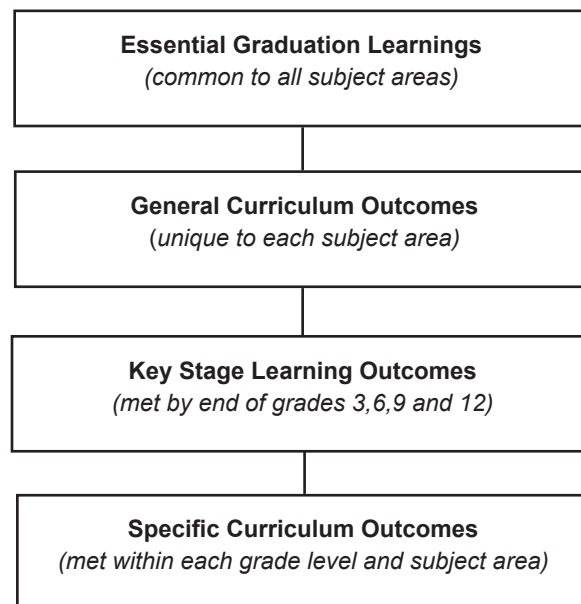
There are multiple factors that impact education: technological developments, increased emphasis on accountability, and globalization. These factors point to the need to consider carefully the education students receive.

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

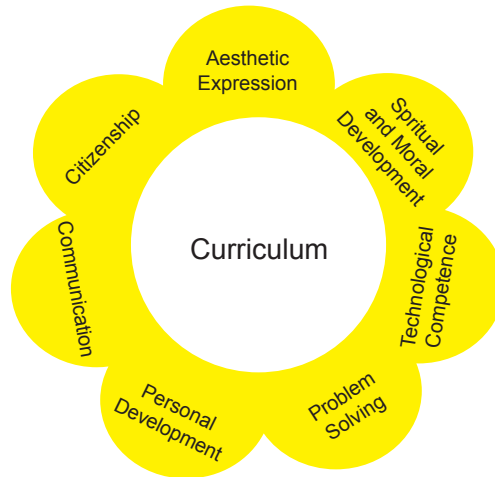
The K-12 curriculum in Newfoundland and Labrador is organized by outcomes and is based on *The Atlantic Canada Framework for Essential Graduation Learning in Schools* (1997). This framework consists of Essential Graduation Learnings (EGLs), General Curriculum Outcomes (GCOs), Key Stage Curriculum Outcomes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

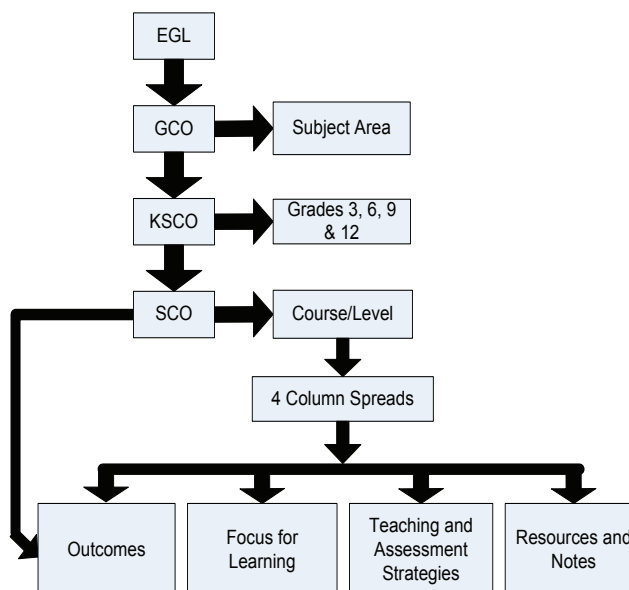
Key Stage Curriculum Outcomes (KSCOs)

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.



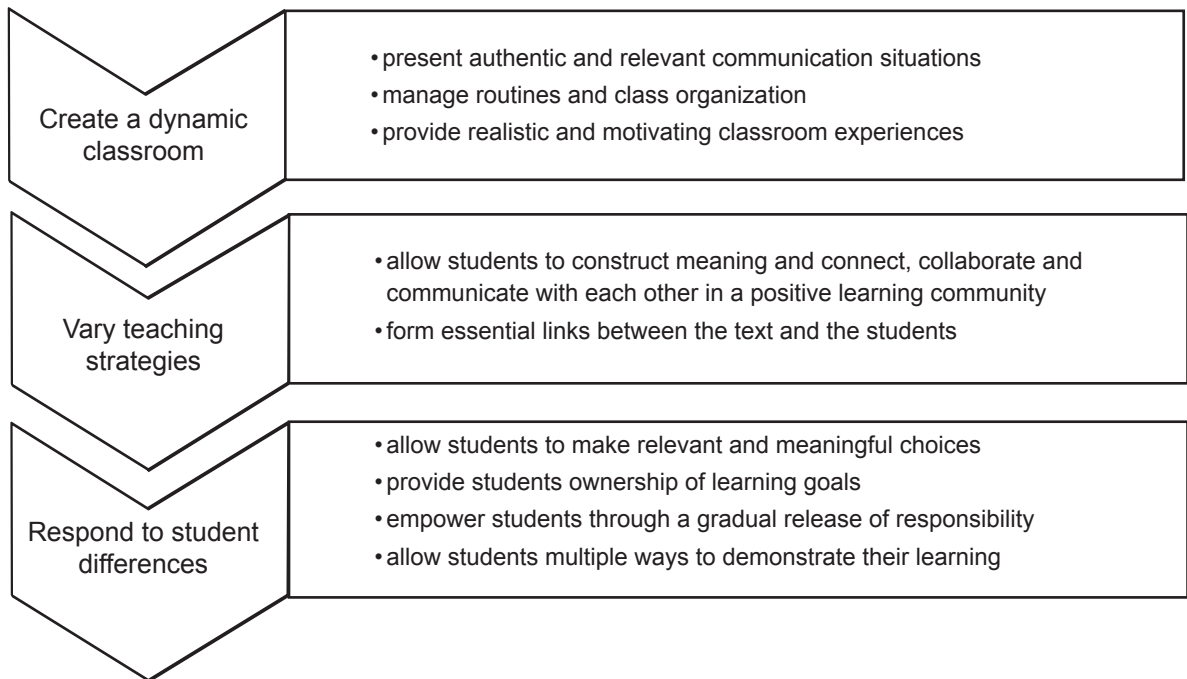
Differentiated Instruction

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

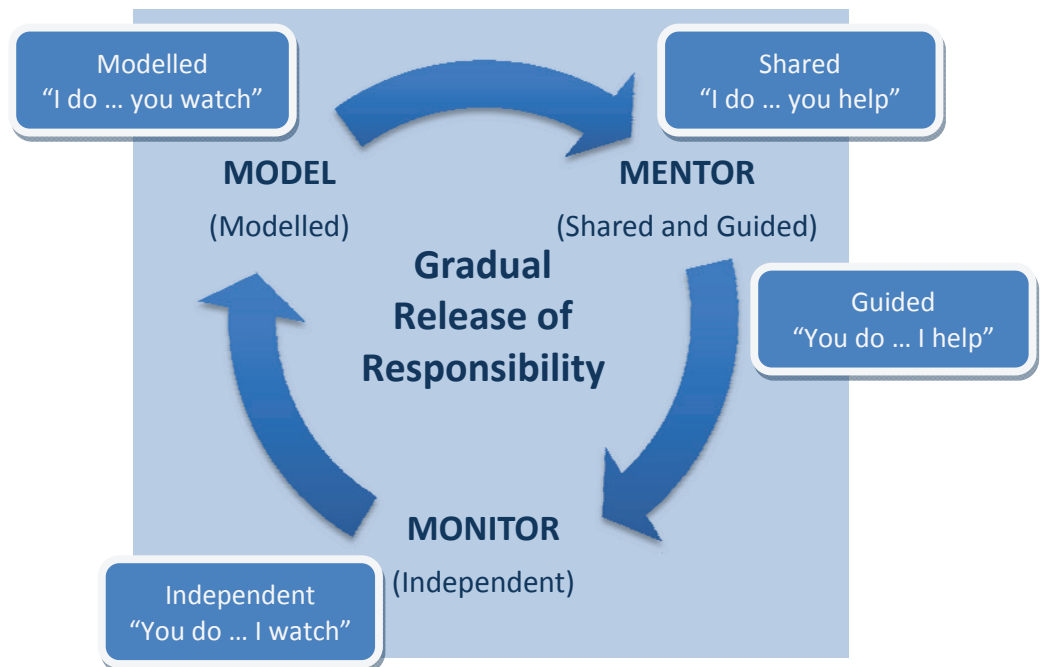
- assign independent study to increase depth of exploration in an area of particular interest;
- compact curriculum to allow for an increased rate of content coverage commensurate with a student's ability or degree of prior knowledge;
- group students with similar abilities to provide the opportunity 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

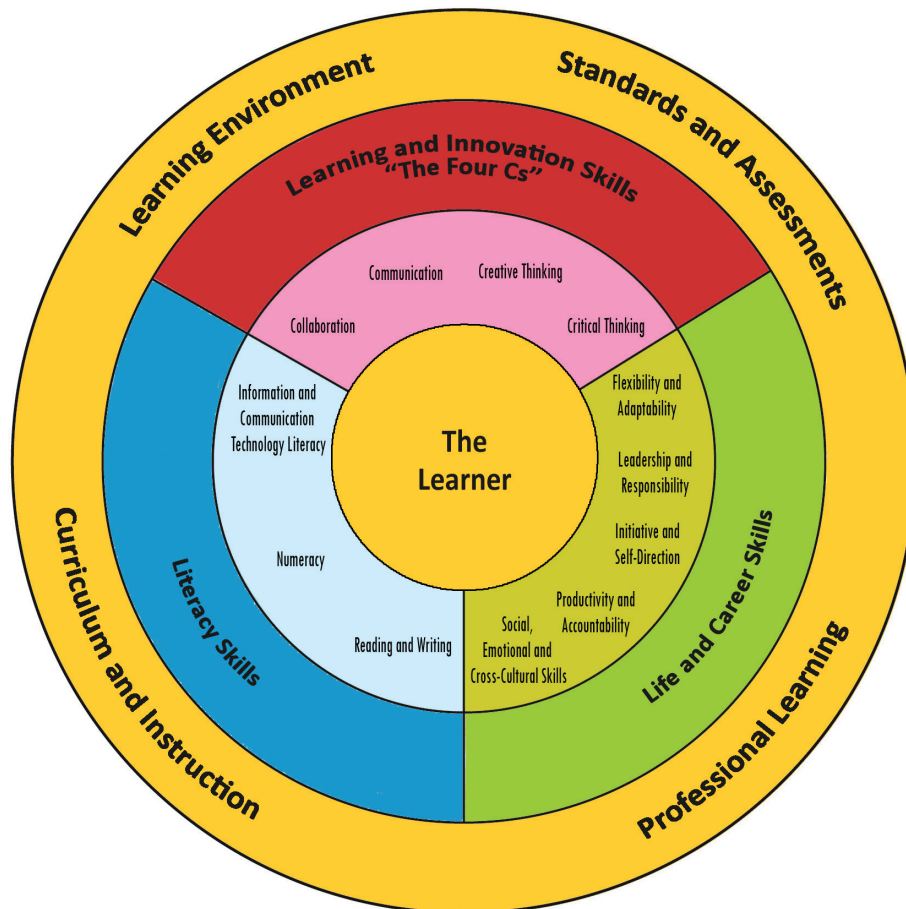
Generation Next is the group of students who have not known a world without personal computers, cell phones, and the Internet. They were born into this technology. They are digital natives.

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.



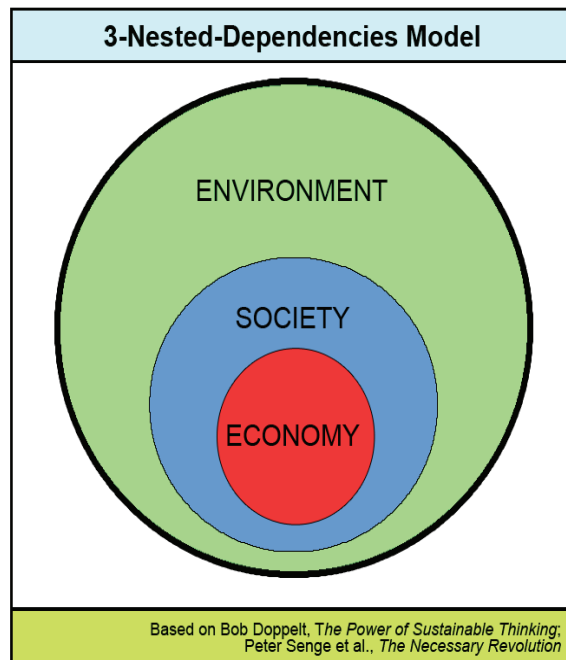
Support for students to develop these abilities and skills is important across curriculum areas and should be integrated into teaching, learning, and assessment strategies. Opportunities for integration of these skills and abilities should be planned with engaging and experiential activities that support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

SCOs are organized into units for each course.

Course Overview

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

Science 5 SCOs are organized into five units:

- Integrated Skills
- Weather
- Forces and Simple Machines
- Properties and Changes of Materials
- Body Systems

Note that 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 will be referred to the Integrated Skills unit for elaboration of specific outcomes.

Suggested Yearly Plan

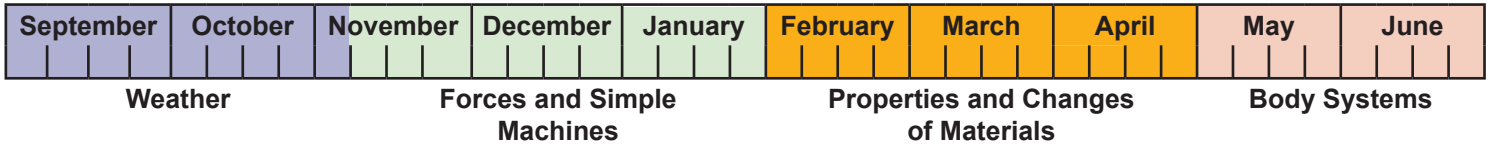
The order in which the units appear in the Science 5 curriculum guide is the recommended sequence.

Unit 1 - Weather

Unit 2 - Forces and Simple Machines

Unit 3 - Properties and Changes of Materials

Unit 4 - Body Systems



How to Use the Four Column Curriculum Layout

Outcomes

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

Outcomes are numbered in ascending order

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

All outcomes are related to general curriculum outcomes.

Focus for Learning

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

This may include:

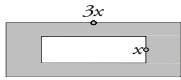
- references to prior knowledge
- clarity in terms of scope
- depth of treatment
- common misconceptions
- cautionary notes
- knowledge required to scaffold and challenge student's learning

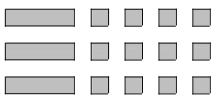
Sample Performance Indicator(s)

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>	
<p>Sample Teaching and Assessment Strategies</p> <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>Resources and Notes</p> <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.

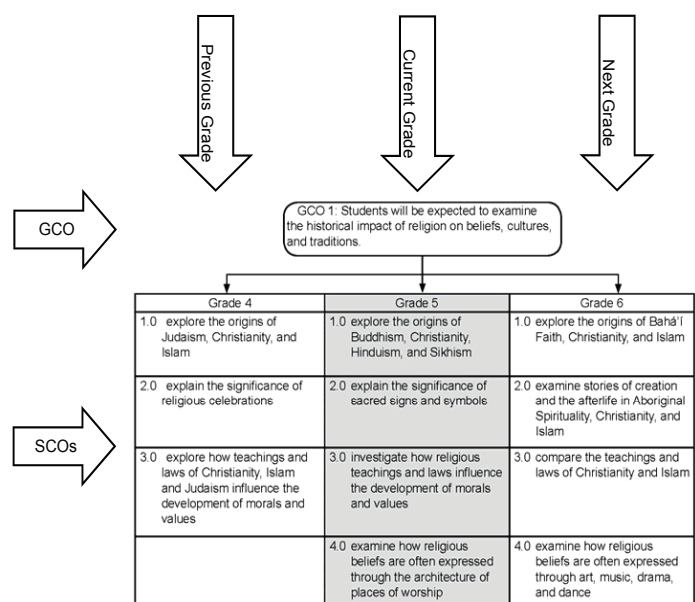
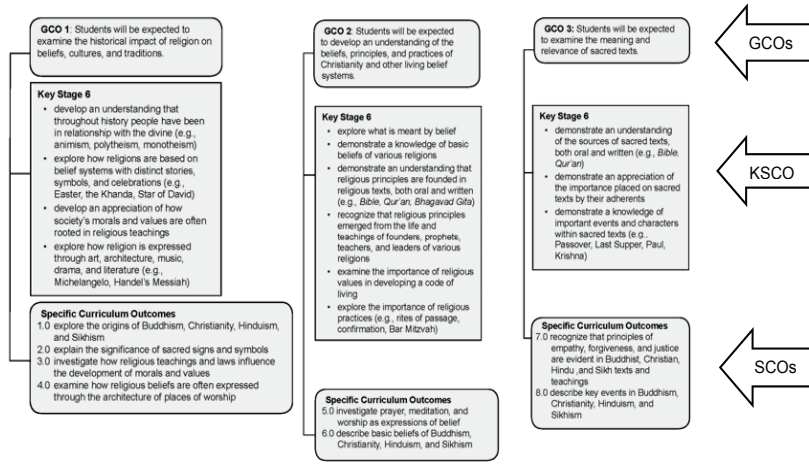
Suggestions for instruction and assessment are organized sequentially:

- **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 Unit overview

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



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 skills - These are the skills of questioning, identifying problems, and developing initial ideas and plans.
- Performing and Recording skills - 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 skills - 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 skills - 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:

- scientific 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 devise procedures to carry out a fair test and to solve a practical problem
- 7.0 identify appropriate tools, instruments, and materials to complete investigations
- 8.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
- 9.0 select and use tools
- 10.0 follow procedures
- 11.0 select and use tools for measuring
- 12.0 make observations and collect information that is relevant to the question or problem
- 13.0 estimate measurements
- 14.0 record observations
- 15.0 identify and use a variety of sources and technologies to gather relevant information
- 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 collaborate with others to devise and carry out procedures
- 27.0 ask others for advice or opinions
- 28.0 identify problems as they arise and collaborate with others to find solutions

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 5	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 materials and suggest a plan for how they will be used 	<ul style="list-style-type: none"> identify and control major variables in investigations devise procedures to carry out a fair test and to solve a practical problem 	<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"> 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 select and use tools for measuring 	<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 	
<ul style="list-style-type: none"> estimate measurements 	<ul style="list-style-type: none"> estimate measurements 	<ul style="list-style-type: none"> estimate measurements
<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

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 5	Science 7-9
<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"> 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
<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

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 5	Science 7-9
	<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 identify problems as they arise and collaborate with others to find solutions collaborate with others to devise and carry out procedures 	<ul style="list-style-type: none"> identify new questions and problems that arise from what was learned collaborate to devise and carry out procedures, and troubleshoot problems as they arise
<ul style="list-style-type: none"> communicate while exploring and investigating 	<ul style="list-style-type: none"> communicate questions, ideas, and intentions, and listen to others while conducting investigations ask others for advice or opinions 	<ul style="list-style-type: none"> receive, understand, and act on the ideas of others

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
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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. It is applied in new contexts (i.e., weather, forces, simple machines, properties of materials, changes of materials, meeting basic life needs, maintaining a healthy body), in Science 5.

Student proposed questions and problems flow from their personal observations, prior knowledge, and experiences. Students will experience difficulty coming up with them if simply asked to brainstorm them at the outset. Students should consider whether proposed questions are testable and problems practical to solve.

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

To initiate science 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.

In experiments, 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
Does it make a difference where you place a load in a wheelbarrow?	How does changing the distance between the load and the fulcrum in a wheelbarrow affect the effort force needed to lift the load?
How can we make more fizz?	What is the effect of increasing the amount of baking soda on the amount of gas bubbles produced in a reaction with vinegar?
Why does my heart beat faster during gym class?	What is the relationship between the type of exercise and heart rate?

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. Combine a seltzer tablet with water, for example, and propose aloud questions to investigate (e.g., I wonder what would happen if I used hot water instead of cold? I wonder what would happen if I broke the seltzer tablet in pieces first?)
- Model proposing practical problems from observations. Observe the weather, for example, and wonder aloud if you could construct an instrument to measure the wind speed and direction, temperature, or the amount of rainfall/snowfall.
- Provide examples of rephrased testable questions. I wonder what would happen if I broke a seltzer table in pieces before putting it in water?, for example, could be rephrased as, What is the effect breaking the seltzer tablet in smaller pieces on the length of time the bubbling reaction lasts?

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 a constructed weather instrument to solve.
- Suggest a testable question related to friction’s affect on an object.

Resources and Notes

Authorized

NL Science 5: 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 5: 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 will or 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 artificial light is shone on dark coloured soil, light coloured sand, and water, then the dark coloured soil will heat up faster because the dark colour absorbs heat.
- If we exercise, then our breathing rate goes up because our muscles need more oxygen.

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.

Cross curricular connections may be made to the predicting strategy unit in English Language Arts.

Students are expected to collaboratively define objects and events, within investigations, to facilitate effective communication. Students could, for example, define

- temperature, when using a personally constructed thermometer, as the height of the coloured water in the straw;
- the load and effort force when using a simple machine;
- force as the distance the elastic band stretches or the number of newtons (N) measured using a 25 N spring scale (force meter);
- reaction time as the distance a ruler falls before it is grabbed; or
- pulse rate as the number of pulses felt on their wrist in 60 seconds or on their neck in 30 seconds.

Use of consistent definitions among groups allows for the comparison of results.

Initiating and Planning

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present relevant texts from the *Moving Up with Literacy Place 5: Predicting Unit* and ask students to make predictions before and during reading. Explicitly connect making predictions in reading to making predictions in science.
- Ask students to make predictions about the weather, the result of mixing two substances, the force required to move a load, or their resting pulse rate or reaction time.

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 whether breathing rate is affected by exercise, for example, ask how they are defining exercise.

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:
 - What affect does shining incandescent light have on the temperature of water samples dyed with different amounts of blue food colouring ?
 - How does changing the location of the fulcrum affect the effort needed to lift a load using a first class lever?
 - What affect does practice have on reaction time?

Consolidation

Students may

- Predict which surface will have the greatest frictional force when attempting to slide a brick.
- Define the distances from the fulcrum the effort force will be applied in investigations using levers.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- *Moving Up with Literacy Place 5: Predicting Strategy Unit (ELA 5)*

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 affect 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

Pulse rate could be affected by numerous factors. In an experiment to test if body position (i.e., standing, sitting, lying down) affects pulse rate, students should identify body position as the independent variable (i.e., variable to test) and pulse rate as the dependent variable (i.e., variable to measure). Other variables that could affect pulse rate (e.g., age, sex, physical fitness, activity level, caffeine intake) must be controlled to know if any affect observed was caused by the change in position and not some other variable or variables.

Students could suggest the following variables to control:

- Test the same person in each body position.
- Measure pulse in the same location, using the same instrument and method each time.
- Ensure the person rests for a minute after assuming a new body position before pulse rate is measured.
- Do not allow participants to exercise, eat, or drink prior to measurements.

Example 2

In an experiment to determine the effect of water temperature on the time it takes a sugar cube to dissolve, students should identify water temperature as the independent variable and time to dissolve as the dependent variable. Controlled variables would include

- use the same type and size of sugar cube each time,
- use the same volume of water each time,
- use an identical container for each test,
- add the sugar to the water instead of pouring water on it, and
- do not stir or disturb the water.

Students were introduced to variables in Science 4. However, identifying them in investigations is a new expectation.

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 length of time exercising have on breathing rate? (*IV - time exercising, DV - breathing rate, CVs - same type of exercise, same intensity, using the same instrument and method to measuring breathing rate*)
 - Does age affect reaction time when attempting to catch a dropped ruler? (*IV - age, DV - reaction time measured using the distance the ruler drops before catching, CVs - same gender participants, no practising, use the same ruler and dropping method each time*)
 - Which material (i.e., water, sand, or potting soil) heats up faster when placed under an incandescent light? (*IV - material, DV- time for temperature rise a specific number of degrees, CVs - place materials the same distance from the light source, same volume of each material, use identical containers for each material, use identical thermometers*)
 - Does the length of a screwdriver affect how easy it is to open a paint can? (*IV - screwdriver length, DV - ease of opening, CVs - same type of screwdriver, how tight the paint can cover is put on, use same method to open the can*)
 - Does the size of a screwdriver's handle (i.e., circumference) affect the effort needed to insert a screw in wood? (*IV- handle circumference, DV - ease of insertion, CVs - same type and size of screw, same type and length of screwdriver, same type of wood*)

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 friction on the movement of objects,
 - how exercise affects pulse rate,
 - how to control the amount of gas bubbles produced by a reaction, and
 - how simple machines affect the force needed to lift a load.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 6.0 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 changing the type of exercise engaged in affect pulse rate?
Independent Variable	Choice of exercise (i.e., variable to test)
Dependent Variable	Pulse rate (i.e., variable to measure)
Controlled Variables	<p>Variables that must be kept the same</p> <ul style="list-style-type: none"> • measure pulse in the same location and using the same method each time • amount of time that pulse is measured • use the same measuring tool for time • length of time engaging in each exercise • allow pulse to return to resting rate before testing a different exercise • complete different exercises with the same intensity

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 jumping jacks increases breathing rate more than running on the spot, 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

Activation

Teachers may

- Have students devise procedures for everyday tasks (e.g., sharpening a pencil, measuring air temperature, doing a jumping jack). Ask specific students to read aloud their procedures while you attempt to carry out their steps. Act confused when procedures are unclear, lack detail, are out of order, or fail to include necessary steps. Provide opportunities for students to orally revise their procedures.

Connection

Teachers may

- Provide students unordered procedural steps and have them sequence the steps in the appropriate order.
- Demonstrate unfair testing procedures (e.g., biased procedures, procedures with inconsistent methods for different trials, procedures that contain more than one independent variable) and ask students to identify the problem with the procedure and suggest solutions.
- Provide testable questions and ask students to identify all the conditions the procedure would need to keep the same (i.e., controlled variables) in order for the test to be fair.
- Use question prompts when students are devising procedures:
 - Have you omitted any steps?
 - Would a diagram or sketch help to explain your procedure?
 - Have you controlled all 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
 - test how different surfaces absorb artificial light;
 - construct a weather instrument, catapult, or model of a human body system;
 - determine the affect of increasing or decreasing force on the motion of objects; and
 - determine the force advantage of various simple machines when moving a load.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
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NL Science 5: Online Student Centre

- Science Skills Toolkit

Initiating and Planning

Outcomes

Students will be expected to

- 7.0 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 5 include, but are not limited to: scientific tools (e.g., beakers, digital camera, electronic scale/balance, graduated cylinders, metre stick, ruler, spring scale, stethoscope, timer); weather instruments (e.g., anemometer, barometer, hygrometer, rain gauge, snow board, thermometer, weather vane, wind sock), and simple machines (e.g., bottle opener, can opener, clamps, clothespin, hammer, nail clippers, nutcracker, pliers, pulleys, scissors, screwdriver, screw jack, tongs).

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 investigating interactions among solids and liquids, for example, ask students to select the materials they wish to test 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
 - how artificial light affects the temperature of various surfaces,
 - the effect of friction on the movement of objects, and
 - how exercise affects pulse rate.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

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NL Science 5: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

9.0 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, pulleys, screwdriver, screw jack, wrenches, utility knives);
- household tools (e.g., bottle opener, can opener, clothespin, glue gun, nail clippers, nutcracker, 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 their resting heart rate, 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 construct a weather instrument.
- Carry out fair-testing procedures when investigating
 - human reaction time,
 - the effect of exercise on pulse rate, and
 - the effect of friction on the movement of objects.
- Select and use simple machines to move loads.

Resources and Notes

Authorized

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NL Science 5: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

10.0 follow procedures
[GCO 2]

11.0 select and use tools for
measuring
[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).

Students are expected to select appropriate measuring tools and use them accurately with the correct unit of measure.

Students should select the best measuring tool from collections that measure

- length (e.g., callipers, laser distance meter, metre sticks, various rulers, tape measures, trundle wheel);
- mass (e.g., bathroom scale, digital mass scale, food scale, pan balance, spring scales, triple beam balance);
- time (e.g., analog clock, mechanical timer, sand timers, digital stop watches);
- volume (e.g., beakers, eye droppers, graduated cylinders, measuring cups, measuring spoons);
- force (e.g., spring scale/force meter); and
- weather (e.g., anemometer, barometer, hygrometer, rain gauge, snow board, thermometers, weather vane, wind sock).

To address this outcome, students should select and use appropriate measuring tools. They should select, when available, scientific measurement tools (e.g., select a graduated cylinder rather than a measuring cup) and use metric or SI units (e.g., meter, gram, litre, °C, Newton, hertz, decibel).

Encourage students to appreciate the importance of accuracy in measurement. To ensure accuracy, students should calibrate instruments prior to use, use consistent measurement techniques, and take repeated measurements.

Cross curricular connections may be made to Mathematics 5 outcomes related to measurement of length and volume.

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Students may

- Play “Simon Says” and barrier games to practice following procedures accurately.

Connection

Teachers may

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

Students may

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

Consolidation

Students may

- Follow teacher-provided procedures to
 - explore properties of air, and
 - determine whether mass changes when materials change.
- Select and use tools to measure
 - specific weather conditions,
 - the force needed to move a specific object,
 - reaction time, and
 - pulse rate.

Resources and Notes

Authorized

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NL Science 5: Online Student Centre

- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

13.0 estimate measurements
[GCO 2]

Focus for Learning

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., buoyancy, cloud cover, colour, flexibility, hardness, strength, texture).

Students have previous experience estimating measurements from Science K-3.

Estimating measurements helps students select the appropriate tool for a task. Different spring scales, for example, measure different capacities (2.5 N, 5 N, 10 N, 20 N, 30 N). If a force is estimated to be more than 10 N, it can not be measured with a 5 N spring scale. A larger capacity spring scale (e.g., 20 N) must be selected. Students will require sufficient measurement practice to reasonably estimate measurements.

Estimating measurements prior to measuring also helps students determine the reasonableness of actual measurements. If students estimate the outside air temperature on an October morning to be around 5°C and the actual thermometer reading is 34°C, then the accuracy of the thermometer or the way it is being used should be questioned.

When using measurement tools, students should be instructed to estimate the first uncertain digit. If the reading on a thermometer, for example, falls between 11°C and 12°C, students should record the certain digits and estimate the next digit (e.g., 11.3°C or 11.4°C).

Performing and Recording

Sample Teaching and Assessment Strategies

Activation

Students may

- Practice observing and describing weather and forms of matter using appropriate senses.
- Practice measuring length, mass, time, volume, temperature, and force using appropriate tools; recording all certain digits and estimating the next digit.

Connection

Teachers may

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

Students may

- Practice estimating length, mass, time, volume, temperature, and force using appropriate tools and then measure to determine the accuracy of the estimate.
- 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

- Make observations and collect information relevant to
 - describing weather conditions,
 - demonstrating properties of air,
 - determining if mass changes when materials change, and
 - determining how increasing or decreasing force affects the movement of objects.
- Estimate
 - the force needed to move a load to select an appropriate spring scale, and
 - uncertain digits when measuring with barometers, rain gauges, rulers, spring scales, and thermometers.

Resources and Notes

Authorized

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

Performing and Recording

Outcomes

Students will be expected to

14.0 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); and

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 how increasing and decreasing a force affects the movement of objects at the playground, for example, students use written descriptions or video to record observations. If investigating the daily activity level of a peer, observational notes 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.

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.

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
 - descriptions of daily weather conditions,
 - demonstrating the properties of air,
 - combining and mixing materials,
 - determining the force advantage achieved using a simple machine, and
 - determining reaction time.

Resources and Notes

Authorized

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- Science Skills Toolkit

Performing and Recording

Outcomes

Students will be expected to

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

16.0 construct and use devices for a specific purpose [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 inquiring 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.

Students are expected to solve practical problems by personally constructing and using devices (i.e., technology).

As part of an engineering design and problem solving process, students should construct prototypes of proposed solutions to problems. Prior to construction, students should review their plan and design sketches, and make sure they know how to correctly and safely use all required tools. Materials may be measured and cut in preparation for construction.

Students should follow their plan when constructing a prototype. Problems encountered during construction may require changes to the plan, design, or the tools, instruments, and materials used. Prototypes rarely work perfectly the first time. Typically, iterative design changes and modifications, and testing and retesting are required to improve the prototype. Once satisfied that the prototype meets the design criteria, the final constructed device (i.e., solution) can be used and shared.

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).
- Brainstorm sources of science information.

Connection

Teachers may

- 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.
- 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 a practical problem.

Students may

- Practice collecting measurements, observations, and information using various magnification tools, measuring tools, and digital technologies.

Consolidation

Students may

- Identify and use a variety of sources and technologies to gather relevant information
 - to construct a weather instrument,
 - to predict short-term and long-term weather,
 - to improve the efficiency of lever designs,
 - regarding human body systems,
 - regarding human nutritional requirements, and
 - regarding the natural source of materials found in objects and how those natural materials are changed in the production of the object.
- Construct and use a weather instrument to measure and describe weather conditions.

Resources and Notes

Authorized

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NL Science 5: Online Student Centre

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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. Clouds, for example, may be classified by shape (i.e., cumulus, cirrus, stratus) and whether they produce precipitation (i.e., nimbus). Materials may be classified according to state (i.e., solid, liquid, gas) and other physical properties (e.g., hardness, flexibility). 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., tree diagram, Venn diagram, Carroll diagram, table).

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).

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 number of mm or rain received each month). Double bar graphs allow two or more data set to be displayed on the same graph (e.g., monthly rainfall for two different locations). Line graphs, addressed in Mathematics 6, are used to represent continuous data (e.g., changing soil temperature over time).

Cross curricular connections may be made to Mathematics outcomes in *Data Relationship* units.

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 kitchen tools according to simple machine type.

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 oobleck to a collection of solids and liquids).
- 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., measure and record outdoor air temperature every 30 minutes) 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 clouds, simple machines, materials as solids, liquids, and gases, and changes as reversible and irreversible.
- Compile and display data collected from investigations to determine
 - which materials react when combined and mixed, and
 - the effect of various surfaces on the amount of friction.

Resources and Notes

Authorized

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NL Science 5: Online Student Centre

- Science Skills Toolkit

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 5, students are expected to identify and suggest explanations for patterns and discrepancies in data.

Patterns refer to general trends (e.g., pulse rate increases as the number of stairs climbed increases, red cabbage juice turns reddish pink in acids and bluish green in bases). 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.

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 effect of varied surfaces on the amount of friction,
 - measuring and describing weather conditions,
 - comparing measurements taken with personally constructed and commercial weather instruments,
 - comparing short- and long-term weather predictions with personal observations, and
 - investigating the effect of exercise on pulse rate.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

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 15.0). 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 5 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 healthy eating, for example, can be gathered from Canada's Food Guide, dietitians, family doctors, magazine articles, product packaging, television commercials, and websites. Students should critically evaluate these sources and use only the most trusted to gather relevant information.

Analyzing and Interpreting

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present students with a set of images and information, such as the Canada Food Guide, the front of a cereal box, and the nutritional information from the side of the cereal box. Students would be asked which source could best answer the question, “Is this food a good source of nutrition?”

Connection

Teachers may

- 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

- Evaluate the usefulness of various sources of nutritional information about foods.

Consolidation

Students may

- Evaluate the usefulness of information sources when
 - creating short-term and long-term weather forecasts,
 - researching how natural resources are modified and changed in the production of objects, and
 - researching nutritional requirements needed to maintain a healthy body.

Resources and Notes

Authorized

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

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 5, 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.

Cross curricular connections may be made to the synthesizing strategy unit in English Language Arts.

In Science K-3, students compared and evaluated personally constructed objects with respect to their form and function. In Science 5, 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., weather instrument, simple machine) and ask students to evaluate it with respect to function, reliability, aesthetics, safety, and efficient use of materials and make suggestions for improvement.
- Provide a collection of similar simple machines (e.g., screw drivers) 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 the properties of air and investigating the effect of varied surfaces on friction and the absorption of heat from an artificial light source.
- Suggest improvements to constructed weather instruments, catapults, toy cars, lever arrangements, and models of human body systems.

Resources and Notes

Authorized

NL Science 5: 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 5: Online Student Centre

- Science Skills Toolkit

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 pulse rate increases with exercise, 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?

Students should be encouraged to recognize the role and contribution of science in their understanding of the world around them.

In Science K-3, students identified new questions that arose from what was learned. In Science 5, 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 “perfection”; it is continuously redesigned and modified to meet ever changing 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 and 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 to
 - determine the effect of varied surfaces on friction,
 - determine how different surfaces absorb heat energy from an artificial light source,
 - determine if mass changes when a material undergoes changes, and
 - determine how exercise affects pulse rate.
- Identify new questions arising from investigations of friction, surface heat absorption, and pulse rate.
- Identify new problems identified through use of personally constructed weather instruments and catapults.

Resources and Notes

Authorized

NL Science 5: 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 5: Online Student Centre

- Science Skills Toolkit

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 collaborate with others to devise and carry out procedures [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 is expanded to include “listen to others”.

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).

Students should work with group members to collaboratively devise and carry out investigative procedures and problem solving plans to find answers to questions and solutions to problems.

Collaboration requires that group members

- understand the required tasks;
- determine and assign collaborative and individual roles;
- communicate effectively, listen, and respond to the questions, ideas, and intentions of group members;
- be open-minded, accept input from all group members; and
- employ collaborative decision making processes.

Encourage students to work collaboratively while exploring, investigating, and problem solving.

Communication and Teamwork

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate team building activities to develop collaborative skills among students.

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

- Work collaboratively to investigate and solve problems.
- Practice collaboratively devising procedures to carry out everyday tasks (e.g., brushing their teeth, washing their hands)
- Digitally record their group conducting an investigation and then view the video to self assess their communication and collaboration skills.

Consolidation

Students may

- Communicate with others when investigating how increasing or decreasing the applied force affects the motion of objects.
- Collaborate to devise and carry out procedures to
 - investigate how varied surfaces absorb heat energy from an artificial light source,
 - investigate how different surfaces affect sliding friction,
 - investigate the effect of exercise on pulse rate,
 - construct a weather instrument or catapult, and
 - construct a model of a human body system.

Resources and Notes

Authorized

NL Science 5: 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 5: 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]

28.0 identify problems as they arise and collaborate with others to find solutions
[GCO 2]

Focus for Learning

In Science 5, students collaborate with others to investigate questions and find solutions to problems (SCO 26.0 and 28.0). At times, during these inquiry and problem solving experiences, students will experience difficulty 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.

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

Students are expected to collaborate with others to carry out investigative procedures and problem solving plans (i.e., SCO 26.0). Invariably, in carrying out procedures and plans, problems will be encountered. Students should collaborate with group members to find solutions to the problems that arise. This may involve asking others for advice and opinions (SCO 27.0).

In identifying and clarifying the problem and generating, trying out, and evaluating various solutions, the focus should be on communication and collaboration. Students should communicate their questions, ideas, and intentions, and listen to other group members (i.e., SCO 25.0). They should be open-minded, accepting input from all group members, and employ collaborative decision making processes.

Encourage students to demonstrate perseverance when collaborating to find solution to problems.

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.

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.
- Present students with incorrect procedures; plans with inaccuracies or unordered steps (e.g., Lego™ kits with missing pages of instructions or incorrect pieces). Ask students to carry out procedures and to collaboratively find solutions to the problems they encounter.
- Facilitate opportunities for students to contact experts, through communication technology, to ask for advice or opinions.

Students may

- Identify problems encountered during investigations or design and problem solving experiences and describe how they collaborated to find a solution.

Consolidation

- Ask others for advice and opinions when constructing weather instruments, catapults, and models of human body systems.
- Identify problems arising during constructing of a weather instrument, catapult, or model of a human body system and collaborate with peers to find solutions.

Resources and Notes

Authorized

NL Science 5: 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 5: Online Student Centre

- Science Skills Toolkit

Section Three:
Specific Curriculum Outcomes

Unit 1: Weather

Focus

Weather is an important aspect of daily life. Students should be provided with opportunities to realize that daily weather conditions are not the result of random occurrences, but rather are part of larger systems and patterns that can be predicted on both a short-term and seasonal basis. An important part of the study of weather is understanding the characteristics of air, its movement, and its ability to hold water. Students should study various aspects of weather such as temperature, wind speed, precipitation and cloud formation, and begin to recognize the role these aspects play in weather systems.

This unit has both a scientific inquiry and design and problem solving focus. The unit emphasizes the development of inquiry skills related to predicting, hypothesizing, selecting and using tools, estimating, measuring, observing, recording, compiling and analyzing data, and drawing conclusions, as well as, problem solving skills related to constructing devices for a specific purpose.

Outcomes Framework

GCO 1 (STSE): Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

- 29.0 demonstrate that specific terminology is used in science and technology contexts
- 31.0 describe examples of tools and techniques that have contributed to scientific discoveries
- 36.0 identify examples of scientific questions and technological problems addressed in the past
- 37.0 describe and compare tools, techniques, and materials used by different people in their community and region to meet their needs
- 38.0 identify individuals in their community who work in science and technology related areas
- 40.0 provide examples of how science and technology have been used to solve problems in their community and region
- 41.0 consider the positive and negative effects of familiar technologies
- 43.0 identify scientific discoveries and technological innovations of people from different cultures

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
- 7.0 identify appropriate tools, instruments, and materials to complete investigations
- 11.0 select and use tools for measuring
- 14.0 record observations
- 15.0 identify and use a variety of sources and technologies to gather relevant information
- 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
- 21.0 draw a conclusion that answers an initial question
- 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.

- 30.0 describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover
- 32.0 explore and describe situations demonstrating properties of air
- 33.0 relate the transfer of energy from the sun to weather conditions
- 34.0 identify patterns in indoor and outdoor air movement
- 35.0 relate the constant circulation of water on Earth to the processes of evaporation, condensation, and precipitation
- 39.0 describe and predict patterns of change in local weather conditions
- 42.0 describe the key features of a variety of weather systems

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
- 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 2	Science 5	Science 1206
<i>Air and Water in the Environment</i>	<i>Weather</i>	<i>Weather Dynamics</i>
<ul style="list-style-type: none"> • explore how air surrounds us, takes up space, and can be felt as it moves • explore characteristics of the three states of water and investigate how they change when heated or cooled • explore and investigate conditions that affect the location, amount, and form of moisture • explore changes in air conditions in indoor and outdoor environments • explore the effects of weather and ways to protect objects under different conditions 	<ul style="list-style-type: none"> • describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover • describe situations demonstrating that air takes up space, has weight, and expands when heated • relate the constant circulation of water on Earth to the processes of evaporation, condensation, and precipitation • describe and predict patterns of change in local weather conditions • identify patterns of indoor and outdoor air movement • describe key features of various weather systems • relate the transfer of energy from the Sun to weather conditions 	<ul style="list-style-type: none"> • describe and explain heat transfer within the water cycle • describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water • describe how the hydrosphere and atmosphere act as heat sinks • describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems • analyze meteorological data for a given time span and predict future weather conditions using appropriate methodologies and technologies.

Suggested Unit Plan

Weather is the Earth science unit of the Science 5 curriculum. It is positioned at the start of the school year to capitalize on the dramatic weather-related changes that can be observed during the fall season and opportunities for outdoor learning.

Aspects of this unit may be addressed throughout the school year as seasonal weather patterns change.

September	October	November	December	January	February	March	April	May	June

Weather

Communicating About Weather Using Scientific Terminology

Outcomes

Students will be expected to

29.0 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 communicate and collaborate.

Students should use specific terminology when communicating in science and technology contexts. To describe cloud formation, for example, students should appropriately use the terms water vapour and condense. Memorizing definitions is not a student expectation.

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

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.

Weather-related terminology includes

- weather, climate, atmosphere, temperature, precipitation, wind speed, wind direction, air pressure, humidity, cloud cover;
- thermometer, rain gauge, anemometer, weather vane, wind sock, barometer, hygrometer;
- energy, evaporate, evaporation, condense, condensation, water vapour, water cycle;
- cirrus, cumulus, stratus, nimbus, cumulonimbus, nimbostratus clouds;
- meteorologist, forecast, high pressure system, low pressure system, thunderstorm, blizzard, hurricane, tornado; and
- climate change, greenhouse effect, global warming.

Communicating using specific terminology is a constant expectation in Science 5. As students progress through the unit their use of appropriate terminology should increase.

Sample Performance Indicator

As a unit culminating activity, create a weather forecast and present it as a broadcast. Include both current weather conditions and a forecast of future weather. The broadcast should include weather-related graphics, illustrations, and maps.

Communicating About Weather Using Scientific Terminology

Sample Teaching and Assessment Strategies

Whenever students are investigating or problem solving, their use of specific terminology in communication can be assessed. Assessments (i.e., self, peer, teacher) may include the use of terminology checklists and audio recordings of collaborative work.

Activation

Teachers may

- Pre-assess student use of specific terminology with graffiti board activities using question prompts:
 - What is science? What is engineering? What is technology?
 - What is science inquiry? and the design and problem solving process?
 - What is weather? What is climate?
- Introduce unit terminology through relevant children’s literature (i.e., fiction and non-fiction).
- Create a class concept map or brainstorming web of weather-related terminology for use as a student reference.
- Create a science word wall and add new words as they are introduced. Alternatively, science words can be added to an existing word wall using a different coloured font or background.

Connection

Teachers may

- Model the use of scientific and technological terminology and encourage students to adopt these terms.
- Use small collaborative groups to carry out inquiry investigations and design and problem solving experiences. Encourage students to think aloud; communicating their ideas, questions, and intentions with their peers.

Students may

- Engage in a book walk through *NL Science 5: Weather* and identify unfamiliar weather-related terms.
- Create a visual glossary, throughout the unit, using personal illustrations and definitions.
- Keep a personal journal throughout the unit, qualitatively describing daily weather.
- Record weather-related inquiry questions on an “I Wonder” wall.
- Starting with the word *weather*, use Scrabble™ tiles to add as many weather-related terms as possible.

Resources and Notes

Authorized

NL Science 5: Weather (Student Resource [SR])

- pp. 1-51, 52-58

NL Science 5: Online Teaching Centre

- Science Skills Toolkit

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Children’s Literature

- *Big Idea: Weather* by A. Chapman
- *Scholastic Discover More: Weather* by P. Arlon
- *Weather Words and What They Mean* by G. Gibbons

How Can We Describe Weather?

Outcomes

Students will be expected to

30.0 describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover
[GCO 3]

31.0 describe examples of tools and techniques that have contributed to scientific discoveries
[GCO 1]

11.0 select and use tools for measuring
[GCO 2]

14.0 record observations
[GCO 2]

Focus for Learning

Students should use weather instruments to observe, measure, and record daily weather conditions (i.e., temperature, wind speed and direction, precipitation, cloud cover and characteristics, air pressure, humidity) and a digital photograph should be taken. This may be achieved as part of a morning routine; one student measuring and describing the weather conditions each day throughout the duration of the unit. Collected daily weather data should be compiled into the master weather log (i.e., charts and tables). The compiled data will be used later in the unit to predict changes in weather patterns.

Students should create daily weather reports from the recorded data. A weather report is a “now cast” of current weather conditions.

Instruments used to measure weather conditions include

- anemometers to measure wind speed;
- barometers to measure air pressure;
- hygrometers to measure humidity (i.e., amount of water in air);
- rain gauges to measure the amount of rain that falls;
- thermometers to measure temperature in degrees Celsius;
- weather vanes to indicate wind direction (i.e., arrow points in the direction that the wind is coming from); and
- wind socks to qualitatively measure wind speed and indicate wind direction (i.e., the sock points in the direction wind is going).

Students should, to the greatest extent possible, use instruments to make first hand measurements. However, second hand measurements (e.g., mobile device weather application) may be used when an instrument is unavailable.

The importance of using consistent measurement methods and measurement accuracy should be stressed when using instruments:

- Using a manual anemometer, students should count the number of rotations per minute. Wind speeds are highly variable; measuring over an extended time period (i.e., one minute) mitigates the effect of wind gusts. If the anemometer is spinning too fast to count, viewing video in slow motion may be helpful.
- To measure air pressure with an aneroid barometer, students should read the position of the needle relative to the scale (scales and graduations vary). A second confirmation measurement, possibly carried out by a peer, should always be taken. Quickly determining if air pressure is rising, falling, or remaining constant is of great value. To facilitate this, students should adjust the manual pointer, if present, to the needle, following each measurement. Subsequent tapping on the glass will cause the needle to move up or down relative to the pointer.
- When using a rain gauge to measure the amount of precipitation, students should place their eye such that it is level with the surface of the water. This eliminates parallax error (i.e., lower than actual readings if viewed from above, higher readings if viewed from below). Students should record all certain digits from

How Can We Describe Weather?

Sample Teaching and Assessment Strategies

Activation

Students may

- View images depicting different types of weather. Describe the weather using weather-related terminology.

Connection

Teachers may

- Provide a collection of weather instruments and ask students to predict what conditions they measure, and how they work.

Students may

- View a local weather report to identify its components, related terminology, and where applicable, units of measurement.
- Look out the class window and describe the weather using only their senses. Daily observations could be compiled into a weather journal. Teachers may use the journal to assess student use of specific terminology.
- Use anemometers, barometers, hygrometers, rain gauges, thermometers, weather vanes, and wind socks to measure current weather conditions.
- Create a daily weather report to describe weather conditions.

Resources and Notes

Authorized

NL Science 5: Weather (Teacher Resource [TR])

- pp. 8-21

NL Science 5: Weather (SR)

- pp. 6-9

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activities 1 and 2

NL Science 5: Online Student Centre

- Science Skills Toolkit

Supplementary

Weather Station

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Weather and weather instrument resources (websites)
- Weather information sources (websites and mobile device applications)
- Science suppliers (websites)

Children's Literature

- *Weather Words and What They Mean* by G. Gibbons

How Can We Describe Weather?

Outcomes

Students will be expected to

30.0 describe weather in terms of temperature, wind speed and direction, precipitation, and cloud cover
[GCO 3]

31.0 describe examples of tools and techniques that have contributed to scientific discoveries
[GCO 1]

11.0 select and use tools for measuring
[GCO 2]

14.0 record observations
[GCO 2]

Focus for Learning

the scale and estimate the first uncertain digit (e.g., recording 4.25 cm if above 4.2 cm but below 4.3 cm). A second confirmation measurement should always be taken. Empty the rain gauge completely after each measurement.

- Prior to first use, a thermometer should be calibrated. Place the thermometer in ice water and confirm that it measures 0°C. If there is a discrepancy, students should add or subtract degrees from all future measurements to account for it. Air temperature measurements should be taken in the shade, ensuring that the bulb is not touching any surface. Students should level their eye with the bottom of the curved liquid surface (i.e., the meniscus) within the thermometer to avoid parallax error. They should record all certain digits and estimate the first uncertain digit. A second confirmation measurement should be taken.
- Wind direction describes the direction air is moving from not the direction it is moving toward. Wind moving from west to east, for example, is described as a westerly wind (i.e., it is moving from the west). Incorrectly identifying wind direction is a common student error. The arrow of a weather vane points toward the direction of the prevailing wind, however, wind socks extend opposite the correct wind direction. Students should use a compass to ensure that the weather vane is properly aligned prior to first use (i.e., north on the weather vane aligns with the magnetic north on a compass). A compass will also be needed to determine wind direction using a wind sock.
- Using a wind sock to measure wind speed requires students record the number of alternating orange and white stripes which are extended by the wind.

Measurements made using weather instruments enable meteorologists to accurately describe weather conditions. Other technologies used by meteorologists include weather balloons, weather buoys, radar, and satellite. These technologies contribute to our understanding of weather.

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

Attitude

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

Sample Performance Indicator

Use weather instruments to accurately measure and record weather. Create a written weather report from recorded observations.

How Can We Describe Weather?

Sample Teaching and Assessment Strategies

Consolidation

Students may

- Compare student prepared weather reports with current weather information found on a website or mobile device application (e.g., AccuWeather, Environment Canada, Weather Network).

Extension

Students may

- Conduct research to learn how anemometers, barometers, and hygrometers work.

Resources and Notes

Authorized

NL Science 5: Weather (Teacher Resource [TR])

- pp. 10-21

NL Science 5: Weather (SR)

- pp. 6-9

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activities 1 and 2

NL Science 5: Online Student Centre

- Science Skills Toolkit

Supplementary

Weather Station

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Weather and weather instrument resources (websites)
- Weather information sources (websites and mobile device applications)
- Science suppliers (websites)

Children's Literature

- *Weather Words and What They Mean* by G. Gibbons

How Can We Construct a Weather Instrument?

Outcomes

Students will be expected to

- 1.0 propose questions to investigate and practical problems to solve [GCO 2]
- 16.0 construct and use devices for a specific purpose [GCO 2]
- 19.0 identify and suggest explanations for patterns and discrepancies in data [GCO 2]
- 27.0 ask others for advice or opinions [GCO 2]

Focus for Learning

Students should follow an engineering design and problem solving process to select, construct, and use a specific weather instrument.

Facilitate an open, student-centred experience. Modifying the experience to make it more teacher directed (e.g., providing design plans, specifying materials), limits the skill outcomes which can be developed and assessed. Students have experienced open design and problem solving activities in previous science courses.

Students should

- select an instrument to construct (e.g., anemometer, barometer, rain gauge, thermometer, weather vane, wind sock) and pose the problem to solve (e.g., How can we make a thermometer?);
- collaborate with group members to conduct research, if necessary, and develop a construction plan that includes labelled sketches and a list of required tools and materials;
- communicate the plan to others, ask for advice, and make adjustments, as needed, in response to the advice received;
- construct a prototype of the instrument, working collaboratively to carry out the plan and solve problems as they arise;
- test and evaluate the prototype;
- suggest improvements to the prototype, make changes, and retest until an optimal solution is reached; and
- use the instrument to measure and record weather conditions.

Students should wear eye protection when building their weather instrument. Adult supervision may be required for use of some tools.

Some constructed instruments will require a scale and/or calibration:

- Constructed weather vanes should be aligned with a compass.
- The scale on rain gauges should be added with a metric ruler.
- Adding a scale to a thermometer or barometer is more challenging and might require support. These instruments should be calibrated against known measures. A constructed thermometer, for example, could be placed in 0°C ice water and then a 20°C room. These two graduations could be marked on the constructed thermometer and other graduations (e.g., 5°C, 10°C, 15°C) added in relation to the two initial marks.

Students should attempt to use their constructed instrument to measure daily weather and compare their measurements with those obtained using commercial instruments. Their weather instruments should be evaluated with respect to their function and reliability.

In addition to outcomes 1.0, 16.0, 19.0, and 27.0, teachers may choose to address and assess additional design- and problem solving-related skill outcomes:

- devising procedures to solve problems (SCO 6.0),
- carrying out procedures to explore a problem (SCO 8.0),

How Can We Construct a Weather Instrument?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Review the stages of design and problem solving processes.

Connection

Teachers may

- Compile a collection of materials for students to use in constructing their weather instruments. Encourage the use of found and recycled materials in designs.

Students may

- Research how to build various weather instruments.
- Contact local meteorologists through social media feeds to ask weather-related questions and seek advice or opinions on constructed weather instruments.

Consolidation

Teachers may

- Provide ample time for students to revise and improve their designs and prototypes.
- Invite knowledgeable community members to view student designs and prototypes and offer advice and opinions.

Students may

- Participate in a gallery walk to view the construction plans of classmates. Tag feedback (i.e., Tell something you like, Ask a question, Give a suggestion) may be used to seek the advice and opinions of peers.
- Document the design and construction process using digital images or video. Documentation may be used to assess communication and collaboration skills and the problem solving process.
- Communicate their final solutions to classmates. Describe any problems encountered during design and construction and how the problem was solved.
- Use the constructed weather instrument to measure weather and compare with a commercial instrument.
- Evaluate the constructed weather instrument with respect to function, reliability, aesthetics, safety, and efficient use of materials.
- Identify new questions or problems that arise from use of the constructed instrument.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 22-23

NL Science 5: Weather (SR)

- pp. 10-11

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)
- IWB Activity 3

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Inquiry and Problem Solving Continuum

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Constructing weather instruments resources (websites)
- Science suppliers (websites)

How Can We Construct a Weather Instrument?

Outcomes

Students will be expected to

- 1.0 propose questions to investigate and practical problems to solve [GCO 2]*
- 16.0 construct and use devices for a specific purpose [GCO 2]*
- 19.0 identify and suggest explanations for patterns and discrepancies in data [GCO 2]*
- 27.0 ask others for advice or opinions [GCO 2]*

Focus for Learning

- make observations and collect information relevant to the problem (SCO 12.0),
- recording observations (SCO 14.0),
- identifying and using a variety of sources and technologies to gather relevant information (SCO 15.0),
- suggesting improvements to a design or constructed object (SCO 22.0),
- collaborating with others to devise and carry out procedures (SCO 26.0), and
- identifying problems as they arise and collaborating with others to find solutions (SCO 28.0).

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

Attitude

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

Sample Performance Indicator

Measure temperature using a thermometer you constructed and a commercial thermometer. Evaluate how well your thermometer works and suggest reasons for any discrepancies in measurements when compared to the commercial thermometer.

How Can We Construct a Weather Instrument?

Sample Teaching and Assessment Strategies

Extension

Students may

- Research how a specific weather instrument has changed or evolved over time.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 22-23

NL Science 5: Weather (SR)

- pp. 10-11

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)
- IWB Activity 3

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Inquiry and Problem Solving Continuum

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Constructing weather instruments resources (websites)
- Science suppliers (websites)

What Are the Properties of Air?

Outcomes

Students will be expected to

32.0 explore and describe situations demonstrating properties of air [GCO 3]

Focus for Learning

Students are expected to investigate weather-related properties of air. Through directed investigations (see Sample Teaching and Assessment Strategies), students should observe that

- air has mass;
- air takes up space (i.e., it has volume);
- air expands (i.e., takes up more space) when heated; and
- air contracts (i.e., takes up less space) when cooled.

Carrying out these directed investigations provides opportunities to address and assess students' ability to follow procedures, make and record observations, draw conclusions, and use scientific terminology (SCOs 10.0, 12.0, 14.0, 21.0, 29.0, refer to the *Integrated Skills* unit).

Students should also apply their understanding of air related properties to explain situations. When taking a deep breath, for example, students should explain that the space inside their lungs fills with air. When noting a decrease in the size of an air-filled balloon after being stored in a freezer, they should explain that the air contracted.

Several other related properties of air have a significant relationship to weather and should be introduced at this time:

- Air density is the mass of air per unit volume (i.e., mass/volume). Air density varies with temperature. When heated, air expands (i.e., increases volume) decreasing density. When cooled, it contracts (i.e., decreases volume) increasing density.
- Air pressure is the pressure air exerts on everything around it. Air pressure also varies with temperature. Cooler air has higher pressure than warmer air.

The effects of these properties of air on weather will be explored as the unit progresses.

Attitude

Encourage students to

- show interest and curiosity about objects and events within different environments; and
- demonstrate perseverance and a desire to understand. [GCO 4]

Sample Performance Indicator

Table tennis balls are air-filled. If dented, submerging the ball in hot water might restore it to its original form. Explain, using the properties of air, how this might work.

What Are the Properties of Air?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Tape a crumpled piece of paper inside the bottom of a transparent drinking glass. Submerge the glass, upside down, in a container of water. Ask students why the paper does not get wet. Tilt the glass to release some air bubbles, then turn it sideways to release all the air. Ask students to explain their observations.

Connection

Teachers may

- Completely fill a drinking glass with water and place an index card over the top, creating a seal. Ensure no air is inside. Hold the index card in place while turning the cup upside down, then release the index card. Ask students to use the properties of air to explain why the water remains in the glass.

Students may

- Measure and compare their chest circumference when they fully inhale and exhale.
- Inflate and deflate balloons, beach balls, and paper or plastic bags to observe that air takes up space and exerts pressure.
- Stretch the mouth of a balloon over the neck of an empty plastic bottle. Place the bottle in hot water to observe expansion, then ice water to observe contraction.
- Inflate a zip top plastic bag with air. Heat the bag with a hair dryer and note any changes in air pressure inside the bag.
- Explore sports balls (e.g., basketball, exercise ball, football, soccer ball, volleyball) that require inflation. Use a manual air pump to inflate balls and make observations related to air pressure. The mass of similar inflated and under-inflated balls could be compared qualitatively or quantitatively if a scale with enough sensitivity is available.
- Observe that air has mass by suspending and balancing two empty balloons from a metal clothes hanger using clothespins. Without changing the location of the clothespins, remove, inflate, and reattach one balloon and observe the effect.

Extension

Students may

- Create a comic strip to depict properties of air.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 26-33

NL Science 5: Weather (SR)

- pp. 16-17

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Properties of air resources (websites)

What Makes Air Move?

Outcomes

Students will be expected to

33.0 relate the transfer of energy from the Sun to weather conditions [GCO 3]

34.0 identify patterns in indoor and outdoor air movement [GCO 3]

Focus for Learning

Changes in air pressure and temperature, caused by the Sun, have a significant affect on weather. Students should explain that

- energy from the Sun passes through the atmosphere and is absorbed by Earth's surface;
- as Earth's surface warms, it warms the air above it;
- this warming air expands, becoming less dense (lower pressure);
- cooler, higher pressure air (more dense) moves underneath the warming air and pushes it upward; and
- this movement of air is felt as wind.

This process has great significance in meteorology (i.e., study of the atmosphere and atmospheric conditions). High pressure systems (cooler, denser air masses) move underneath low pressure systems (warmer, less dense air masses) and cause them to rise.

Students should relate the transfer of energy from the Sun to air temperature, air pressure, and the formation of wind. The Sun's relation to cloud cover, precipitation, and humidity will be explored later in the unit.

Treatment of this outcome should include discussion of the greenhouse effect and its role in keeping Earth warm. The connection between the greenhouse effect and climate change will be explored later in the unit.

Students should explore the movement of air on school grounds using anemometers and bubbles or use pinwheels. Students may observe, for example, stronger winds on one side of the school. Questions arising from exploration may be investigated further.

Students should also observe and record outdoor wind direction daily, throughout the unit, using a weather vane or wind sock, and compile records. These observations may comprise part of the morning routine (p. 76). A weather vane, wind sock, or student-constructed instrument may be used. Analysis of compiled data should reveal a prevailing wind pattern.

To identify indoor air movements, students could use bubbles or fine strips of a light weight material (e.g., ribbon, tinsel, tissue paper). They should identify air patterns caused by opening a classroom door or window (e.g., air flows out the window). They should also identify patterns when all doors and windows are closed.

When on, a baseboard heater warms the air around it (becomes less dense with lower pressure). Cooler, higher pressure air will move across the floor, toward the heater, and force the warm air to rise. As it rises away from the heater, it cools, contracts, and eventually sinks back to the floor. The transfer of energy creates a pattern of air movement. Students should observe evidence of this pattern.

The notion that warm air rises because it is lighter is a common misconception. Warm air rises because it is pushed upward by air under higher pressure.

What Makes Air Move?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Present video clips demonstrating convection currents caused by energy transfers.

Students may

- Brainstorm different ways to detect indoor and outdoor movement of air.
- Blow bubbles outdoors and identify patterns in air movement.
- Compare patterns of air movement in varied locations around the school and at different elevations above the ground, using commercial or student-constructed anemometers, pinwheels, weather vanes, and wind socks.
- Create a wind spinner by drawing a spiral on a thin paper plate, cutting along the line, and attaching a thin string to the centre. Position the spinner above a heat source and observe its motion. Place the spinner in various locations within the classroom and observe patterns.
- Place their hand above a baseboard heater that has been turned on, then place their hand along the floor directly in front of the heater. Describe the movement and air felt.

Consolidation

Students may

- Compare patterns of outdoor air movement in varied locations around the school and at different elevations above the ground, using commercial or student-constructed anemometers, pinwheels, weather vanes, and wind socks.
- Blow bubbles and create indoor air patterns using fans or hair dryers, and opening doors or windows. Observe the patterns of air movement created.
- Compare patterns of indoor air movement near open windows in various locations in the school.
- Draw and label a diagram of the pattern of indoor air movement caused by turning on the baseboard heater in a classroom.

Extension

Students may

- Investigate the affect of Earth's tilt on the transfer of energy from the Sun.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 34-39

NL Science 5: Weather (SR)

- pp. 18-19

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Air convection currents (videos)
- Science suppliers (websites)

How Does Energy from the Sun Affect Different Surfaces?

Outcomes

Students will be expected to

- 3.0 state a prediction and a hypothesis
[GCO 2]
- 7.0 identify appropriate tools, instruments, and materials to complete investigations
[GCO 2]
- 18.0 compile and display data
[GCO 2]
- 21.0 draw a conclusion that answers an initial question
[GCO 2]

Focus for Learning

Students have learned that solar energy is absorbed by Earth's surface and that this energy transfer relates to weather. Students are now expected to design and carry out a guided inquiry investigation to determine how well different surfaces absorb energy from an artificial light source. In small collaborative groups, students should

- select various surface materials (e.g., asphalt, gravel, potting soil, sand, sod, water) to test;
- devise a procedure to fairly test the temperature changes of different surface materials when exposed to a light;
- identify the tools, instruments, and materials needed;
- predict which surface material(s) will have the greatest increase in temperature and hypothesize a reason;
- carry out the procedure fairly, measuring and recording temperature changes;
- compile and display data in data tables and identify patterns and discrepancies; and
- draw a conclusion that answers the initial question and indicate whether data supports or rejects the prediction and hypothesis.

In addition to outcomes 3.0, 7.0, 18.0, and 21.0, teachers may choose to address and assess additional science inquiry-related skill outcomes (e.g., SCOs 6.0, 8.0, 12.0, 13.0, 14.0, 19.0, 23.0, 26.0). Refer to the *Integrated Skills* unit for elaboration of skill outcomes.

Students should calibrate thermometers prior to use (p. 78) and account for any discrepancies when measuring. All certain digits should be recorded and the first uncertain digit estimated. Confirmation measurements should always be taken.

Students should recognize that this investigation models the heating of Earth's surface by the Sun. They should relate and apply their findings to real world situations (e.g., absorption of solar energy by an asphalt parking lot compared to a grassy field).

Different surfaces absorb energy at different rates. Unequal heating causes differences in air temperature and pressure which relates to weather. Teachers may choose to introduce how unequal heating of water and land leads to the formation of land and sea breezes.

Attitude

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

Sample Performance Indicator

On a calm, sunny day, a gentle breeze is blowing off the lake toward a farmer's field ready for planting. Apply what you have learned to explain why the air moves from the lake toward the land.

How Does Energy from the Sun Affect Different Surfaces?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to recall walking outside, barefoot on a sunny summer day. How warm did the ground feel when you walked on asphalt, concrete, grass, sand, soil, and wood?
- Ask students to share observations about wearing dark or light coloured clothing on a warm summer's day.

Connection

Teachers may

- Model devising a fair procedure to determine if construction paper colour affects how fast an ice cube placed upon it melts, when placed in a sunny location. Set up the investigation unfairly (e.g., starting with different sized ice cubes, placing one set up in sun the other in shade) and have students identify and explain why the investigation would be unfair if carried out.

Students may

- Carry out an investigation to determine if black construction paper causes an ice cube placed upon it to melt faster than a similar set up on white construction paper, when both are placed in a sunny location.
- Record their predictions and hypotheses as “If..., then...” and “If..., then... because...” statements.

Consolidation

Students may

- Carry out a guided inquiry investigation to determine how well sand, soil, and water absorb energy from a desk lamp. Place an equal volume of each material in a drinking cup and insert a thermometer into each cup. Ensure the temperature of each material is the same before starting. Record the temperature at five minute intervals for a 30 minute period and record the measurements in a data table. Create a bar graph to display the change in temperature for each material.
- Draw conclusions from their investigations and relate what is learned to the absorption of solar energy by an asphalt parking lot, a black or white sand beach, an evergreen forest, a grassy field, a lake or ocean.
- Relate what is learned from investigations to the heating and movement of air.
- View digital recordings of peer groups carrying out their investigations and assess whether the investigations were fair tests.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 40-43

NL Science 5: Weather (SR)

- pp. 20-21

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Inquiry and Problem Solving Continuum

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Inquiry investigation resources (websites)
- Science suppliers (websites)

How Does Earth's Water Affect Weather?

Outcomes

Students will be expected to

35.0 relate the constant circulation of water on Earth to the processes of evaporation, condensation, and precipitation [GCO 3]

Focus for Learning

Clouds, humidity, and precipitation are weather components that relate to the water cycle; the constant movement of water from Earth's surface to the atmosphere and back to Earth's surface.

Students should describe the water cycle and relate it to the processes of evaporation, condensation, and precipitation:

- Evaporation - energy from the Sun heats water on Earth's surface, water evaporates forming water vapour.
- Condensation - water vapour rises in the atmosphere, cools, and condenses forming water droplets (i.e., clouds).
- Precipitation - when the air cannot hold the water droplets anymore they fall to Earth's surface as precipitation.

Students should participate in directed investigations to model the water cycle and related processes. Students could, for example, place a small amount of water in a zip top plastic bag, fill it with air, place it in a sunny location, and make observation after several hours.

Students should explain that the transfer of energy from the Sun to water on Earth's surface drives the water cycle. This cycle has a significant relationship with weather:

- Evaporation of surface water increases humidity.
- Warmer air holds more water vapour than cooler air.
- Warm humid air, cools and condenses as it rises in the atmosphere forming water droplets (i.e., clouds).
- Wind moves water vapour from where it evaporates to where it returns as precipitation.
- Precipitation type (e.g., rain, snow) depends on air temperature.

Attitude

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

Sample Performance Indicator

Be a drop of water in the ocean and describe your journey through the water cycle.

Student responses provide evidence to assess SCOs 35.0 and 29.0 (i.e., use of specific terminology).

How Does Earth's Water Affect Weather?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Temporarily use humidifiers and dehumidifiers in the classroom and relate to processes of evaporation and condensation.
- Soak two paper towels in water and hang both to dry. Place an electric fan in front of one towel. Ask students to make a prediction and a hypothesis (i.e., if a fan is placed in front of one paper towel, then... because...). Discuss how this investigation relates to the water cycle.

Connections

Students may

- Use misting bottles to add moisture to the air. Relate observations to the processes of the water cycle.
- Breathe on a mirror or glass and quickly observe the condensation and evaporation of moisture.
- Place a plastic plate in a sunny location and draw a circle on the plate with a permanent marker. Use an eyedropper to add water to the centre of the circle until filled. Make repeated observations, over time, of the water amount in relation to the outline and relate to the water cycle.
- Place a cold water bottle upon a desk with paper towelling placed underneath. Observe moisture that forms on the exterior of the bottle and relate to the water cycle.
- Place wet paper towelling inside a zip top plastic bag, fill with air, and affix to a classroom window with tape. Make repeated observations of the location and amount of moisture. Relate observations to the processes of the water cycle.

Consolidation

Students may

- Follow a provided procedure to model the water cycle. Place dirty water (e.g., water with soil added) in the bottom of a large mixing bowl. Position a heavy drinking glass in the centre of the bowl. Tightly cover the bowl with plastic wrap and place it in a sunny location. Place a small stone upon the plastic wrap, directly above the glass. As the water evaporates it will condense on the under side of the plastic wrap, trickle inward due to the stone, and drop into the glass. Students should relate their observations to the water cycle and the processes of evaporation, condensation, and precipitation.
- Creatively present the water cycle and its processes through a foldable, kinaesthetic movement, or a video.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 44-49

NL Science 5: Weather (SR)

- pp. 22-23

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- The Water Cycle (BLM)
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 6

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Water cycle resources (websites and videos)

How Can We Classify Clouds?

Outcomes

Students will be expected to

36.0 identify examples of scientific questions and technological problems addressed in the past [GCO 1]

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

Focus for Learning

In the past, indicators such as cloud characteristics were relied on to predict the weather. Detailed observations on clouds led to their classification and naming. Today, more than 20 different categories of clouds are recognized by meteorologists.

Students should observe clouds daily, throughout the unit, and compile records of their characteristics (i.e., colour, shape) and associated weather. These observations may comprise part of the morning routine (p. 76).

Students are expected to recognize common cloud types and, based on analysis of their recorded observations, associate them with particular weather patterns:

- Cirrus clouds appear as white, thin, wispy streaks, high in the sky. They form from ice crystals but do not produce precipitation.
- Cumulus clouds are fluffy, piled up clouds. They are associated with fair weather when relatively small and widely spaced. Cumulonimbus clouds are darker, present in larger numbers, and are associated with powerful thunderstorms and heavy precipitation.
- Stratus clouds appear as a low layer of cloud covering the sky. Nimbostratus clouds are associated with precipitation.

Note the term nimbus refers to any cloud that produces precipitation.

Students should classify clouds as cirrus, cumulus, cumulonimbus, stratus, or nimbostratus, according to their observable characteristics.

Research may identify additional cloud types (e.g., altostratus, cirrocumulus, cirrostratus, stratocumulus). Teachers may choose to include these cloud types in classification activities.

Note that fog is classified as a stratus cloud.

Refer to the *Integrated Skills* unit for elaboration of outcome 17.0 (pp. 54-55).

Attitude

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

Sample Performance Indicator

Create a field guide of cloud types and their associated weather.

How Can We Classify Clouds?

Sample Teaching and Assessment Strategies

To use clouds to predict weather, students must associate cloud characteristics with specific weather conditions. This requires daily observations of clouds. Cloud descriptions should be included in weather reporting from the outset of the unit. Incorporating weather reporting as part of a morning routine, and compiling the reports into a master weather log for the duration of the unit is strongly encouraged.

Activation

Teachers may

- Demonstrate the formation of a cloud in a jar by following an online procedure.

Connection

Students may

- Describe and record cloud characteristics and associated weather over an extended period of time. Records may include digital images.
- Analyze recorded weather data from the beginning of the unit. Identify patterns of association between specific cloud types and other weather conditions.
- View websites related to types of clouds and identify cloud related terminology.
- Search for online cloud identification guides and note the attributes which are used to classify clouds (e.g., altitude, appearance, colour, presence of precipitation, size).
- Use an age appropriate cloud identification field guide to classify clouds or cloud images.

Consolidation

Students may

- Create a personal cloud identification guide. Include digital images of different cloud types.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 50-55

NL Science 5: Weather (SR)

- pp. 24-25

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 7

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Cloud classification resources (websites)

How Can We Predict Weather?

Outcomes

Students will be expected to

37.0 describe and compare tools, techniques, and materials used by different people in their community and region to meet their needs
[GCO1]

38.0 identify individuals in their community who work in science and technology related areas
[GCO 1]

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

Focus for Learning

Weather predicting (i.e., forecasting) provides a context to address numerous STSE, skill, and knowledge outcomes.

Over time, people have developed different ways to predict weather. In the past, predictions were solely based on observations of the natural world (e.g., animal behaviour, cloud characteristics, sky colour). Folklore was often created to pass on these prediction methods to future generations. Eventually, weather instruments were developed to make and record observations. Analysis of these recorded observations led to predictions of greater accuracy.

Students should describe examples of local forecasting methods used in the past. For example

- the use of weather folklore (e.g., Red sky at night, sailors delight; red sky in the morning, sailors take warning);
- predicting changes in weather based on a headache or joint pain; and
- tapping a barometer to determine if pressure was rising or falling (i.e., rising pressure means weather improving, falling pressure means weather worsening).

Students should compare the accuracy of these forecasting methods.

Today, meteorologists forecast weather by analyzing data gathered from various technologies and information sources:

- Historical records of past weather reveal patterns.
- Radar images indicate precipitation amounts.
- Satellites images show the location and movement of clouds.
- Weather balloons and sensors on some aircraft collect weather data in the atmosphere.
- Weather stations, ships, and buoys collect weather data on Earth's surface.

Collectively, these technologies enable the prediction of future weather. Considered separately, pieces of the prediction puzzle are missing. Radar data, for example, does not include information about cloud cover, it only shows precipitation.

Students should identify a variety of sources and technologies from which to gather information to use when forecasting.

Attitude

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

How Can We Predict Weather?

Sample Teaching and Assessment Strategies

Activation

Students may

- Share personal situations when bad weather changed or altered their plans.
- Distinguish between current weather conditions (i.e., “now cast”) and a forecast (i.e., prediction of future weather conditions).
- Brainstorm individuals who might rely on accurate weather forecasts for their jobs.
- Explore weather predictions printed in farmer’s almanacs and discuss the potential accuracy of these predictions.

Connection

Teachers may

- Direct students to various sources of weather information (e.g., digital weather stations, mobile device weather applications, printed weather maps, websites [historical weather/climate data, radar, satellite, television weather broadcasts, weather station data]).

Students may

- Compile local weather folklore from a variety of sources (e.g., community elders, family members, Internet).
- View and interpret current weather conditions and conditions in the past 24 hours on weather-related websites or mobile device applications.
- View and interpret weather maps printed in daily newspapers.
- View and interpret animated radar images from local Environment Canada radar stations (e.g., Holyrood, Marble Mountain).
- View and interpret animated satellite images (IR and visible).

Consolidation

Students may

- Measure air pressure repeatedly over a period of days using a barometer to determine if it is rising or falling. Assess whether weather improves when air pressure is rising.
- View and interpret short and long term forecasts presented on local television weather broadcasts, weather-related websites and mobile device applications.

Extension

Students may

- Research how to become a meteorologist.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 56-61, 72-75

NL Science 5: Weather (SR)

- pp. 26-29, 36-37

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 8

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Weather folklore resources (websites)
- Weather information sources (websites and mobile device applications)

How Can We Predict Weather?

Outcomes

Students will be expected to

- 39.0 describe and predict patterns of change in local weather conditions [GCO 3]
- 15.0 identify and use a variety of sources and technologies to gather relevant information [GCO 2]
- 19.0 identify and suggest explanations for patterns and discrepancies in data [GCO 2]
- 40.0 provide examples of how science and technology have been used to solve problems in their community and region [GCO 1]
- 41.0 consider the positive and negative effects of familiar technologies [GCO 1]

Focus for Learning

Students are expected, in small collaborative groups, to create a weather forecast for the following day. They should analyze and interpret information gathered from radar, satellite, weather maps, weather stations, and the master class weather log (SCO 15.0). Their forecast should make predictions about temperature, winds, cloud cover, precipitation and air pressure. Their predictions should be based on trends and patterns identified during data analysis (SCO 19.0). Predictions may be qualitative (e.g., it will be warmer and windier) in nature.

Students should provide an evidence-based rationale for their predictions and compare their forecast with actual media forecasts.

The following day, students should evaluate and discuss the accuracy of their forecast, and if inaccurate, identify reasons why (SCO 19.0). The accuracy of media forecasts may also be evaluated.

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

Science and technology can be used to solve problems. Everyday, at a personal, local, and regional level, decisions are made that are influenced by the weather (e.g., What should I wear to play outside today?, Should schools close due to predicted weather?, Should a forest fire advisory be issued to the public?). The ability to accurately forecast weather plays a significant role in these and other decisions. Students should provide additional examples of decisions influenced by the weather and explain how different forecasts might impact the decision making process.

Students should easily recognize the positive effects of accurately forecasting weather. However, they should also consider the limitations of weather forecasting.

Students may mistakenly believe that the use of modern technology makes accurate weather forecasting easy. However, meteorologists' forecasts are still predictions. Earth's atmosphere is huge and its conditions are changing constantly. Forecasting is a complex process that requires vast amounts of data being analyzed by human-created computer models. Weather forecasts always carry a degree of uncertainty (e.g., probability of precipitation).

To illustrate the limitation of current weather predicting technologies, students should access an online weather information source and record the predicted short-term and long-term weather (e.g., hourly, 24 hour, 36 hour, 7 day, 14 day forecasts). They should verify the accuracy of these predictions over time. They will likely note that shorter term forecasts are often more accurate than longer term forecasts.

How Can We Predict Weather?

Sample Teaching and Assessment Strategies

As part of an established morning routine, teachers could present daily weather maps and animated radar and satellite imagery from weather-related websites to build capacity for student weather forecasting.

Connection

Students may

- View weather-related websites, mobile device applications, or local television broadcasts for exemplars of what weather forecasts entail.
- Compare short- and long-term forecasts from various weather-related websites and mobile device applications and note any differences in their predictions. What might account for these differences?
- Analyze the class data compiled in the master weather log and identify trends and associations (e.g., wind direction is most often westerly, precipitation is always associated with cloud cover, precipitation is associated with low air pressure, southerly winds are associated with warmer temperatures).
- Analyze current weather maps and animated radar and satellite images to identify trends.
- Analyze historic weather/climate data from a weather-related website for a specific date.
- Identify the current air pressure trend (i.e., rising, falling, stable).

Consolidation

Students may

- Analyze and interpret weather data to create a next day weather forecast; making predictions about temperature, winds, cloud cover, precipitation, and air pressure. Provide an explanation for predictions.
- Compare their next-day forecast to next-day forecasts found on weather-related websites or mobile device applications and identify and suggest explanations for discrepancies.
- Evaluate the accuracy of their next-day forecast.
- Record the hourly, 36 hour, and 7 day predictions of a specific weather-related website, mobile device application, or local television broadcast. Evaluate the accuracy of these predictions over time.
- Discuss which information source was most useful when creating a next-day forecast and why meteorologists use more than one source or technology to make predictions.
- Discuss why short-term forecasts might be more accurate than long-term forecasts.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 56-61

NL Science 5: Weather (SR)

- pp. 26-29

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Weather information sources (websites and mobile device applications)

How Can We Describe Weather Systems?

Outcomes

Students will be expected to

42.0 describe the key features of a variety of weather systems
[GCO 3]

Focus for Learning

In meteorology, weather systems refer to large circulating air masses. Low pressure systems are relatively moist and unstable air masses. They create strong winds and are associated with precipitation. High pressure systems are relatively cool and dry air masses. They are associated with clear skies and light winds. When low and high pressure systems meet they form a weather front (e.g., cold front, warm front). It is along these fronts that storms typically form.

Students are expected to

- describe the key features of low pressure and high pressure systems; and
- research and describe the key features of blizzards, hurricanes, Nor'easters, thunderstorms, and tornadoes.

This not intended to be a significant research project. Tornadoes, for example, could be described as funnel-shaped clouds, developing from powerful thunderstorms, that spin in a circle. Their winds can cause significant damage and their intensity is measured on the Fujita scale.

Teachers may use a jigsaw cooperative learning strategy to facilitate research.

Attitude

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

Sample Performance Indicator

Use a T-chart to compare the characteristics of low pressure systems and high pressure systems.

How Can We Describe Weather Systems?

Sample Teaching and Assessment Strategies

Activation

Students may

- Share recollections of experiences during extreme weather events (e.g., blizzards, hurricanes, thunderstorms).

Connection

Teachers may

- Model what happens when high pressure and low pressure systems interact using students to kinaesthetically represent air particles.

Students may

- Search for, view, and share videos of extreme weather events.
- Track Atlantic hurricanes through the Canadian Hurricane Centre.
- Track potential blizzards using radar and satellite imagery.
- Research the important role of hurricane hunter planes in predicting the track and intensity of hurricanes.

Consolidation

Teachers may

- Facilitate a cooperative learning jigsaw by organizing students into home groups of five and assigning a different extreme weather system (i.e., blizzard, hurricane, Nor'easter, thunderstorm, tornadoes) to each member of the group. Students then separate, regroup according to weather system (e.g., team blizzard), and collaboratively research and record the key features of their extreme weather event. Once completed, students return to their home group and share what was learned in their expert group.

Students may

- Create a graphic organizer to describe the key features of high and low pressure systems and extreme weather events.

Extension

Students may

- Research and create an extreme weather preparedness kit.
- Research the scale used to describe the intensity of a hurricane or tornado. Share findings with classmates.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 62-67

NL Science 5: Weather (SR)

- pp. 30-31

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Weather systems resources (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 5* (ELA 5)
 - *Snowstorm*
 - *Tornadoes*

How Do We Adapt to Weather and Climate?

Outcomes

Students will be expected to

43.0 identify scientific discoveries and technological innovations of people from different cultures [GCO 1]

Focus for Learning

Weather refers to the daily conditions in the atmosphere. Climate refers to the typical weather over a long period of time.

Adapting to weather conditions and climate is one of the most essential of human behaviours. Throughout history, people from different cultures have adapted through the development and use of innovative technologies.

Equating the term technology with electronic devices is a common misconception. Technology refers to products, processes, or systems that are designed to solve a problem. An electric vehicle, wooden pencil, and a recycling process are all technologies.

Students should recognize the diversity of innovations that have been developed to adapt to weather and climate. They should explore technologies such as shelter and clothing developed by people from different cultures. They could, for example, compare traditional salt box houses to those used by local indigenous groups (e.g., wigwam), and other cultures, and contemplate reasons for their unique designs and material use. Other examples could include hats, or heating and cooling technologies.

Cross curricular connections may be made to Social Studies 5 outcomes; examine specific ways ancient societies used resources to meet their needs (e.g., clothing, shelter).

Treatment of this outcome should include scientific discoveries related to climate change. Students should explore climate change science (e.g., warming air temperatures, melting of polar ice caps, changing sea ice patterns, rising sea level, increasing coastal erosion, warming oceans, more frequent extreme weather events, changing habitats) and technologies that have been proposed or developed to reduce greenhouse gas emission and slow climate change.

Students should relate the greenhouse effect to climate change.

Attitude

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

How Do We Adapt to Weather and Climate?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present images of hats from different cultures (e.g., beret, bush, cowboy, toque, sombrero, conical Asian, Amish straw, ushanka, baseball, bowler, Sou'wester, rain bonnet, pang). Ask students to consider how their design and materials might help someone adapt to the weather/climate in the region where they are used.

Connection

Teachers may

- Invite guest speakers (e.g., Conservation Corps) to present on local effects of climate change.

Students may

- View images of homes from different cultures and discuss how their design and materials relates to the weather/climate of the region.
- Interpret graphs of average yearly temperatures for local communities and relate to climate change.

Consolidation

Students may

- Create an info-graphic to communicate the effects of climate change on Newfoundland and Labrador.
- Investigate different fabrics to determine which would be the best to make a hat that is waterproof, windproof, or visible in the fog.
- Research and share how the greenhouse effect contributes to climate change.
- Create an information flyer to inform community members about things they can do to help reduce climate change and its affects.

Resources and Notes

Authorized

NL Science 5: Weather (TR)

- pp. 76-89

NL Science 5: Weather (SR)

- pp. 38-45

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- St. John's Average Yearly Temperature (BLM)
- Stephenville Average Yearly Temperature (BLM)
- IWB Activities 8 and 10

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci-5/links/weather.html

- Climate change resources (websites)

Section Three:
Specific Curriculum Outcomes

Unit 2: Forces and Simple Machines

Focus

The study of motion and the forces causing motion help students build a more sophisticated understanding of forces. Students are able to move from qualitative to simple quantitative descriptions of forces acting on objects as they manipulate simple machines. The effects of friction on the movement of objects are also explored. The ability of simple machines to accomplish a task with less effort is a major emphasis as students compare and improve the ability of these machines to function. Simple machines are used in many aspects of life, and students should become familiar with their design and their advantages.

This unit has both a scientific inquiry and a design and problem solving focus. The unit emphasizes the development of inquiry skills related to rephrasing questions in a testable form, making predictions and hypotheses, defining objects and events in investigations, identifying and controlling major variables, devising procedures to carry out fair tests, using tools for measuring, estimating measurements, and identifying new questions arising from what was learned. Design and problem solving experiences develop the skills of gathering information from a variety of sources and technologies, and selecting and using tools.

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.

29.0 demonstrate that specific terminology is used in science and technology contexts
41.0 consider the positive and negative effects of familiar technologies
48.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
49.0 describe examples of technologies that have been developed to improve living conditions
55.0 identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence

GCO 2 (Skills): Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

- 2.0 rephrase questions in a testable form
- 3.0 state a prediction and a hypothesis
- 4.0 define objects and events in their investigations
- 5.0 identify and control major variables in investigations
- 6.0 devise procedures to carry out a fair test and to solve a practical problem
- 9.0 select and use tools
- 11.0 select and use tools for measuring
- 12.0 make observations and collect information that is relevant to the question or problem
- 13.0 estimate measurements
- 14.0 record observations
- 15.0 identify and use a variety of sources and technologies to gather relevant information
- 22.0 suggest improvements to a design or constructed object
- 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

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.

- 44.0 investigate different kinds of forces used to move objects or hold them in place
- 45.0 observe and describe how various forces can act directly or from a distance to cause objects to move
- 46.0 demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object
- 47.0 investigate and compare the effect of friction on the movement of an object over a variety of surfaces
- 50.0 investigate and compare the force needed to lift a load manually with that required to lift it using a simple machine
- 51.0 use levers to accomplish tasks and differentiate between the position of the fulcrum, load, and effort force
- 52.0 design the most efficient lever to accomplish a task
- 53.0 demonstrate the use of rollers and wheel and axles in moving objects
- 54.0 investigate and compare the force needed to lift a load using a single pulley system with that needed to lift it using a multiple pulley system

GCO 4 (Attitudes): Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Students are encouraged to:

- appreciate the role and contributions of science and technology in their understanding of the world
- realize that the applications of science and technology can have both intended and unintended effects
- recognize that individuals of any cultural background can contribute equally to science
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions
- appreciate the importance of accuracy and honesty
- demonstrate perseverance and a desire to understand
- work collaboratively while exploring and investigating
- 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 2	Science 5	Science 6
<i>Relative Position and Motion</i>	<i>Forces and Simple Machines</i>	<i>Flight</i>
<ul style="list-style-type: none"> investigate patterns of movement identify factors that affect movement 	<ul style="list-style-type: none"> investigate forces used to move or hold objects in place describe how forces act directly or from a distance to cause objects to move describe the effect of increasing and decreasing the force applied to an object investigate the effect of friction on the movement of an object over various surfaces investigate the force needed to lift a load manually compared with using a simple machine use levers to accomplish tasks and differentiate the position of the fulcrum, load, and effort force design the most efficient lever to accomplish a task demonstrate the use of rollers and wheel and axles in moving objects investigate the force needed to lift a load using a single pulley system compared with a multiple pulley system 	<ul style="list-style-type: none"> describe how lift is affected by the shape of a surface describe methods for altering drag in flying devices describe the role of lift in overcoming gravity identify situations which involve Bernoulli's principle describe the means of propulsion for flying devices
Science 3		Science 8
<i>Invisible Forces</i>		<i>Fluids</i>
<ul style="list-style-type: none"> investigate conditions that affect the force of magnets investigate conditions that affect the force of static electricity 		<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

Forces and Simple Machines is the first of two consecutive physical science units.

September	October	November	December	January	February	March	April	May	June

**Forces and Simple
Machines**

What Are Forces and How Do They Act on Objects?

Outcomes

Students will be expected to

44.0 investigate different kinds of forces used to move objects or hold them in place
[GCO 3]

45.0 observe and describe how various forces can act directly or from a distance to cause objects to move
[GCO 3]

Focus for Learning

Forces cause objects to start or stop moving, or change direction. Invisible forces were explored in Science 3. In Science 5, students will investigate gravity, magnetic force, and mechanical force.

At learning centres, students should apply different kinds of forces on objects and investigate personal inquiry questions (SCO 1.0):

- Gravity centre - Drop objects (e.g., balls, modelling clay, sheets of paper) to observe the pulling effect of gravity. Investigate, for example, whether similar objects of different masses hit the ground at the same time when dropped.
- Magnetic force centre - Compare the strength of different magnets (e.g., bar, disc, fridge, horseshoe). Investigate, for example, how many paper clips a magnet can attract or how many sheets of paper a fridge magnet can hold in place.
- Mechanical force centre - Move objects (e.g., a coin, table tennis ball) by directly applying pushing and pulling forces in different ways. Investigate, for example, how changing the diameter of a straw affects how far you can blow a table tennis ball.

Students are expected to classify forces as pushes or pulls, and as gravitational, magnetic, or mechanical forces.

A common misconception is that forces act one at a time. Throw a paper ball across the room to clarify this misconception. Note that the ball does not follow a linear path. The initial throwing force (mechanical) is applied in one direction, however, the force of gravity (i.e., pulling down) and air resistance (i.e., friction slowing down) acting on the ball cause it to arc toward the floor.

Students should observe and describe forces that cause objects to move as contact or non-contact. Contact forces are applied directly on objects (e.g., mechanical forces), while non-contact forces are applied from a distance, without contact (e.g., gravity, magnetic force).

Students are expected to classify forces as contact or non-contact.

Teachers may choose to address outcome 29.0 (i.e., demonstrate that specific terminology is used in science and technology contexts) at this time. Refer to the initial elaboration provided on pp. 74-75.

When communicating about forces students should use specific terminology, which includes: mechanical force, gravitational force, magnetic force, contact force, and non-contact force.

Sample Performance Indicator

Demonstrate different ways you could move a paper clip through a maze copied onto construction paper and indicate if it is an example of a contact or non-contact force.

What Are Forces and How Do They Act on Objects?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate a force walk around the school to identify forces in everyday life and ask students to group them in a table with columns. Students could choose their own headings for groups (e.g., pushing forces, pulling forces).
- Provide a collection of materials (e.g., magnet, metre stick, straw, string, toothpick) and ask students to use them to move an object (e.g., block, marble, paper clip) or stop an object from moving.
- Demonstrate static electric forces by rubbing a balloon against their hair and using it to pick up paper confetti and stick to a wall.

Students may

- Apply forces to beach balls and observe how they act.

Connection

Teachers may

- Provide materials at three centres (i.e., gravity centre, magnetic centre, mechanical force centre) for students to explore and ask students to investigate a personal inquiry question at each centre.

Students may

- Explore different ways to move a pencil across a desktop and describe the related forces using appropriate terminology.
- View images depicting forces being applied to objects and classify the forces as pushes or pulls, gravitational, magnetic, or mechanical, and as contact or non-contact.
- Move a table tennis ball through a constructed maze using different methods (e.g., blowing through a straw, using hand held fan or water spray bottle, stick handling with a ruler, using pool strokes with a pencil, repelling with a ruler charged with static electricity, tilting the maze).

Consolidation

Teachers may

- Read Aloud *Neo Leo: The Ageless Ideas of Leonardo da Vinci*, or a similar title. Ask students to create an inventor's journal to use throughout the unit to sketch and record their ideas.

Students may

- In small collaborative groups, create a museum display to represent one type of force. Displays could include objects or illustrations related to the type of force. During a gallery walk each group could present their force type to their classmates.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (Teacher Resource [TR])

- pp. 6-17

NL Science 5: Forces and Simple Machines (Student Resource [SR])

- pp. 6-11, 56-59

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Forces (websites and videos)
- Science suppliers (websites)

Children's Literature

- *A Crash Course in Forces and Motion with Max Axiom, Super Scientist* by E. Sohn
- *Neo Leo: The Ageless Ideas of Leonardo da Vinci* by G. Barretta
- *Cleonardo: The Little Inventor* by M. GrandPré

What Happens When Forces are Increased or Decreased?

Outcomes

Students will be expected to

46.0 demonstrate and describe the effect of increasing and decreasing the amount of force applied to an object [GCO 3]

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

Focus for Learning

Students should investigate and describe the effect of increasing and decreasing the amount of mechanical force applied to an object. They should devise and carry out procedures to qualitatively vary the force applied (e.g., push harder, pull more gently), observe the effect on the object, and record relevant observations (SCOs 6.0, 8.0, 12.0, 14.0). Contexts to investigate could include applying push and pull forces to playground or sports equipment, or using a variable speed hair dryer to apply force (i.e., a push of air) to a table tennis ball.

Varying the amount of force applied to an object may cause the object to start or stop moving, speed up, slow down, or change direction.

Students should carry out these investigations in small collaborative groups to encourage student development of communication and listening skills. Refer to the *Integrated Skills* unit for elaboration of outcome 25.0 and other skill outcomes.

Introduce the concept of balanced and unbalanced forces. Students should come to recognize that

- objects have more than one force acting on them at any one time;
- forces can either be balanced or unbalanced;
- when balanced forces are acting on an object, objects at rest remain still and moving objects continue to move at a constant speed in the same direction; and
- when forces applied to an object are unbalanced (i.e., one force is stronger than another), objects at rest may start to move and moving objects may change speed or direction or both.

Students should observe and describe balanced and unbalanced forces.

Students may mistakenly believe that an object at rest has no forces acting on it. To clarify, ask them to hold a heavy object in an outstretched hand, palm up, so that the object is not moving. They should feel the object pushing down on their hand due to gravity. To keep it still, their hand is applying an equal, opposite, upward force.

Attitude

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

Sample Performance Indicator

Demonstrate and describe how the motion of a pinwheel is affected by blowing air against it:

- with a gentle, medium, and strong force, starting from rest;
- while it is already in motion; and
- from the opposite direction while already in motion.

What Happens When Forces are Increased or Decreased?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate a tug of war to demonstrate the concept of balanced and unbalanced forces. For each tug of war, students should determine the direction in which the ribbon tied in the centre of the rope is moving, if at all, and whether the forces are balanced or unbalanced.

Students may

- Construct simple Lego™ cars and investigate how increasing and decreasing the amount of force applied affects them.

Connection

Students may

- Participate in various sporting activities in the gymnasium or play with equipment at a local playground and note how increasing or decreasing the applied force affects the movement of objects.
- Play 3-coin hockey to explore how mechanical forces affect the movement of coins.
- Affix the long part of a bendable straw to a desktop with the end extended over the desk's edge. Bend the shorter end 90° upward and place a table tennis ball upon it. Vary the force of air blown through the straw until the ball can be suspended in air. Describe the forces acting on the ball when rising, falling, and suspended.

Consolidation

Students may

- In small collaborative groups, use straws to investigate how blowing on a table tennis ball affects its motion (i.e., apply multiple forces on the ball from varied directions, while at rest and when in motion, and record observations).
- Propose personal inquiry questions related to increasing and decreasing forces and devise and carry out investigations to find answers (e.g., How far can a table tennis ball roll when moving air is applied from a hair dryer set to low medium and high power?).
- Create a “how to guide” for riding a skateboard that includes how to start moving, stop moving, slow down, speed up, and turn.

Extension

Students may

- Research how increasing and decreasing forces (i.e., throwing force and sweeping force) affects the motion of rock in the sport of curling.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 18-21

NL Science 5: Forces and Simple Machines (SR)

- pp. 12-13

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Balanced and unbalanced forces (websites and videos)

How Can You Predict the Force Needed to Move an Object?

Outcomes

Students will be expected to

11.0 select and use tools for measuring
[GCO 2]

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

13.0 estimate measurements
[GCO 2]

Focus for Learning

Students should investigate the amount of force needed to lift different objects. Forces should initially be measured using elastic bands with paper clips hooked onto them to attach objects.

In pairs or small collaborative groups, students should

- select the number and size of elastics they wish to use,
- attach an object to the elastics and pull upward until the object lifts off the surface,
- measure and record the length (cm) of the stretched elastics (the greater the stretch the greater the force), and then
- predict and measure the stretch length needed to lift other objects.

Introduce spring scales (i.e., force meters) as a tool to measure force and the newton (N) as the standard unit. Different spring scales have different capacities (2.5 N, 5 N, 10 N, 20 N, 30 N, 50 N). Direct instruction on how to use a spring scale may be required.

Students should use spring scales to measure the number of newtons needed to lift the objects previously tested with elastics. They should estimate the force needed and select a spring scale with sufficient capacity to lift the load (e.g., selecting a 20 N spring scale if estimating that more than 10 N of force is required).

To ensure measurement accuracy, students should calibrate spring scales to zero prior to use, use consistent measurement techniques, and take a second confirmation measurement each time. When reading the scale, all certain digits should be recorded and the first uncertain digit estimated.

Note that spring scales can be used to measure both mass and force. As a result, they are often calibrated in both grams and newtons. Ensure that students use the newton scale to measure force. If the available spring scale is not calibrated in newtons, the following conversion may be used, $100 \text{ g} = 1 \text{ N}$ or $1 \text{ kg} = 10 \text{ N}$.

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

Attitude

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

Sample Performance Indicator

Predict the amount of force, in newtons (N), needed to lift a notebook, a binder, and a lunch bag. Select an appropriate spring scale for each and measure and record the force needed.

How Can You Predict the Force Needed to Move an Object?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to brainstorm units of measurement, guide discussion toward the need for standard units (e.g., gram, litre, metre), then introduce the newton as the standard unit for force.

Connection

Teachers may

- Demonstrate how force meters measure force.
- Demonstrate estimation procedures when measuring.

Students may

- Construct and use elastic band force meters to predict and measure the force needed to move (e.g., lift) various objects. The strength of the force should be equated to the amount of stretch in the elastic. Stretch should be measured in cm.
- Predict how far an elastic band force meter will stretch in order to lift various classroom objects and test to confirm predictions.
- Compare spring scales with different capacities (2.5 N, 5 N, 10 N, 20 N, 30 N, 50 N).
- Demonstrate how to calibrate a spring scales to zero.
- Use spring scales to lift known masses (e.g., 10 g, 100 g, 1 kg).
- Select appropriate capacity spring scales to lift various objects and test their appropriateness. Measuring a 4 N force with a 2.5 N spring scale stretches the spring beyond the scale. A 4 N force could be measured with a 50 N spring scale, however, greater accuracy would be obtained with a 5 N or 10 N spring scale.

Consolidation

Students may

- Predict how many newtons of force are required to lift various objects. Measure the force required with a spring scale to confirm or refute predictions.
- Select four objects from a collection. One object should require about 5 N to lift it, one should require less than 5 N, and two should require more than 5 N. Select appropriate spring scales to test predictions.

Extension

Students may

- Research the difference between mass and weight.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 22-25

NL Science 5: Forces and Simple Machines (SR)

- pp. 14-15

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Elastic band force meter - alternative designs (websites and videos)
- Spring scale suppliers (websites)

How Does Friction Affect the Movement of Objects?

Outcomes

Students will be expected to

47.0 investigate and compare the effect of friction on the movement of an object over a variety of surfaces [GCO 3]

2.0 rephrase questions in a testable form [GCO 2]

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

Focus for Learning

Friction is the resistance to movement created when two surfaces are in contact with each other.

Students should, through guided inquiry, investigate how friction affects the force needed to start or keep a wood block (or similar object) moving over different surfaces. The amount of force needed to start an object moving is always greater than the amount needed to keep an object in motion. Forces should be measured quantitatively using spring scales. Inserting an eye screw into the end of the wood block will allow it to attach to a spring scale.

Students should

- collaboratively select the surfaces they wish to test (e.g., asphalt, cardboard, carpet, cotton towel, crushed stone, grass, sandpaper, tile floor, wood) and decide whether they will investigate the force needed to start a wood block sliding or keep it sliding;
- pose a testable question that includes both the independent and the dependent variable (e.g., How do different surfaces affect the amount of force needed to start a wood block sliding?);
- predict which surfaces will require the most and least force and provide explanations for the prediction;
- collaboratively devise a procedure, identifying required materials and measuring instruments, to fairly test each surface;
- carry out their procedure to ensuring a fair test, taking repeated measurements of the force needed to slide the wood block;
- record measurements in a table, compare results, and provide explanations for any patterns or discrepancies noted; and
- draw a conclusion, ordering the surfaces from least to greatest according to the amount of force required to slide the wood.

Students should relate their findings to the effect of friction. Generally, the greater the force required to move an object the greater the friction. To start or keep an object moving, the applied force must overcome (i.e., be stronger than) the force of friction.

In addition to SCOs 2.0 and 3.0, this guided inquiry investigation provides an opportunity to address and assess numerous skill outcomes (e.g., 1.0, 4.0, 5.0, 6.0, 8.0, 11.0, 12.0, 13.0, 14.0, 18.0, 19.0, 21.0, 23.0, 24.0, 26.0). Refer to the *Integrated Skills* unit for elaboration of these skills.

Attitude

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

How Does Friction Affect the Movement of Objects?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Review the role of independent, dependent, and control variables in experiments.

Students may

- Use prior knowledge to define friction and describe its effects on objects.
- Play tug of war in the gymnasium wearing sneakers, then replay again in just their socks to demonstrate role of friction in footwear.

Connection

Teachers may

- Present digital images of everyday activities and ask students to identify where friction is occurring in the images.
- Facilitate a friction walk around the school. Ask students to look for surfaces that are in contact and identify features of those surfaces that increase or decrease friction.
- Investigate if it requires more force to start or keep an object moving.

Students may

- Use magnification devices to view surfaces they perceive as smooth (e.g., desktop, marble). Alternatively, teachers could present digital images of “smooth surfaces” taken with high powered microscopes (e.g., glass, paper). Students should recognize that these surfaces are not frictionless.
- Play 3-coin hockey on varied surfaces (e.g., cardboard, carpet, cotton towel, floor tiles) and note the amount of force needed to advance the coins.

Consolidation

Students may

- Devise and carry out a fair test to investigate the effect of friction on the force required to start or keep an object sliding over a variety of surfaces.
- Propose another inquiry question, arising from what was learned, and devise and carry out an investigation to answer it (e.g., How would increasing or decreasing the mass of the object, or lubricating the surface affect results?).

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 26-33

NL Science 5: Forces and Simple Machines (SR)

- pp. 16-19

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Friction resources (websites and videos)

How Do We Use Friction?

Outcomes

Students will be expected to

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

Focus for Learning

Scientific ideas lead to the development of new inventions and applications. This is an important aspect of the nature of the relationship between science and technology.

Friction slows down objects and makes objects at rest difficult to move. Friction also wears down objects (e.g., tires), and produces heat. The amount of friction between surfaces depends on

- surface texture (rougher surfaces generally have more friction),
- surface area (larger contact areas generally have more friction), and
- the magnitude of other forces acting on the surfaces (e.g., gravity, static electricity).

Our scientific understanding of friction and its effects has led to the development of technologies, both products and processes:

- Lubricants (e.g., engine oil, snowboard wax) reduce friction between moving solid surfaces by eliminating or reducing surface contact.
- Winter tire treads are made from materials that do not stiffen as much in cold weather allowing for more traction. Adding metal studs to tires increases friction on icy roads. Under-inflating tires during winter increases surface contact.
- Treads on winter boots have deep grooves to increase friction.
- Spreading sand on icy roads increases friction by preventing ice from forming quickly.
- Grip tape on stair treads and skateboards increases friction.
- Swim caps reduce friction between our hair and water.

Applying what they have learned, students should identify whether friction-related technologies increase or decrease friction.

Attitude

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

Sample Performance Indicator

Group the following products and processes according to whether they increase or decrease friction:

- brake pads, hockey stick tape, oiling door hinges, ball bearings, soccer cleats, gymnasts applying powder to their hands, curling brooms, double layered running socks, adding snow to the pan of a truck in winter, sanding handrails, waxing snowboards.

How Do We Use Friction?

Sample Teaching and Assessment Strategies

Connection

Students may

- Vigorously rub their hands together to observe some effects of friction.
- Identify and explain real life situations where increasing or decreasing friction solves a problem:
 - adding studs to winter tires (increasing friction),
 - spreading sand on icy roads (increasing friction),
 - using a crazy carpet for sliding (decreasing friction), and
 - adding oil to the piston of an engine (decreasing friction).
- Collect a variety of shoe types with different soles (e.g., ballet shoes, bowling shoes, hiking boots, slippers, sneakers, winter boots). Attach each shoe individually to an appropriate spring scale and gently pull it across the floor, ensuring that the sole is down, and record the force required to move it. Sequence the shoes according to the amount of force required. Discuss why different types of shoes require different types of soles.
- Predict what will happen to the amount of friction between surfaces when you put a lubricant (e.g., cooking spray, water, hand cream) between them. Test the prediction.

Consolidation

Students may

- Provide everyday examples of situations when friction is helpful and harmful.
- Suggests methods to increase and decrease the force of friction (e.g., sanding wood to reduce friction, adding grip tape to increase friction).
- Redesign familiar friction-related products to increase or decrease the force of friction.
- Identify where friction occurs in ice hockey and describe methods used to increase or decrease the force of friction.

Extension

Students may

- Create a cartoon strip to illustrate a problem caused when the force of friction is increased or decreased too much.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 34-37

NL Science 5: Forces and Simple Machines (SR)

- pp. 20-21

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Friction resources (websites and videos)

What Is a Simple Machine?

Outcomes

Students will be expected to

49.0 describe examples of technologies that have been developed to improve living conditions
[GCO 1]

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

Focus for Learning

Technology is the application of science to solve practical problems. Our human ancestors developed simple technologies to make work easier. These simple machines are basic tools we continue to use every day to complete tasks (e.g., change a tire, open a can). They can increase the force we apply; making work easier to do.

Students should explore the physical relationships that exist in each of the simple machines below (i.e., Where is effort applied?, In what direction?, What is the result?), identify key distinguishing features, and describe some of the benefits provided by their use.

- A lever is a stiff bar that moves. It moves on a point, called a fulcrum. Pushing or pulling on the bar helps move an object (e.g., opening a paint can with a screwdriver) using less force.
- A wheel and axle is a big wheel attached to a smaller wheel (axle) which move together (e.g., a door knob). Applying a small turning force on the wheel creates a large output force on the axle.
- A pulley is a grooved wheel with a rope that goes around it. Pulleys move objects up and down, or sideways. Pulleys can change the direction of and/or multiply an applied force.
- An inclined plane is a surface that is slanted (e.g., a ramp). Inclined planes help to move loads up or down using less force.
- A screw is a curved inclined plane that goes around in a circle. Screws help move loads up and down using less force.
- A wedge is a type of inclined plane that pushes things apart using less force.

Students should identify simple machines in everyday technologies. A manual can opener, for example, contains a wheel and axle (turning key attached to the cutting wheel), a wedge (edge of cutting wheel), and two levers (handles). Students should also consider how hard it would be to perform tasks without these machines (e.g., How hard would it be to open a can without a can opener?).

When communicating about forces and simple machines, students should use specific terminology, which includes

- force, mechanical force, gravitational force, magnetic force, contact and non-contact force, balanced and unbalanced force;
- spring scale, newton, friction;
- effort force, load, lever, fulcrum, wheel and axle, fixed and movable pulley, inclined plane, screw, wedge, force advantage.

Refer to the previous elaboration provided on pp. 74-75.

Sample Performance Indicator

Find an example of each simple machine within the school or classroom and describe how they are used to make life easier.

What Is a Simple Machine?

Sample Teaching and Assessment Strategies

Activation

Teacher may

- Ask students to identify simple tools developed by our ancestors to make work easier and relate to simple machines.

Connection

Teachers may

- Present one example of each simple machine to be investigated (e.g., stapler, doorknob, blind pulley, wheel chair ramp, water bottle collar and cap, letter opener), identify its key features, and demonstrate its use.
- Create a centre for each type of simple machine. Place related objects in each centre for students to explore.

Students may

- Participate in a simple machines scavenger hunt at school. Observations should be recorded using a data table or digital images. Students should group recorded objects according to the type of simple machine. Note that some objects fit into more than one category (e.g., a staple remover fits with levers and wedges).

Consolidation

Teachers may

- Provide a collection of objects related to simple machines and ask students to record the name of each object in a table and identify which simple machines it includes (e.g., a cork screw may contain levers, a screw, a wedge, and a wheel and axle).

Students may

- Create a physical collection of objects representing all the simple machine types.
- Create a digital or physical collage of images of simple machines.
- Discuss which simple machine type it would be easiest and/or hardest to live without.
- Collaboratively create and illustrate a superhero whose super powers and/or body features incorporate simple machines. Challenge students to include all six types of simple machines.
- Create a sales advertisement for a simple machine.

Extension

Students may

- Research Rube Goldberg machines and sketch a design for one that incorporates several simple machines to accomplish a task.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 40-45

NL Science 5: Forces and Simple Machines (SR)

- pp. 26-31, 56-59

NL Science 5: Online Teaching Centre

- IWB Activity 4
- Image bank

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Simple machines (websites and videos)

What Is a Force Advantage?

Outcomes

Students will be expected to

- 50.0 investigate and compare the force needed to lift a load manually with that required to lift it using a simple machine [GCO 3]
- 5.0 identify and control major variables in investigations [GCO 2]
- 6.0 devise procedures to carry out a fair test and to solve a practical problem [GCO2]
- 14.0 record observations [GCO 2]

Focus for Learning

Simple machines can provide a force advantage, or mechanical advantage, when performing tasks. A force advantage refers to the gain in force achieved when the output force is greater than the input force, or effort force (e.g., lifting a 10 N load with a movable pulley using only a 5 N effort force). Achieving a force advantage, however, requires a trade-off of effort for distance (i.e., less effort applied over a greater distance). For the example above, lifting the load 1 m will require pulling 2 m of rope.

Students should, through guided inquiry, devise and carry out investigations to compare the effort force needed to move a load manually with that required to lift it using various simple machines. Students should

- choose an object to be the load and select three simple machines to test (e.g., lever, pulley, inclined plane);
- pose their inquiry question identifying the independent variable (simple machines) and dependent variables (effort force);
- consider variables that need to be controlled and devise a procedure to carry out a fair test for each simple machine;
- make predictions, then fairly carry out their procedure;
- make and record observations including sketches or digital images of how the simple machines are set up and measurements of the effort force needed to lift the load;
- draw a conclusion that answers the initial question;
- compare results with those of other groups; and
- identify and suggest explanations for patterns and discrepancies in results of different groups.

Students should measure forces using an appropriate spring scale.

The effort force needed to lift the load will vary depending on the simple machine used and how it is set up (e.g., the proximity of a lever's fulcrum to the load, the steepness of the inclined plane, whether the pulley is fixed or movable, wheel circumference in relation to the axle). This variability will likely result in new questions for students to investigate further (e.g., How does changing the fulcrum's position affect the lever's force advantage? How does the steepness of an inclined plane affect its force advantage?).

In addition to SCOs 5.0, 6.0, and 14.0, this guided inquiry investigation provides an opportunity to address and assess additional skill outcomes (e.g., 1.0, 2.0, 3.0, 7.0, 8.0, 9.0, 11.0, 12.0, 13.0, 18.0, 19.0, 21.0, 24.0, 26.0). Refer to the *Integrated Skills* unit for elaboration of these skills.

Sample Performance Indicator

Using a spring scale, load, and a simple machine (e.g., lever, pulley, inclined plane), provide quantitative evidence to demonstrate that the simple machine reduces the force needed to lift the load.

What Is a Force Advantage?

Sample Teaching and Assessment Strategies

Emphasis should be placed on identifying and controlling variables and carrying out fair procedures when students are investigating.

Activation

Students may

- Attempt to accomplish a difficult or “impossible” task without a tool (e.g., removing the lid from a tin can), then use a simple machine (e.g., manual can opener) to accomplish the same task.

Connection

Teachers may

- Present and/or sketch the following scenario: a load of concrete blocks need to be lifted into the back of a pickup truck. Ask students to sketch different ways simple machines could be used to accomplish the task. Students should share their ideas and collaboratively discuss the efficiency of each method. Introduce the concept of force advantage into the discussion.

Students may

- In small collaborative groups, devise and carry out a procedure to investigate and compare how much a lever, pulley, and inclined plane reduce the amount of force needed to lift a load. Based on their results, students should identify which simple machines provided a force advantage, if any. They should then compare their results with those of other groups. Results might vary widely depending on the type of lever used and the location of the fulcrum and effort force, whether a fixed or movable pulley was used, and the slope of the inclined plane. If digital images of each set up were recorded, students could compare images and note differences. Students may wish to make changes to the set up of their simple machines and retest.

Consolidation

Students may

- Propose new questions to investigate, arising from what was learned, and devise and carry out new investigations to find answers to their inquiry questions (e.g., investigate how changing the slope of the inclined plane affects the force advantage achieved when lifting a load).

Extension

Students may

- Research why switchback roads are used on steep slopes.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (Teacher Resource [TR])

- pp. 46-51

NL Science 5: Forces and Simple Machines (SR)

- pp. 30-33

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

How Can We Use Levers?

Outcomes

Students will be expected to

51.0 use levers to accomplish tasks and differentiate between the position of the fulcrum, load, and effort force
[GCO 3]

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

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

Focus for Learning

Students should identify the position of the fulcrum, load, and effort force when investigating everyday levers (e.g., bottle opener, hammer, hole punch, nail clippers, nutcracker, pliers, scissors, stapler, tweezers, wheel barrow) and represent their position symbolically on diagrams (i.e., using a square, triangle, and arrow, to represent the load, fulcrum, and effort force respectively). Note that levers often occur in pairs.

Scientists classify levers into three different types:

- Class 1 - the fulcrum between the load and effort force (e.g., a see-saw). The load moves opposite the direction of and a shorter distance than the applied force. The closer the fulcrum to the load, the greater the force advantage.
- Class 2 - the load between the fulcrum and the effort force (e.g., a wheelbarrow). The load moves in the same direction as and a shorter distance than the applied force. The closer the load to the fulcrum, the greater the force advantage.
- Class 3 - the effort force is between the fulcrum and load (e.g., hockey stick). The load moves in the same direction as and a larger distance than the applied force. Class 3 levers do not produce a force advantage, they increase speed.

Students should construct models of the different lever classes, using metre sticks, and observe their different effects on the loads they move. They should investigate how changing the position of the fulcrum, load, or effort force, without changing their order, affects the amount of effort needed to move the load. In addition to SCO 4.0, skill outcomes 3.0, 9.0, 12.0, 14.0, 19.0, and 21.0 may be addressed. Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Students should also use everyday levers to accomplish tasks (e.g., open paint can lids with a screwdriver, pick up objects with various types of tongs, punch holes using a single or three hole punch, staple paper with a stapler, cut materials with scissors, remove nails from wood with a hammer). They should investigate how changing the position of the applied force or load affects the effort required to use the tool (e.g., compare the effort needed to pick up blocks with class 3 tongs when applying effort near the fulcrum, load, and in the middle).

Technologies are never perfect and require improvements. Students should consider the benefits and drawbacks of the everyday levers explored. A three hole punch, for example, is a useful organizational tool, however, it may require a significant effort force, can only punch a limited number of pages at a time, and frequently jams with use.

The trade off of effort for distance when simple machines achieve a force advantage could also be considered.

Attitude

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

How Can We Use Levers?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide a collection tools that contain levers for students to use and explore. Students should note where effort force is applied.

Connection

Teachers may

- Demonstrate the relative position of the fulcrum, load, and effort for each class of lever:
 - Class 1: Balance a metre stick on a student's finger (fulcrum). Use an elastic band to hang a load from one end of the metre stick and push down (effort) on the other end to lift the load.
 - Class 2: Tape the end of a metre stick to the edge of a desk so that it pivots up and down (fulcrum). Hang a load in the middle of the metre stick and pull up (effort) on the unattached end to lift the load.
 - Class 3: Use the same setup as for a class 2 lever, however, reverse the location of the load and effort (i.e., hang the load from the unattached end of the metre stick and pull up in the middle to lift it).

Students may

- Using a ruler (lever), pencil (fulcrum), and eraser (load), construct a model of each type of lever.
- Identify the location of the fulcrum, load, and effort when using levers (e.g., baseball bat, bottle opener, broom, chop sticks, garlic press, hockey stick, hole punch, nail clipper, nut cracker, pliers, scissors, see-saw, stapler, tongs, tweezers, wheel barrow).

Consolidation

Students may

- Using the metre stick set ups described above, investigate how changing the position of the fulcrum, load, and applied force, affects the effort required to lift the load, for a first, second, and third class lever. A spring scale, attached to the metre stick with an elastic band, should be used to measure effort force and the position of the fulcrum, load, and effort should be recorded using the graduations on the metre stick (e.g., 0 cm, 15 cm, 80 cm). Alternatively, a ruler could be used as the lever.
- Demonstrate best practices when using levers to accomplish tasks (e.g., picking up objects with tongs, cutting materials with scissors, using a 3-hole punch, opening a paint can with a screwdriver, removing a nail from wood with a hammer, hitting a softball with a bat). Where is it best to position the load and/or fulcrum? Where is it best to apply the effort force?

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 52-55

NL Science 5: Forces and Simple Machines (SR)

- pp. 34-37

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 6
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Levers (videos)
- Lever investigations (websites and videos)

How Can We Design the Most Efficient Lever?

Outcomes

Students will be expected to

52.0 design the most efficient lever to accomplish a task [GCO 3]

9.0 select and use tools [GCO 2]

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

Focus for Learning

Having explored and constructed different classes of levers and investigated how changing the position of the fulcrum, load, or applied force affects their use, students should apply their learning to design the most efficient lever to accomplish a task.

Provide contexts where an efficient lever would be needed to accomplish a task (e.g., scissors to cut sheets of metal, tongs to remove hot coals from a fire, a hammer to remove nails from concrete). Students should design the most efficient lever to accomplish the task. They should make a labelled sketch of their lever, including estimated dimensions, the location of the fulcrum, load, and effort, and materials to be used in construction. Students could evaluate the lever designs of classmates and suggest improvements (SCO 22.0).

Students should then apply their understanding of levers in a design challenge. They should construct a catapult capable of launching a mini-marshmallow. The challenge could initially be to reliably hit a target, such as a bowl, from a short distance (e.g., 1 m). Once students have constructed and tested their catapults, they could then be challenged to modify their design to maximize the distance the marshmallow is thrown.

Design challenges provide an opportunity to address and assess design and problem-solving skills. Students should

- research catapult designs;
- generate possible solutions and choose one to test;
- make a labelled sketch of their catapult;
- identify appropriate tools and materials to use;
- collaborate to devise and carry out a plan to construct their prototype;
- test their prototype, identify problems, and suggest and make necessary improvements until an optimal solution is reached; and
- test and evaluate their final catapult.

In addition to SCOs 9.0 and 15.0, participating in the design challenge described above could provide evidence to assess SCOs 6.0, 7.0, 8.0, 12.0, 14.0, 16.0, 22.0, 26.0, 28.0. Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Attitude

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

How Can We Design the Most Efficient Lever?

Sample Teaching and Assessment Strategies

Activation

Students may

- Construct a class 1 lever by positioning a pencil underneath the 15 cm mark of a 30 cm ruler and placing a load over the 0 cm. Push down at the 30 cm mark to lift the load and qualitatively compare with the effort needed if pushing at the 20 cm mark. Reposition the pencil at the 10 cm mark and repeat observations.

Connection

Teachers may

- Provide a collection of slotted screwdrivers of varying lengths. Ask students to qualitatively compare how the length of the screwdriver affects the force required to open a paint can.
- Present examples of levers (e.g., scissors) and ask students how they might modify them to make them more efficient.

Students may

- Sketch designs for an efficient lever that could lift a heavy load a small distance and/or lift a small load a great distance.

Consolidation

Teachers may

- Provide a collection of tools and materials for students to use in the construction of their levers (e.g., binder clips, bottle caps, craft sticks, dental floss, elastic bands, glue, glue gun, hole punch, Lego™ blocks, medicine cups, paper clips, paper towel rolls, rulers, spoons, string, tape, toothpicks, wooden dowels).

Students may

- In small collaborative groups, research, design, and construct a catapult to reliably launch a mini-marshmallow into a bowl positioned 1 m away. Reliability could be determined by recording the number of times out of ten attempts that the marshmallow hits the target.
- In small collaborative groups, follow an engineering design and problem solving process to construct a lever capable of launching a table tennis ball high enough in the air to catch it.
- Communicate their design challenge solutions to classmates and discuss problems encountered and how they solved them.
- Reflect on and evaluate their group problem solving process.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 56-59

NL Science 5: Forces and Simple Machines (SR)

- pp. 38-39

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
- Design Challenge: Catapults

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Catapults (websites)

How Can We Use Rollers and Wheel and Axles?

Outcomes

Students will be expected to

53.0 demonstrate the use of rollers and wheel and axles in moving objects
[GCO 3]

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

Focus for Learning

A wheel and axle produces a force advantage because the circumference of the wheel is greater than the circumference of the axle and a complete turn of one results in a complete turn of the other. Applying a small effort force to the wheel, over a long distance, creates a larger output force on the axle, over a shorter distance. This force advantage can be used to move loads.

Prior to the development of wheel and axles, rollers were used to move heavy loads (e.g., using logs as rollers to move a boat on land). Rollers reduce the force of friction as objects are moved over them. Note, that wheels which spin freely around a stationary axle are actually rollers. To be classified as a wheel and axle, the wheel must be fixed to the axle, such that turning one turns the other.

Students should explore the use of wheel and axles to move objects. They could

- turn the handle (wheel) of classroom pencil sharpeners to rotate the sharpening blades inside,
- turn doorknobs to make the latch move in and out, or
- use screwdrivers to insert screws into wood (note that the screwdriver is the wheel and axle; the screw itself is another type of simple machine).

Students should also demonstrate the use of rollers to move loads. They should quantitatively compare the amount of force needed to move an object across a surface with and without rollers. They could, for example, use a spring scale to measure the force needed to slide a brick across a surface and compare with the force needed if the brick was placed upon numerous wooden dowel rollers.

Students should then apply their learning to design and build a toy car that uses wheel and axles for power and rollers to reduce friction. They should

- as a class, decide how the cars will be evaluated;
- in small collaborative groups, conduct research, if needed, generate possible solutions, and choose a design for their toy car;
- devise a design plan, including sketches and necessary materials and tools, and construct their prototype;
- test and evaluate their car against the established criteria; and
- suggest improvements, make changes, and retest, in iterative cycles, until an optimal solution to the problem is reached.

In addition to skill outcome 22.0, this design and build activity may be used to address and assess numerous engineering design- and problem solving-related skill outcomes (i.e., SCOs 6.0, 7.0, 8.0, 9.0, 12.0, 14.0, 15.0, 16.0, 24.0, 26.0, 27.0, 28.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

How Can We Use Rollers and Wheel and Axles?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Qualitatively demonstrate the use of rollers by comparing the effort required to slide a box of paper across the floor with the effort required to move it atop pool noodles acting as rollers.
- Provide a collection of tools that contain wheel and axles for students to use and explore (e.g., classroom pencil sharpeners, door knobs, faucet handles, keys on wind-up toys, Lego™ wheels and axles, lock and key assemblies, manual can openers, manual hand mixers, rolling pin, screw drivers, steering wheels, winch). Students should compare the effort needed to turn the machine when the effort is applied to the wheel as opposed to the axle.
- Demonstrate the use of rollers and wheel and axles in a bicycle or go-cart.

Students may

- Quantitatively demonstrate the use of rollers by placing a load upon a square of cardboard and measuring the force needed to slide the cardboard across a desktop with an attached spring scale. Then, place the cardboard and load atop a number of wooden dowels, or similar objects acting as rollers, and repeat the measurement.

Consolidation

Students may

- Participate in a design challenge to personally construct a toy car that uses wheel and axles for power, and rollers to reduce friction. Where possible, prototypes should be constructed from found and recycled materials. Following construction, students should present their prototype to classmates and give and receive suggestions for improvement.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 60-65

NL Science 5: Forces and Simple Machines (SR)

- pp. 40-43

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Wheel and axle (videos)
- Self-propelled cars (websites and videos)

How Can We Use Pulleys?

Outcomes

Students will be expected to

54.0 investigate and compare the force needed to lift a load using a single pulley system with that needed to lift it using a multiple pulley system
[GCO 3]

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

Focus for Learning

A pulley, or system of pulleys, can change the direction of a force used to move a load and help move heavy loads using less force.

Through directed inquiry, students should carry out an investigation to quantitatively compare the force needed to lift a load using a single fixed pulley, a single movable pulley, and systems of two or more pulleys. Pulleys can be fixed with string to a metre stick laid across the backs of two chairs.

Students should

- measure the effort force required to lift a load without the use of a pulley, using an appropriate spring scale;
- predict the effort force needed to lift the load using each pulley arrangement;
- construct and use each pulley arrangement, noting the direction the string is pulled to lift the load (i.e., up or down);
- measure the effort force needed to lift the load for each pulley arrangement and record measurements in a table;
- lift the load 10 cm off the ground with each pulley arrangement and measure and record the length the string pulled to achieve the lift;
- analyze and interpret recorded data and draw conclusions;
- identify potential applications of findings; and
- communicate what was learned and identify new questions to investigate that arise (e.g., Does the size of the pulley or the thickness of the string affect the force advantage of a pulley?).

In addition to skill outcome 24.0, this directed investigation provides opportunity to address and assess additional inquiry-related skill outcomes (i.e., SCOs 8.0, 11.0, 12.0, 13.0, 14.0, 16.0, 18.0, 19.0, 21.0, 23.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

The belief that a single fixed pulley provides a force advantage is a common misconception. A fixed pulley provides no force advantage. It simply changes the direction of the force; allowing us to pull down instead of up.

Attitude

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

Sample Performance Indicator

Sketch a design for a pulley system to lift a load into a tree house that provides a force advantage.

How Can We Use Pulleys?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Demonstrate how a fixed pulley differs from a movable pulley.

Student may

- Explore the use of various pulley arrangements to lift objects. The pulley and/or string could be attached to a metre stick laid across the backs of two chairs.
- Investigate, in small collaborative groups, how changing the number of pulleys affects the effort force needed to lift a load. Force should be measured using an appropriate spring scale.
- Investigate, in small collaborative groups, how changing the number of pulleys affects the length of string that must be pulled to raise a load 10 cm off the ground.

Consolidation

Students may

- Predict the amount of effort force required to lift a 100 N load using an arrangement of four pulleys.
- As a culminating unit activity, design, construct, test, and present a machine that combines two or more simple machines to move a load. The machine could be fashioned after a Rube Goldberg machine. This engineering design and problem solving experience could provide evidence to assess skill outcomes 6.0, 8.0, 9.0, 16.0, 22.0, 24.0, 26.0, 27.0, and 28.0.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 70-73

NL Science 5: Forces and Simple Machines (SR)

- pp. 46-47

NL Science 5: 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)
- IWB Activity 7
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Design Challenge: Rube Goldberg Machine

Supplementary

Pulley investigation kits

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Pulleys (videos)
- Rube Goldberg machines (websites and videos)

How Have Simple Machines Changed over Time?

Outcomes

Students will be expected to

55.0 identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence
[GCO 1]

Focus for Learning

To address this STSE outcome, students should identify methods used by past cultures to lift and move heavy objects, and relate these methods to our present knowledge and use of simple machines.

Students should research early historical uses of each simple machine (i.e., lever, wheel and axle, pulley, inclined plane, screw, wedge). The Archimedes screw, for example, could be identified as an early use of a screw. This simple machine was used to lift water from a river to a higher elevation.

Researching simple machine use provides an opportunity to readdress SCO 15.0 (i.e., identify and use a variety of sources and technologies to gather relevant information).

Students should then briefly trace the use of each simple machine through to the present day and come to recognize that while simple machines are still in use, their materials, designs, and applications have changed as scientific knowledge and human need have evolved.

This research activity is not intended to be time consuming. Students could be divided into teams (e.g., Team levers, Team Wheel and Axles, etc.) and assigned one type of simple machine to research. Relevant findings (e.g., annotated digital images) should be recorded and communicated, to illustrate how simple machines have developed.

Teachers could choose to readdress SCO 41.0 (i.e., consider the positive and negative effects of familiar technologies). As the uses of simple machines are researched, the positive benefits and negative drawbacks of their use could be considered. The Archimedes screw, for example, helped move water to other areas for farming, but it required significant human or animal power to turn it. Its widespread use had positive societal effects but could have negative environmental effects due to the removal of water from rivers.

Attitude

Encourage students to

- recognize that
- of any cultural background can contribute equally to science; and
- realize that the applications of science and technology can have both intended and unintended effects. [GCO 4]

How Have Simple Machines Changed over Time?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Present examples of tools used by local indigenous peoples (e.g., bow and arrow, canoe, harpoon, kayak, komatik, knives of bone or stone, snowshoe, travois, ulu). Ask students to identify and compare modern tools used to accomplish the same tasks. What are the positive and negative effects of using the modern tool as opposed to the traditional indigenous tool?
- Facilitate a cooperative jigsaw activity to research early historical uses of each simple machine. Organize students into home groups of six. Assign each member of the home group a simple machine. Reorganize students according to simple machine and ask them to research early use of their simple machine and trace how its use has changed over time. Once all research has been completed, students should return to their home group and share what was learned with other members.

Students may

- Create a print or digital display to illustrate how simple machine use has changed over time.

Resources and Notes

Authorized

NL Science 5: Forces and Simple Machines (TR)

- pp. 74-77

NL Science 5: Forces and Simple Machines (SR)

- pp. 48-49

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Historical use of simple machines (websites)

Section Three:
Specific Curriculum Outcomes

Unit 3: Properties and Changes
of Materials

Focus

Materials around us have properties that are important to their use. By studying materials used in various applications, students become aware of properties such as strength, flexibility, buoyancy, and they learn the significance of these properties to particular uses. Students learn that the form a material takes, including its shape and structure, can be modified as required. They also learn that material substances themselves can be changed, and that some changes involved the production of new materials through reactions that are non-reversible.

This unit has a science inquiry focus. The unit emphasizes the development of skills related to phrasing questions in a testable form, identifying and controlling major variables, collaboratively devising and carrying out fair procedures, making and recording observations, classifying, compiling and displaying data, and identifying applications of findings.

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.

- 29.0 demonstrate that specific terminology is used in science and technology contexts
- 31.0 describe examples of tools and techniques that have contributed to scientific discoveries
- 36.0 identify examples of scientific questions and technological problems addressed in the past
- 48.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
- 49.0 describe examples of technologies that have been developed to improve living conditions
- 63.0 demonstrate processes for investigating scientific questions and solving technological problems
- 64.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations
- 66.0 describe the impact of school and community on natural resources

GCO 2 (Skills): Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

- 2.0 rephrase questions in a testable form
- 5.0 identify and control major variables in investigations
- 6.0 devise procedures to carry out a fair test and to solve a practical problem
- 10.0 follow procedures
- 12.0 make observations and collect information that is relevant to the question or problem
- 15.0 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
- 18.0 compile and display data
- 23.0 identify potential applications of findings
- 26.0 collaborate with others to devise and carry out procedures

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.

- 56.0 group materials as solids, liquids, or gases, based on their properties
- 57.0 identify properties that allow materials to be distinguished from one another
- 58.0 identify changes that can be made to an object without changing the properties of the material making up the object
- 59.0 describe changes that occur in the properties of materials when they interact with each other
- 60.0 describe examples of interactions between materials that result in the production of a gas
- 61.0 investigate whether mass changes when materials interact
- 62.0 identify and describe some changes to materials that are reversible and some that are not
- 65.0 identify the source of the materials found in an object and describe the changes to the natural materials required to make the object

GCO 4 (Attitudes): Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Students are encouraged to:

- appreciate the role and contributions of science and technology in their understanding of the world
- realize that the applications of science and technology can have both intended and unintended effects
- show interest and curiosity about objects and events within different environments
- willingly observe, question, explore, and investigate
- show interest in the activities of individuals working in scientific and technological fields
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions
- appreciate the importance of accuracy and honesty
- 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 2	Science 5	Science 7
<i>Liquids and Solids</i>	<i>Properties and Changes of Materials</i>	<i>Heat and Mixtures and Solutions</i>
<ul style="list-style-type: none"> investigate and compare the properties of familiar liquids and solids investigate and describe the interactions of familiar liquids and solids identify ways to combine solids and liquids to make useful materials investigate changes that result from the interaction of materials and describe how their characteristics have changed describe the characteristics of the three states of water 	<ul style="list-style-type: none"> group materials as solids, liquids, or gases identify properties that allow materials to be distinguished from one another identify changes that can be made to an object without changing the properties of the material making up the object describe changes that occur in the properties of materials when they interact describe examples of interactions between materials that result in the production of a gas investigate whether mass changes when materials interact identify and describe some reversible and non-reversible changes to materials identify the source of the materials found in an object and describe the changes to the natural materials required to make the object 	<ul style="list-style-type: none"> explain temperature using the particle model of matter explain how each state of matter reacts to changes in temperature explain changes of state using the particle model of matter identify and separate the components of mixtures
		Science 9
		<i>Atoms and Elements</i>
		<ul style="list-style-type: none"> investigate materials and describe them in terms of their physical properties describe changes in the properties of materials that result from some common chemical reactions use models in describing the structure and components of atoms and molecules

Suggested Unit Plan

Properties and Changes of Materials is the second of two consecutive physical science units.

September	October	November	December	January	February	March	April	May	June

Properties and Changes of Materials

What Are Properties?

Outcomes

Students will be expected to

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

Focus for Learning

Matter is anything that has mass and volume (i.e., takes up space). A material is a type of matter that is used to make things (e.g., glass, iron, plastic, rock, wood). Students should distinguish objects (i.e., products) from the materials used to make them. A pencil, for example, is an object made from wood, graphite, metal, and rubber.

Properties describe how a material looks, feels, tastes, sounds, or smells, and what it can do. We use properties to identify and group materials (e.g., colour, texture, hardness, flexibility, strength, solubility, buoyancy, and the ability to conduct heat and electricity). In this unit, students will use properties to describe, classify, and identify materials.

When describing the properties and changes of materials, students are expected to use specific terminology. Terminology should be introduced and defined as the need emerges. As students' progress through the unit their use of specific terminology should increase.

Properties and changes of materials-related terminology includes

- matter, mass, volume, object, material, property (e.g., colour, texture, hardness, flexibility, strength, solubility, buoyancy, density, magnetic, malleability, ductility, viscosity, flammability, melting and boiling point);
- state of matter, solid, liquid, gas, change of state, melting, solidification (i.e., freezing), evaporation, condensation, sublimation, deposition; and
- reversible change, non-reversible change, natural resource, product, renewable, non-renewable.

Science inquiry process- and skill-related terminology includes

- question, predict, hypothesis, procedure, observe, measure, record, classify, data, conclude; and
- fair test, independent, dependent, and controlled variables.

Communicating using specific terminology is a constant expectation in Science 5.

Refer to the initial elaboration provided on pp. 74-75.

Attitude

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

What Are Properties?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Collect different materials with a variety of textures (e.g., aluminum, bark, flexible plastic, hard plastic, rock, sandpaper, sponge, steel, Velcro™, wood) and place them in a cloth drawstring bag, or similar opaque bag. Ask a student to reach into the bag, without looking, and describe one material aloud, using their sense of touch. Prompt them with questions such as: What does it feel like? Does the surface feel like metal, plastic, cloth, or wood? Can you bend it? Can you scratch it? Does it make a sound when you tap it? Students should, with the help of classmates, try to guess the identify of the material before removing it from the bag.
- Use physical science-related children's literature to introduce the unit and build curiosity.

Students may

- Create a concept map, using prior knowledge, for the term matter.

Connection

Teachers may

- Present a classroom object, such as a pencil. As part of a whole class discussion, ask students to identify the different materials the object is made from and to discuss the function and properties of each material.
- Present spoons made of different materials (e.g., metal, plastic, wood) and ask students to identify each material, describe its properties, and consider how the different properties affect the use of each spoon.
- Create an anchor chart of property-related terms. Add new terms to the chart as they emerge throughout the unit.

Students may

- Create a table or graphic organizer to record the different materials explored and investigated throughout the unit and their identified properties.
- Sort a bag of cleaned recycling based on material type and properties.
- Engage in a science book walk to identify unfamiliar terminology.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (Teacher Resource [TR])

- pp. 8-15

NL Science 5: Properties and Changes of Materials (Student Resource [SR])

- pp. 6-7, 54-58

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Properties of Materials

Suggested

Other curriculum resources

- *From Wax to Crayon* (Science 1 - Science library)
- *Things People Make* (Science 3 - Science library)
- *Where Do T-Shirts Come From?* (Science 3 - Science library)
- *Where Does Chocolate Come From?* (Science 3 - Science library)
- *Where Does Popcorn Come From?* (Science 3 - Science library)

How Can We Classify Solids, Liquids, and Gases?

Outcomes

Students will be expected to

56.0 group materials as solids, liquids, or gases, based on their properties
[GCO 3]

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

Focus for Learning

Matter can be grouped in different ways. Scientists classify matter as solids, liquids, or gases (i.e., states of matter), according to their properties:

- Solids keep the same shape and the same volume.
- Liquids keep the same volume, but they flow and take the shape of their container.
- Gases can change volume and change shape as they expand to completely fill their container.

Teachers should note that many familiar objects are not uniformly solid, liquid, or gas. Milk, for example, while outwardly a liquid, may contain very small suspended solid particles.

Students should classify and group objects and materials as solids, liquids, or gases, based on observable properties.

Classification involves sorting items into human-created groups, based on similarities and differences in their properties or attributes. Students should create a table, chart, or diagram (e.g., Carroll diagram, tree diagram, Venn diagram) to show how they classified objects and materials according to their state of matter.

Students should come to recognize that some objects and materials may be difficult to classify. Salt is a solid, for example, but it pours like liquids and appears to take the shape of its container. Each tiny crystal, however, has its own shape that does not change.

Refer to the *Integrated Skills* unit for further elaboration of outcome 17.0 (pp. 54-55).

Particle models of matter may be useful to explain differences in properties of solids, liquids, and gases. Their use, however, is not an expectation of Science 5.

Sample Performance Indicator

Group the following items as solids, liquids, or gases, based on their properties: air inside a soccer ball, apple juice, baby powder, book, carbon dioxide bubbles in a soda, gasoline, glass, milk, oxygen, pencil, pepper corns, propane inside a cylinder, salt water, sand, shampoo, soap, vegetable oil, vinegar, and water vapour.

Name three items you found difficult to classify. Explain why.

How Can We Classify Solids, Liquids, and Gases?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Provide a class list of student names to introduce the skill of classification using one or more attributes. Ask students to sort the names into groups using a personal sorting rule and then, where possible, subsort initial groups according to another attribute (e.g., sort by letter of the alphabet, then number of letters). Once completed, students should create a chart or diagram to show the method of classifying.
- Use a placemat activity to pre-assess student understanding of mass and volume.
- Facilitate a game of “Who am I” using images of different materials placed on the backs of students. They should ask yes or no questions, related to properties of materials, until they are able to guess their material. Once all materials have been identified, ask students to sort themselves into groups.

Connection

Teachers may

- Provide a collection of materials for students to sort that include solids, liquids and gases. Possible materials include: air, aluminum foil, bark, dish liquid, feathers, honey, paper, pepper, rocks, salt, shampoo, sugar, and water. Small solids, liquids, and gases can be placed in zip-top bags. Ask students to sort the materials using their properties and to communicate their sorting rule to others. Inform students that one way scientists classify matter is as solids, liquids, and gases.
- Present images of materials from the image bank and ask students to classify them as solids, liquids, or gases.
- Follow a recipe to make fudge, or similar food. Students should identify the solid, liquid, and gas ingredients and could use scientific tools to measure their mass and volume. The activity could also activate discussion regarding changes of state.

Students may

- Physically label objects and materials within the classroom as solids, liquids, or gases.

Consolidation

Students may

- Create a three tab foldable to distinguish among solids, liquids, and gases. Include answers to the following questions:
 - Does it change shape when placed in a new container?
 - Does it change volume, expanding to completely fill its new container?

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 16-23

NL Science 5: Properties and Changes of Materials (SR)

- pp. 8-11

NL Science 5: Online Teaching Centre

- Solids, Liquids, and Gases Table (BLM)
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 2
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Teaching and Learning Strategies

- www.k12pl.nl.ca/curr/k-6/sci/sci-5/teaching-and-learning-strategies.html
 - Properties of Materials

Supplementary

- Polypropylene beaker and graduated cylinder sets

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Solids, liquids, and gases (websites and videos)
- Placemat activity (website)

How Can We Identify Materials?

Outcomes

Students will be expected to

57.0 identify properties that allow materials to be distinguished from one another
[GCO 3]

Focus for Learning

Scientists use many different properties to describe materials (e.g., colour, texture, hardness, flexibility, solubility, buoyancy, density, magnetic, malleability, ductility, viscosity, flammability, melting and boiling point, the ability to conduct heat or electricity). These properties are also used to distinguish one material from another. What properties, for example, could be used to distinguish a plastic water jug from one made from glass? Classifying properties as either physical or chemical is not an expectation.

Students should explore properties at hands-on centres (e.g., texture, hardness, flexibility, solubility, buoyancy, density). At each centre, include a variety of materials to test. At a solubility centre, for example, students could test the ability of baking powder, baking soda, chalk, flour, pepper, salt, and sugar to dissolve in water. At a flexibility centre, students could test the ability of cardboard, fabrics, glass, metals, paper, plastic, rubber, and wood to bend.

Following exploration, students should apply their learning to identify properties that allow materials to be distinguished from one another. What properties, for example, would allow you to distinguish between

- glass, metal, plastic, and wood;
- soda, vegetable oil, vinegar, water;
- aluminum, copper, gold, iron, and mercury; or
- baking soda, brown sugar, corn starch, ground pepper and salt?

Attitude

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

Sample Performance Indicator

Identify properties that allow bricks made from cardboard, clay, plastic, and Styrofoam™ to be distinguished from one another.

How Can We Identify Materials?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Revisit the cloth drawstring bag of materials introduced on p. 139. Ask students to identify one material contained within the bag, without looking, and indicate which properties were helpful in the identification process.

Consolidation

Teachers may

- Set up centres around the classroom for students to do hands-on explorations of different properties
 - Solubility - Provide a collection of solids, ensuring that it includes examples of soluble, insoluble, and partially soluble materials. Ask students to investigate the solubility of the materials in water.
 - Hardness - Provide a collection of solid materials and tools with which to scratch them (e.g., soft pencil lead, fingernail, dime, copper, iron nail, butter knife, steel file, mineral streak plate, sandpaper). Students should attempt to scratch the materials with the pencil lead. If unable to scratch it with the pencil, they should choose the next hardest tool in sequence until the material can be scratched. The more resistant to scratching the harder the solid.
 - Flexibility - Provide a collection of solid materials with varying degrees of flexibility (i.e., the ability to bend without breaking). Ask students to sequence the materials from most flexible to least flexible.
 - Strength - Provide a collection of solids materials and appropriate tools (e.g., hammer, single hole punch, scissors). Students should explore how resistant materials are to damage (i.e., breaking, cutting, denting, puncturing, tearing).
 - Buoyancy - Provide a collection of solid materials for students to sort according to whether they float or sink in water. Additionally, provide a collection of liquid materials (e.g., corn syrup, dish washing liquid, food colouring, rubbing alcohol, vegetable oil, water) for students to combine. While some combinations of liquids will combine, others will not and one liquid will float on the surface of the other.
 - Texture - Provide a collection of solid and liquid materials with different textures for students to explore and describe.
- Provide student groups with “mystery materials” to identify based on their properties. Materials could include baking powder, baking soda, flour, salt, and sugar, or other similar white powders. This activity could be set up to resemble a crime scene investigation.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 24-27

NL Science 5: Properties and Changes of Materials (SR)

- pp. 12-13

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- IWB Activities 3 and 4
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Properties of materials (websites and videos)

How Do Changes Affect the Properties of Materials?

Outcomes

Students will be expected to

58.0 identify changes that can be made to an object without changing the properties of the material making up the object
[GCO 3]

Focus for Learning

Objects can be changed in many ways. A wooden object could be burned, cut, drilled, hammered, painted, sanded, soaked in water, split, stained, steamed, or waxed. Some of these changes affect one or more properties of the wood (e.g., steaming the wood makes it more flexible) while other changes do not (e.g., cutting wood does not change its colour, texture, hardness, density, flammability, flexibility, buoyancy, or inability to conduct electricity). Sometimes changes result in the formation of a new material.

Through a guided inquiry investigation, students should

- select an object to change,
- identify the properties of the material making up the object,
- propose different ways to change the object,
- carry out approved changes to the object, and
- determine whether the properties of the material that make up the object have changed.

Students should consider whether investigated changes formed new materials.

In conjunction with the investigation, teachers may choose to reassess skill outcomes 12.0, 14.0, and 21.0 and introduce skill outcomes 23.0 and 26.0 (Refer to the *Integrated Skills* unit).

Classifying changes as physical or chemical changes is not an expectation. Use of these terms should be avoided.

Changes of state should be addressed at this time. Changes of state always affect one or more properties of a material. Students should identify and provide examples of

- melting - changing a solid to a liquid,
- evaporation - changing a liquid to a gas,
- condensation - changing a gas to a liquid,
- solidification (i.e., freezing) - changing a liquid to a solid,
- sublimation - changing a solid to a gas, and
- deposition - changing a gas to a solid.

Evaporation and condensation were addressed in the *Weather* unit.

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

Brainstorm three different ways to change a crayon. Explain which properties of the paraffin wax, if any, are affected as a result of changing the crayon.

How Do Changes Affect the Properties of Materials?

Sample Teaching and Assessment Strategies

Teachers may choose to address outcome 62.0 (p. 150), describing changes as reversible or non-reversible, at this time.

Activation

Teachers may

- Hold up a piece of paper and ask students how the paper could be changed. After eliciting a number of suggestions, ask which changes will leave most of the properties of the paper the same (e.g., folding, tearing) and which change will turn the paper into something different with different properties (e.g., burning the paper).

Connection

Teachers may

- Fill a transparent plastic cup with water and place an egg in the water. Students should observe that the egg sinks. Add a significant amount of salt to the water until the egg floats. Students should come to recognize that changing a material (i.e., adding salt) can change its properties (i.e., buoyancy) and its potential uses.
- Demonstrate how changing the temperature of soda water affects the solubility of gases. Gases are less soluble in warmer liquids.
- Demonstrate melting (e.g., melt snow), evaporation (e.g., breath closely on glass and observe the moisture evaporate), condensation (e.g., condense water on the surface of a cold water bottle), solidification (e.g., make ice pops), deposition and sublimation (e.g., formation and disappearance of frost).

Consolidation

Students may

- Choose a material (e.g., aluminum pop can, apple, bread, chocolate chips, glue, masking tape, milk, modelling clay, plastic ruler, newspaper, rubber eraser, salt, wood block, wooden pencil) and devise procedures to make changes to the material. They should carry out approved changes, using appropriate tools, and determine whether the change affected the properties of the material or not. Procedures may include measuring the mass of materials before and after changes to introduce outcome 61.0.

Extension

Students may

- Create a flow chart for the changes of state in the water cycle that includes deposition and sublimation.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 30-37

NL Science 5: Properties and Changes of Materials (SR)

- pp. 18-19

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Changes of state (websites and videos)

What Happens When Materials Interact?

Outcomes

Students will be expected to

59.0 describe changes that occur in the properties of materials when they interact with each other [GCO 3]

60.0 describe examples of interactions between materials that result in the production of a gas [GCO 3]

Focus for Learning

When two or more materials interact, they sometimes react to form new materials. The properties of these new materials differ from the properties of the original materials. When wood burns, for example, the wood interacts with oxygen in the air and forms ash and invisible gases. The properties of the ash and gases differ completely from the properties of the wood and oxygen.

Provide students with a collection of materials to combine. Ensure it contains some materials that will react (e.g., vinegar and baking soda). Through a guided inquiry investigation, students should,

- devise a plan to test different combinations of materials;
- select appropriate tools, instruments, and materials to use;
- predict which combinations of materials will react;
- carry out their procedures;
- observe and record whether the combined materials react; and
- describe any changes that occur in the properties of the materials when they react with each other.

This investigation provides an opportunity to readdress and assess skill outcomes 3.0, 4.0, 7.0, 9.0, 12.0, 14.0, 18.0, 21.0, 24.0, and 25.0. Refer to the *Integrated Skills* unit for elaboration of these SCOs.

Students may confuse changes of state and dissolving with changes in which materials react to form new materials. When a material changes state it is still the same material, even though some of its properties change. Similarly, when a material dissolves (e.g., salt in water), a new material has not formed. The salt is still present in the solution and can be separated out again by evaporating the water.

The use of some materials may require direct adult supervision and/or the use of personal safety equipment (e.g., gloves, safety glasses, lab coat).

Use of the terms chemical change and physical change should be avoided.

Students should identify when materials interact to form something new. Signs include the formation of bubbles (i.e., gas), colour changes, and the production of heat or light.

Students should observe and describe examples of interactions that produce gases (e.g., combining baking soda and vinegar, water and effervescent tablets, or hydrogen peroxide and yeast, rising of bread dough, cooking of pancakes).

Sample Performance Indicator

Describe the properties of the steel wool and water provided. Then, place the steel wool in the water. After several hours, observe and describe how the properties of the steel wool and water have changed.

What Happens When Materials Interact?

Sample Teaching and Assessment Strategies

Teachers may choose to address outcome 62.0 (p. 150), describing changes as reversible or non-reversible, at this time.

Activation

Teachers may

- Demonstrate an “elephant toothpaste” reaction. Ask students, What materials are interacting? How can you tell that a new material is forming?
- Burn a mini marshmallow on top of a toothpick anchored in modelling clay. Ask students, What are the initial properties of the marshmallow? What materials are interacting when something burns? How can you tell that a new material forms? Is burning a change of state?

Connection

Teachers may

- Provide a collection of solid and liquid materials (e.g., baking soda, effervescent tablets, flour, pepper, raisins, salt, Skittles™, sugar, carbonated water, concentrated grape juice, lemon juice, syrup, vinegar, water) and appropriate tools with which to mix them. Students should participate in a “Mad Mixology” activity; combining different materials together to test whether they interact or not. Alternatively, teachers could assign student groups a specific set of materials to test. Testing procedures could include measuring the mass of materials before and after mixing to address outcome 61.0 (p. 148).

Consolidation

Teachers may

- Invite a community elder to class to make homemade bread. Ask students to describe the changes occurring as materials interact. What materials are interacting? What evidence of interactions is observed?

Students may

- Communicate combinations of materials that resulted in a reaction from the “Mad Mixology” activity and identify signs that indicate an interaction has taken place (e.g., colour change, bubbles, production of heat).

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 38-43

NL Science 5: Properties and Changes of Materials (SR)

- pp. 20-23

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 6
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Elephant toothpaste reactions (websites and videos)

Does Mass Change When Materials Interact?

Outcomes

Students will be expected to

61.0 investigate whether mass changes when materials interact
[GCO 3]

10.0 follow procedures
[GCO 2]

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

Focus for Learning

Students should carry out a guided investigation to determine whether mass changes when materials interact to form new materials (e.g., cream and vinegar). They should

- observe and describe the properties of both cream and vinegar;
- devise a procedure to measure and compare the mass of the materials before and after mixing;
- identify and select appropriate measurement tools, instruments, and materials to complete their investigation;
- develop a hypothesis to predict and describe what will happen when the cream and vinegar are mixed;
- carry out their procedure, making observations of interaction and recording total mass, before and after mixing;
- record their observations and measurements; and
- draw a conclusion that answers the initial question.

Students should come to conclude that the total mass before and after the interaction is the same (i.e., the law conservation of mass). Their learning should lead to new questions to investigate (e.g., Does mass change when materials change state? Does mass change when a solid dissolves in a liquid? Does mass change when an interaction produces a gas?).

When measuring mass, consideration must be given to the mass of any containers used. This mass should be accounted for when comparing initial and final masses.

These investigations provide an opportunity to address and assess numerous skill outcomes 3.0, 7.0, 9.0, 11.0, 13.0, 14.0, 18.0, 21.0, 24.0, and 25.0. Refer to the *Integrated Skills* unit for elaboration of these SCOs.

Attitude

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

Sample Performance Indicator

An empty beaker with a mass of 60 g is placed on a scale. 20 g of material A and 100 g of material B are added to the beaker. The materials interact and form new materials with different properties. What mass should the scale read following the reaction? How might the reading be different if one of the new substances was a gas and the beaker was left uncovered?

Does Mass Change When Materials Interact?

Sample Teaching and Assessment Strategies

Connection

Students may

- Practice using scales and/or balances to measure the mass of objects. When reading mechanical scales and balances, students should record the certain digits and estimate the first uncertain digit. If the reading falls between 32 g and 33 g, for example, students should record the certain digits (i.e., 32) and estimate the next digit (e.g. 32.2 g, 32.6 g).
- Explore whether mass changes when
 - paper is crumpled into a ball,
 - an ice pop melts,
 - sugar is dissolved in water, and
 - vegetable oil and water are mixed.

Consolidation

Students may

- Investigate whether mass changes when two materials (e.g., cream and vinegar) interact. Students should make an “If..., then... because...” hypothesis and devise a procedure to test their hypothesis. The initial and final mass of materials should be measured using a scale or balance. When measuring, all certain digits should be noted and the first uncertain digit should be estimated. Measurements could be recorded in a table and observations recorded in words or sketches. Students should recognize that the materials interacted to produce new materials (e.g., curdled cream) and that the total mass before and after the interaction remained the same. New questions to investigate should be proposed based on what was learned.
- Consider the following problem. The total mass of an opened bottle of Diet Coke™ and a Menthos™ candy are measured. The candy is added to the soda and an interaction takes place. The total mass after the interaction, however, is less than it was before. Does this disprove the law conservation of mass?
- Add some vinegar in an Erlenmeyer flask, or similar shaped container, and place the flask on a scale or balance. Add baking soda to a balloon and carefully attach the mouth of the balloon over the neck of the flask. Note and record the total mass of the set up. Carefully upend the balloon causing the baking soda to fall into the flask with the vinegar and initiating an interaction that produces a gas. Compare the total mass after the interaction to the measurement taken before the interaction.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 44-45

NL Science 5: Properties and Changes of Materials (SR)

- pp. 24-25

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Conservation of mass (websites and videos)

Are All Changes Reversible?

Outcomes

Students will be expected to

62.0 identify and describe some changes to materials that are reversible and some that are not
[GCO 3]

Focus for Learning

Students have observed changes to materials. Some of these changes are reversible; meaning they can be changed back. Other changes are non-reversible; they can not be undone.

Students should

- determine whether changes made to materials are reversible or non-reversible changes;
- identify and describe changes of state (i.e., condensation, deposition, evaporation, melting, solidification, sublimation) as reversible changes;
- identify and describe dissolving as a reversible change; and
- recognize that some interactions between materials are reversible, however, most (e.g., baking, burning, rotting) are non-reversible.

Teachers may choose to address this outcome when previously investigating changes that could be made to an object without affecting the properties of the material and changes that occur when materials interact.

Attitude

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

Sample Performance Indicator

Identify whether the following changes are reversible or non-reversible:

- chocolate melting,
- paper burning,
- water boiling,
- sugar dissolving in water,
- iron rusting,
- eating a sandwich,
- chopping a carrot, and
- mixing oil and water.

Are All Changes Reversible?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Discuss two changes from everyday life, one that is reversible, such as freezing water, and one that is non-reversible, such as burning wood. Ask students to compare the two changes. How are they similar to each other? How are they different?

Connection

Students may

- Carry out hands-on changes to explore whether changes are reversible or non-reversible:
 - toast a slice of bread,
 - melt an ice cube or freezie,
 - add a spoonful of baking soda to a cup of purple grape juice,
 - dissolve some salt in water,
 - add lemon juice to cream,
 - write on a piece of paper with “invisible ink” (lemon juice and water) and hold it a safe distance over a candle flame,
 - add an effervescent tablet to water,
 - mix salt and pepper,
 - observe a birthday candle burning, and
 - add steel wool to water.

Students should attempt to reverse each change. The mass of materials before and after changes could be measured and compared.

- Compare digital images of materials taken before and after the change.

Consolidation

Students may

- Wrap several pennies in a paper towel and place it in the bottom of a container (e.g., beaker). Pour vinegar over the pennies to saturate the paper towel and leave some excess in the container. Predict if/how the pennies will change and if the change will be reversible or not. Examine the pennies periodically over a couple of days and describe any observed changes.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 46-49

NL Science 5: Properties and Changes of Materials (SR)

- pp. 26-27

NL Science 5: Online Teaching Centre

- Types of Changes Cards (BLM)
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activities 7 and 8
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Reversible and non-reversible changes (websites and videos)

How Can We Control the Gas Produced by an Interaction?

Outcomes

Students will be expected to

- 63.0 demonstrate processes for investigating scientific questions and solving technological problems [GCO 1]
- 2.0 *rephrase questions in a testable form* [GCO 2]
- 5.0 *identify and control major variables in investigations* [GCO 2]
- 6.0 *devise procedures to carry out a fair test and to solve a practical problem* [GCO 2]
- 18.0 *compile and display data* [GCO 2]
- 64.0 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations [GCO 1]

Focus for Learning

Students should use science inquiry processes to investigate factors that may affect the gas produced by an interaction.

Students should

- observe a teacher demonstrated interaction between two materials that produce a gas (e.g., baking soda and vinegar, effervescent tablet and water);
- identify factors that could be changed prior to the interaction (i.e., potential independent variables) and factors that could be observed or measured during the interaction (i.e., potential dependent variables);
- select one independent variable and one dependent variable, and pose a testable question to investigate;
- devise and carry out a fair procedure which controls for all the unselected, potential independent variables;
- compile and display their results in a data table; and
- draw a conclusion which answers their initial question.

This investigation provides a significant opportunity to address and assess additional outcomes from the *Integrated Skills* unit (e.g., SCOs 1.0, 3.0, 4.0, 7.0, 8.0, 11.0, 12.0, 13.0, 14.0, 18.0, 19.0, 21.0, 23.0, 24.0, 25.0, 26.0).

Interactions between materials are affected by many factors. The reaction between baking soda and vinegar, for example, may be affected by the

- volume, temperature, and age of the baking soda, as well as whether it is in powdered or tablet form (i.e., surface area);
- volume, temperature, and concentration of the vinegar;
- method and speed of combining;
- shape and capacity of the container in which they interact; and
- presence of other materials.

Consequently, simply combining baking soda and vinegar may yield varied results. When designing their investigation, students must ensure that only one variable (i.e., the independent variable) is tested (i.e., changed) and all other variables of influence are controlled (i.e., kept the same). When investigations are fair, patterns identified in the results can logically be attributed to changes in the independent variable. When investigations fail to control variables of influence, conclusions cannot be drawn.

Repeating the investigation should yield the same results each time (i.e., reliability). Variation in repeated results should cause the student to reflect on the design of their investigation and whether a variable of influence remained uncontrolled.

How Can We Control the Gas Produced by an Interaction?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- As a initial demonstration, add a whole Alka-Seltzer™ tablet to 100 mL of tap water to produce a gas. Allow the students to observe all aspects of the set up and resultant interaction. Once completed, ask students to brainstorm things they could observe or measure about the interaction (e.g., production of gas, length of time bubbles are produced, amount of gas produced, length of time until the tablet completely dissolves, change in water temperature). These are potential dependent variables (i.e., responding variables). Then, ask students to brainstorm things they could change about the initial setup that might affect the interaction (e.g., size of container used, amount of water, water temperature, number of tablets, surface area of tablet - whole, halved, crumbled, or crushed). These are potential independent variables (i.e., manipulated variables).

Consolidation

Students may

- In small collaborative groups, select one independent variable and one dependent variable from the brainstormed lists in the activation strategy above and create a testable question to investigate (e.g., What is the affect of water temperature on the time it takes the tablet to dissolve? What affect does surface area of the tablet have on the amount of time bubbling occurs?).
- Collaboratively devise a procedure to test how changing their independent variable affects the dependent variable. As part of their procedure, they should operationally define their independent and dependent variables. If they are going to change the temperature of the water, for example, what temperatures are they going to test? If they are going to measure tablet dissolving time, what measuring tool and scale will they use? When will they start timing? When will they stop timing? To ensure a fair test the procedure must also control for the non-selected independent variables which could also affect the interaction.
- Repeat their investigation to compare results to the initial test and suggest possible explanations for any variation observed.
- Construct data tables to collect the results of their investigations and, if appropriate, display their data on a bar graph.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 50-51

NL Science 5: Properties and Changes of Materials (SR)

- pp. 28-29

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Fair testing and variables (websites and videos)

Where Do Materials Come From?

Outcomes

Students will be expected to

65.0 identify the source of the materials found in an object and describe the changes to the natural materials required to make the object [GCO 3]

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

Focus for Learning

Every object that we use is made of materials. Some objects are made of a single material. Others are made of two or more different materials.

All materials come from natural sources (e.g., animals, minerals, plants, petroleum). Even synthetic materials, such as plastic and nylon are made from natural resources (i.e., petroleum). While some materials are used in their raw form, almost all materials undergo some form of processing before use. During processing, materials are refined and changed in ways to make them more useful. These changes often involve a change in the properties of the material.

Students are expected to use research inquiry to identify the source of materials found in familiar objects and describe the changes those materials undergo to make the object. Students could, for example, identify that a towel is made from cotton and research the source of the cotton and the manufacturing processes cotton undergoes to produce a useful fabric. Common materials used in the production of many objects include glass, leather, metals, paper, plastic, rubber, and wood.

Researching how materials are changed to make useful objects provides an opportunity to revisit knowledge outcomes 58.0, 59.0, and 62.0.

Teachers may choose to address the impact that product use has on natural resources at this time (SCO 66.0, p. 164).

As part of their research process, students should identify and use a variety of sources and technologies to gather relevant information about the source of materials found in objects and the changes they undergo. Information may be gathered from

- print resources (e.g., encyclopedias, ingredient lists on packaging, magazines, non-fiction literature, textile labels);
- online resources (e.g., digital versions of print resources, how it's made videos, web pages); and
- observations from field trips to manufacturing plants or interviews with plant workers.

Attitude

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

Where Do Materials Come From?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Ask students to imagine they are stranded on a deserted island. Create a list of survival needs (e.g., food, cooking pots and containers, water, shelter, clothing, bedding, tools, transportation) and the kinds of materials needed to meet those needs. Next, guide a discussion about the comfort of our lives compared with life on a deserted island. Highlight that this is because we change materials to make them into the things we need.

Connection

Teachers may

- Facilitate a brainstorming session to identify Newfoundland and Labrador's natural resources (e.g., agricultural products, fish, iron ore, nickel, oil, wood) and products made from these materials.

Students may

- Brainstorm lists of products made from glass, leather, metal, paper, plastic, and wood.
- Explore garment labels (i.e., tags) on various items of clothing to compile a list of the different materials used (e.g., cotton, nylon, modal, polyester) in their production.
- Explore ingredient lists found on the packaging of various food items.

Consolidation

Students may

- Select an object and use research inquiry to identify the source of one or more materials found in the object and describe changes the materials undergo during processing. Prior to initiating research, they should brainstorm possible sources of information and use some of these sources in conducting their research. Once their initial questions have been answered, they should share what they have learned with classmates.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 54-59

NL Science 5: Properties and Changes of Materials (SR)

- pp. 34-37

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Other curriculum resources

- Science Library (Science 3)
 - *Where Do T-Shirts Come From?*
 - *Where Does Chocolate Come From?*
 - *Where Does Popcorn Come From?*

How Do We Change Materials for Our Use?

Outcomes

Students will be expected to

36.0 identify examples of scientific questions and technological problems addressed in the past [GCO 1]

49.0 describe examples of technologies that have been developed to improve living conditions [GCO 1]

31.0 describe examples of tools and techniques that have contributed to scientific discoveries [GCO 1]

Focus for Learning

Processing materials to make them more useful provides a context to address STSE outcomes.

To identify technological problems addressed in the past, students should consider the challenges faced by indigenous peoples and early settlers of our province. What products and materials were necessary for their survival? Products and materials related to food, clothing, shelter, tools, and transportation could be considered. Where did the objects and materials come from? How were materials changed to produce useful objects? How did they help to solve problems?

Technologies, both products and processes, are developed to solve problems and meet human needs. Students are expected to describe examples of the development of technologies that improved living conditions. The production of soap is one example. Historically, soap in Newfoundland and Labrador was produced from animal fat or oil (e.g., cod, seal, whale) which was boiled with lye. Today, soaps and other detergents are made from materials separated from crude oil. The use of soap greatly improved living conditions; improving sanitation and preventing illness.

Petroleum (i.e., crude oil) is a mixture of many materials. These include bitumen, fuel oil, diesel, kerosene, naphtha, gasoline, and gases. These materials may be used directly as fuels or as petrochemicals used in the production of a wide variety of products we use daily in our homes, schools, and communities (e.g., asphalt, tar, roofing tiles, paraffin wax, lubricating oils, detergents, plastics, and synthetic fibres - rayon, nylon, vinyl).

To separate the crude oil into its various materials, oil refineries use a process called fractional distillation. Distillation is a common separation and refining technique used in materials science and its use has contributed to scientific discoveries. Distillation involves two changes of state. Materials are heated causing liquid materials to evaporate and change to a gas. The gas is then collected, cooled, and condensed to change it back to a liquid. Since crude oil is a mixture of many materials, heating it to different temperatures causes different materials to evaporate. Gasoline, diesel, and home heating oil all have different boiling points and evaporate at different temperatures. Through distillation the many different materials in crude oil can be separated out from each other.

Students should describe the process of distillation in the production of materials from crude oil.

Students may be familiar with aspects of the distillation process from their study of the water cycle in Science 5. The evaporation and condensing of water is a distillation process that purifies water.

How Do We Change Materials for Our Use?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Facilitate exploration of different soaps (e.g., body wash, dish soap, hand soap, laundry detergents, shampoo). Apply stains (e.g., grass, permanent marker, soil, tomato sauce) to pieces of cotton fabric and ask students to attempt to remove the stain using different types of soap and water. Explain that soap is made of lye (i.e., a type of mineral salt) and fat or oil. Ask students to describe how the properties of minerals, salt, fat, oil, and soap are different. Highlight that soap is one example of how materials are changed to make them more useful and improve our lives.

Connection

Students may

- Consider how Newfoundland and Labrador's indigenous peoples changed materials obtained from natural sources (e.g., birch trees, caribou, seals, whales) to make useful objects.
- Investigate how water treatment plants change water to make it safer to drink.
- Investigate how sewage treatment plants change wastes to make them less harmful to the environment.
- View videos related to the extraction and refining of crude oil.
- Consider the properties of gasoline and diesel fuel. How have these petroleum materials improved living conditions?

Consolidation

Students may

- Use the *Crude Oil Refining Process* BLM as a reference to explain the process of distillation in the separation of crude oil.

Extension

Students may

- Create a "Mystery Object" game by developing clues regarding the source of materials and changes to the materials required to make their mystery object. Classmates can use the clues to guess the mystery object.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 60-63

NL Science 5: Properties and Changes of Materials (SR)

- pp. 38-39

NL Science 5: Online Teaching Centre

- Crude Oil Refining Process (BLM)
- Science Skills Toolkit
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 10
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Soap production (websites and videos)
- Oil exploration, extraction, and distillation resources (websites and videos)

How Can We Change Materials to Solve Problems?

Outcomes

Students will be expected to

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

26.0 collaborate with others to devise and carry out procedures [GCO 2]

23.0 identify potential applications of findings [GCO 2]

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

Focus for Learning

Materials science involves designing and testing new materials to help solve problems. Students should participate in an engineering design and problem solving experience to modify a material to make it more useful. Students could, for example, modify cotton fabric; changing its properties to make it waterproof.

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

- clarify the problem to be solved and, if needed, conduct research;
- collaborate with others to brainstorm possible ways to modify the material to make it more useful;
- select a promising solution to try, devise a plan to modify the material, and make a list of all required tools and materials;
- carry out the plan and test the solution, making observations and collecting information relevant to the problem;
- if testing results are promising, suggest additional changes that could be made to improve the solution;
- if testing results are not promising, abandon the idea and select another possible way to modify the material;
- carry out design changes and retest until an optimal solution is reached; and
- communicate the solution to others and submit the modified material for evaluation.

Modification plans devised by students should be approved to ensure student safety. Some plans may require direct adult supervision.

This design and problem solving experience provides an opportunity to address and assess numerous skill outcomes related to problem solving (e.g., SCOS 1.0, 6.0, 7.0, 8.0, 9.0, 12.0, 14.0, 22.0, 24.0, 27.0, 28.0). Refer to the *Integrated Skills* unit for elaboration of these outcomes.

Following any inquiry investigation or design and problem solving experience, students should identify potential applications of their findings. With respect to the design and problem solving experience above, students should identify potential uses of their modified material based on its changed properties. What could waterproof cotton fabric, for example, be used for?

Materials scientists often look to nature for ideas for new materials. Velcro™, for example, was developed based on observations of burdock burrs. Students should describe examples of new materials that were inspired by the specific shape or texture of natural materials (e.g., sticky slug slime inspired the development of surgical glues).

Attitude

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

How Can We Change Materials to Solve Problems?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Review with students the typical stages of an engineering design and problem solving process.

Connection

Students may

- Examine and describe the properties of flour, salt, and water. Then, combine 60 mL of salt, 125 mL of flour, and 60 mL of water in a mixing bowl to make play dough. Describe the properties of the play dough and compare to those of the original materials.
- Use a recipe to make “ooblek” or “silly putty”. Describe how the properties of the initial materials change.

Consolidation

Students may

- Participate in a design challenge to modify a material to change its properties and make it more useful. Students could choose their own materials to waterproof cotton fabric cut into 15 cm squares (e.g., rubbing with warmed wax, soaking in an oil and blotting off the excess, covering with glue and allowing to dry) and seek approval before making modifications. They should test both the modified material and an unmodified piece of material used as a control. Testing could involve spraying the fabrics with water from a spray bottle and measuring the number of sprays needed to soak the material. Once an optimal solution has been reached, students should describe their design and how effective it was for waterproofing. They should consider potential applications for their modified fabric based on its new properties.
- Compare the results of their waterproofing modifications with those obtained using commercial waterproofing products.
- Research one of the materials below to determine what natural thing it imitates, how it works, and what problem it solves:
 - fastskin
 - geckskin
 - biosteel
 - surgical glue made from mussels or slugs.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 64-69

NL Science 5: Properties and Changes of Materials (SR)

- pp. 40-45

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Design and Problem-Solving rubric builder (BLM)
- IWB Activity 11
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Waterproofing fabrics (websites and videos)

How Does Using Materials Affect Our Environment?

Outcomes

Students will be expected to

66.0 describe the impact of school and community on natural resources [GCO 1]

Focus for Learning

The production, use, and disposal of products and materials can have a host of negative environmental impacts.

Students should consider how their collective use of products and materials affects the environment. They should describe the impacts of

- extracting natural resources (e.g., minerals);
- pollution caused by use of materials and products (e.g., use of pesticides and fertilizers, burning of fuels for home heating or transportation); and
- pollution caused by the disposal of materials and products (e.g., ocean micro-plastics, pollution from landfills or incinerators).

Students should

- distinguish between renewable and non-renewable resources,
- recognize that use of non-renewable resources causes more negative environmental affects,
- recognize that changing how we use materials and products can help protect the environment, and
- suggest ways to reduce their personal impact on the environment.

Attitude

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

Sample Performance Indicator

Over the course a school day, collaboratively record the different products and materials thrown into a school garbage can. Analyze the list of discarded products and materials. How might disposal of these products and materials affect the environment? How might these negative effects be reduced?

How Does Using Materials Affect Our Environment?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Display images by Edward Burtynsky of industrial waste. Ensure students understand what they are viewing. Ask them how each image shows the affect of humans on the environment and how it relates to our use of materials.

Connection

Teachers may

- Provide a sample of liquid soap that contains micro-beads. Direct students to soak up the liquid using paper towels, leaving the micro-beads behind. Ask students where the beads go when the soap is used.
- Discuss the terms renewable and non-renewable, ask students to identify examples of materials made from both, and discuss differences in how materials made from renewable and non-renewable resources affect the environment.

Students may

- Consider the properties of phosphates, micro-beads, and plastic that make them useful, identify the natural source of these materials, and explain how they may harm the environment and what could be done to prevent it.

Consolidation

Students may

- Explore the use of different packing materials (e.g., bubble wrap, foam peanuts, newspaper, popcorn, rags, shredded paper, straw) to protect an egg in a box when dropped. Students should compare the properties, advantages, and disadvantages of each material, including usability and environmental impact. Packing materials could be tested by dropping the box from an initial height, then systematically increasing the height until the egg breaks. Results should be compiled and displayed in a bar graph. Based on their findings, students should identify the most effective and environmentally friendly packing material.
- Identify products made from recycled materials.

Extension

Students may

- Research the environmental concerns caused by ocean plastics and share what is learned with classmates.

Resources and Notes

Authorized

NL Science 5: Properties and Changes of Materials (TR)

- pp. 70-75

NL Science 5: Properties and Changes of Materials (SR)

- pp. 46-47

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Environmental affects of material and product use (websites and videos)

Section Three:
Specific Curriculum Outcomes

Unit 4: Body Systems

Focus

Students can develop the understanding that the body has organs and systems that function together to help humans and other animals meet their basic needs. Students should have the opportunity to explore major internal organs through the use of models and simulations, and know where they are located in the body. It is important for students to recognize that many things may affect a healthy body. The body has its own defences against germs, but students should understand that they must meet their bodies' requirements for nutrition and physical activity.

This unit has both a scientific inquiry and a design and problem solving focus. Inquiry investigations provide opportunities for students to propose and rephrase testable questions, define objects and events, carry out procedures to ensure a fair test, and evaluate the usefulness of different information sources. Design and problem solving experiences to build working models of body systems enable students to identify problems as they arise and collaborate with others to find solutions.

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.

- 31.0 describe examples of tools and techniques that have contributed to scientific discoveries
- 36.0 identify examples of scientific questions and technological problems addressed in the past
- 37.0 describe and compare tools, techniques, and materials used by different people in their community and region to meet their needs
- 38.0 identify individuals in their community who work in science and technology related areas
- 40.0 provide examples of how science and technology have been used to solve problems in their community and region
- 43.0 identify scientific discoveries and technological innovations of people from different cultures
- 48.0 describe instances where scientific ideas and discoveries have led to new inventions and applications
- 49.0 describe examples of technologies that have been developed to improve living conditions
- 63.0 demonstrate processes for investigating scientific questions and solving technological problems
- 74.0 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.

- 1.0 propose a question to investigate and practical problem to solve
- 2.0 rephrase questions in a testable form
- 4.0 define objects and events in their investigations
- 8.0 carry out procedures to explore a given problem and to ensure a fair test, controlling major variables
- 9.0 select and use tools
- 14.0 record observations
- 18.0 compile and display data
- 19.0 identify and suggest explanations for patterns and discrepancies in the data collected
- 20.0 evaluate the usefulness of different information sources in answering a question
- 28.0 identify problems as they arise and collaborate with others to find solutions

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.

- 67.0 describe how body systems help humans meet their basic needs
- 68.0 describe the structure and function of the major organs of human body systems
- 69.0 demonstrate how the skeletal, muscular, and nervous systems work together to produce movement
- 70.0 describe the role of the skin
- 71.0 describe the body's defenses against infections
- 72.0 relate bodily changes during puberty to growth and development
- 73.0 describe nutritional and other requirements for maintaining a healthy body

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 in science
- show interest and curiosity about objects and events within different environments
- willingly observe, question, explore, and investigate
- show interest in the activities of individuals working in scientific and technological fields
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions
- appreciate the importance of accuracy and honesty
- demonstrate perseverance and a desire to understand
- work collaboratively while exploring and investigating
- 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

SCO Continuum

GCO 3 (Knowledge): Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Science 2	Science 5	Science 8
<i>Animal Growth and Changes</i>	<i>Body Systems</i>	<i>Cells, Tissues, Organs, and Organ Systems</i>
<ul style="list-style-type: none"> describe changes in humans as they grow identify constant and change traits in organisms as they grow and develop identify the basic food groups, and describe actions and decisions that support healthy lifestyles 	<ul style="list-style-type: none"> describe how body systems help humans meet their basic needs describe the structure and function of the major organs of human body systems demonstrate how the skeletal, muscular, and nervous systems work together to produce movement describe the role of the skin describe the body's defenses against infections relate bodily changes during puberty to growth and development describe nutritional and other requirements for maintaining a healthy body 	<ul style="list-style-type: none"> explain structural and functional relationships between and among, cells, tissues, organs, and organ systems relate the needs and functions of various cells and organs to the needs and function of the human organism as a whole describe basic factors that affect the functions and efficiency of the human respiratory, circulatory, digestive, excretory, and nervous systems describe examples of the interdependence of various systems of the human body
Science 1		
<i>Needs and Characteristics of Living Things</i>		
<ul style="list-style-type: none"> describe the different ways that humans move to meet their needs recognize that humans depend on their environment, and identify personal actions that can contribute to a healthy environment 		

Suggested Unit Plan

Body Systems is the final unit in the Science 5 curriculum. The knowledge outcomes addressed in this life science unit are prerequisite for understanding concepts in the Science 8 *Cells, Tissues, Organs, and Organ Systems* unit.

September	October	November	December	January	February	March	April	May	June
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Body Systems

What Are Body Systems?

Outcomes

Students will be expected to

67.0 describe how body systems help humans meet their basic needs
[GCO 3]

Focus for Learning

The human body is comprised of many different organs. Each has a specific function or job to do. Some organs work together in systems to perform their functions.

Inform students that there are ten organ systems in the human body: the nervous, muscular, skeletal, respiratory, digestive, excretory, and circulatory systems (which are addressed in detail in this unit) and the endocrine, reproductive, and lymphatic/immune systems.

Note that some science information sources classify skin as a separate body system (i.e., integumentary system). In this unit, skin is classified as an organ.

Students should describe how each of the following body systems helps humans meet their basic life needs:

- The nervous system helps the body gather information from the environment, make decisions, and react to stimuli. The nervous system tells the muscles to move.
- The muscular system works with the skeletal system to help the body move. This system also helps humans breathe, digest food, and circulate blood.
- The skeletal system supports the body and helps it move. Bones such as the skull and ribs provide protection to internal organs.
- The respiratory system provides the body with oxygen and removes carbon dioxide waste.
- The digestive system takes in food and water, processes most of it into required nutrients, and gets rid of what remains.
- The excretory system removes waste from the body.
- The circulatory system transports blood around the body. It carries needed oxygen and nutrients and removes carbon dioxide and other wastes.

Students should recognize that body systems work together to maintain human health.

While not a Science 5 expectation, teachers may find it useful to define cells and tissues and describe their relationship to organs and organ systems.

Attitude

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

What Are Body Systems?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Collect non-fiction literature related to health and body systems to display at a curiosity centre with relevant physical objects and materials (e.g., reflex hammer, stethoscope).
- Assess students' prior knowledge of organ systems by asking them to name any body systems they are already familiar with.
- Direct students to complete a task (e.g., blink, breathe deeply, feel their pulse, stand, swallow, wave) and ask them to identify which body system(s) might be involved.

Students may

- Brainstorm body functions required for life (e.g., breathing, moving); writing each function on a separate sticky note. They should then collaboratively attempt to group functions according to the body system involved.

Connection

Teachers may

- Ask students to collaboratively discuss why a human body needs a nervous, skeletal, muscular, respiratory, digestive, excretory, and circulatory system.

Students may

- Physically model the concept of body systems using unit cubes or Lego™ blocks to represent cells, and joining them to form tissues, organs, and organ systems.
- Individually brainstorm a list of organs and other parts of the human body, then combine their list with classmates to compile a class list. They should then attempt to group the organs and parts according to body system.

Consolidation

Students may

- Compare and contrast organs and body systems using a Venn diagram. Cells and tissues could also be compared.

Resources and Notes

Authorized

NL Science 5: Body Systems
(Teacher Resource [TR])

- pp. 8-13

NL Science 5: Body Systems
(Student Resource [SR])

- pp. 6-7

NL Science 5: Online Teaching Centre

- Term Box (BLM)
- IWB Activity 1
- Image bank

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Body systems resources (websites and videos)

How Do Our Nerves, Muscles, and Skeleton Work Together?

Outcomes

Students will be expected to

68.0 describe the structure and function of the major organs of human body systems [GCO 3]

68.1 describe the structure and function of the major organs of the nervous, muscular, and skeletal systems

69.0 demonstrate how the skeletal, muscular, and nervous systems work together to produce movement [GCO 3]

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

14.0 *record observations* [GCO 2]

Focus for Learning

Students should describe the structure and function of the major organs in the nervous, skeletal, muscular, respiratory, digestive, excretory, and circulatory systems. Structure refers to the organization of organs in a body system (i.e., What are the major organs? How are they arranged?). Function refers to the activities or processes of the organ (i.e., What does the organ do? Why is it part of this system?).

Rather than address all body systems at once, the unit groups systems and treats them separately. Students should describe the nervous, muscular, and skeletal systems as follows:

- The nervous system is the control system of the human body. It includes the brain, spinal cord, nerves, and sense organs. Nerves send information to the brain along the spinal cord. The brain processes this information and returns messages to the body.
- The muscular system works with the skeletal system to help the body stand and move. It includes more than 600 muscles (e.g., abdominal, biceps, calf) and tendons which connect the muscles to bones. Muscles also help the body breathe and digest food.
- The skeletal system gives the body its shape and helps it move. It includes 206 bones (e.g., skull, spine, ribs) and ligaments which connect the bones together. Where one bone meets another at a joint, the skeleton can be moved. The skeletal system also protects the organs in the body (e.g., the skull protects the brain, ribs protect the heart and lungs).

Students should recognize that these three systems work together to produce movement. To demonstrate how they work together, they should carry out a directed investigation of reaction time.

In groups, one student should hang their hand over the edge of their desk, holding their thumb and index finger apart. A partner should dangle the end of a ruler between the open thumb and index finger and drop it without warning. Reaction time should be defined as the distance the ruler drops before it is pinched. This procedure can be repeated multiple times and the results recorded in a table.

Students should recognize that the eye senses when the ruler starts to move and sends information to the brain through nerves. The brain receives, processes, and sends a message back through the spinal column and nerves to the muscles of the hand. The muscles of the hand pull on the attached bones causing the fingers to close and grasp the falling ruler.

In addition to skill outcomes 4.0 and 14.0, teachers could address and assess outcomes 3.0, 8.0, 10.0, 11.0, 13.0, and 24.0 (Refer to the *Integrated Skills* unit for elaboration).

Sample Performance Indicator

Identify the body systems involved when reacting to touching something very hot or very cold. How do these systems work together to produce movement?

How Do Our Nerves, Muscles, and Skeleton Work Together?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Review sense organs and the type of information they send to the brain.
- Provide images of colour words depicted using the wrong font colour (e.g., the word green in blue font). Ask students to shout out the font colour for each image word and discuss how the brain might process the information it receives.
- Show images of facial expressions and ask students to use the muscles of their face to mimic the expression.
- Ask students to lean their head back and using only their facial muscles, try to move a cracker placed on their forehead down and into their mouth.
- Show images of skeletons in various positions and ask students to create the position with their body.

Connection

Teachers may

- Facilitate a game of “Who Am I” by placing the names and representations of major organs or body parts of the nervous, muscular, and skeletal systems (include sense organs and names of familiar bones and muscles) on index cards and attaching one card to the back of each student. Students should ask yes/no questions of classmates until they can identify the organ then sort themselves according to system.
- Use a reflex hammer to introduce the concept of reflexes. Facilitate a discussion regarding how such automatic reactions might help the body.
- Read *How You’re Different From a Sea Star* on pages 8-9 of *Dive In!* (ELA 5) and identify differences in their respiratory systems.

Students may

- Create a tower from ten inverted cups (i.e., four cups for the base followed by three, then two, then one). They should start with all cups stacked together and time how long it takes. Students should continue to practice the activity to determine if practice improves their time.

Consolidation

Students may

- Carry out the reaction time investigation *Drop It!* on pages 12-13 in *Gear Up!* (ELA 5).
- Measure reaction time using online reaction time tests.
- Represent the structure of the skeletal system using pasta, Q-tips™, stir sticks, or toothpicks as bones.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 14-19

NL Science 5: Body Systems (SR)

- pp. 8-11

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- How Quickly Can You React? (BLM)
- Skills and Processes for Scientific Inquiry rubric builder (BLM)
- IWB Activity 2
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Nervous, muscular, and skeletal system resources (websites and videos)
- Reaction time tests (websites)

Other curriculum resources

- *Moving Up with Literacy Place 5* (ELA 5)
 - *Drop It!* in *Gear Up!*
 - *How You’re Different From a Sea Star* in *Dive In!*

How Can You Build a Model of a Body System?

Outcomes

Students will be expected to

69.0 *demonstrate how the skeletal, muscular, and nervous systems work together to produce movement*
[GCO 3]

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

9.0 *select and use tools*
[GCO 2]

28.0 identify problems as they arise and collaborate with others to find solutions
[GCO 2]

Focus for Learning

Modelling is a scientific activity undertaken to make something easier to understand or visualize. The use of modelling is suggested in multiple places within this unit.

At this time, students should follow an engineering design and problem solving process to construct a model of a human joint that shows how the muscular and skeletal systems work together. Common joints to model are the elbow and fingers.

In small collaborative groups, students should

- decide whether they will construct a model of an elbow joint, fingers, or some other joint;
- briefly research their joint to see how the bones and muscles connect;
- select the materials they will use for the different parts, decide how to arrange and join the parts, and identify any tools needed;
- devise and carry out a plan to construct the prototype;
- test the prototype to determine if it moves as planned; and
- suggest and carry out modifications to improve the function of the prototype.

Use of some tools may require adult supervision.

Students could be challenged to incorporate paired muscles into their design, similar to biceps and triceps, that allow the joint to bend and unbend when pulled.

During construction of the model, problems with materials, joiners, and joining methods, as well as problems with the functioning of the model will likely arise. Students should be encouraged to persevere when encountering problems, to generate alternatives, and collaborate to find a solution.

Students should be expected to orally describe their model, demonstrate how it works, and communicate problems their group encountered during construction and how they solved them.

In addition to skill outcomes 8.0, 9.0, and 28.0, teachers may choose to assess additional design and problem solving skills (e.g., 4.0, 6.0, 7.0, 12.0, 15.0, 16.0, 22.0, 26.0). 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]

How Can You Build a Model of a Body System?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Present familiar objects that could be considered models of actual objects (e.g., dolls, Lego™ structures, stuffed animals, toy cars). Ask students what information about the object can be learned from the model and what the limitations of the model are.

Connection

Teachers may

- Provide a collection of “bone and muscle” materials (e.g., cardboard, card stock, dental floss, elastic bands, pipe cleaners, stir sticks, paper or plastic straws, string, wool), joining materials (e.g., brass paper fasteners, glues, tapes, twist ties, wire), and construction tools (e.g., glue gun, scissors, single hole punch) for students to select and use in constructing their models.

Consolidation

Students may

- Construct a working model of a human joint to demonstrate how bones and muscles work together to create movement. Digital images may be captured to document the procedures followed, problems that arose, and solutions found. Students should be able to compare the workings of their model to an actual joint and describe the limitations of their model.
- Brainstorm medical conditions of the skeletal, muscular, or nervous systems (e.g., arthritis, carpal tunnel syndrome, multiple sclerosis, muscular dystrophy, osteoporosis, paralysis, Parkinson’s disease, tendinitis) and discuss how they may affect movement and other body functions.

Extension

Students may

- Apply what they have learned to construct a model of a different joint (e.g., grasshopper’s leg, snake’s jaw).

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 20-21

NL Science 5: Body Systems (SR)

- pp. 12-13

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

How Does Our Respiratory System Help Us Breathe?

Outcomes

Students will be expected to

68.0 describe the structure and function of the major organs of human body systems [GCO 3]

68.2 describe the structure and function of the major organs of the respiratory system

Focus for Learning

Students are expected to describe the structure and function of the major organs of the respiratory system.

Students should describe the respiratory system as the body system that provides the body with the oxygen it needs. The system includes the nose, mouth, trachea (windpipe), lungs, and diaphragm. Air comes into the body through the nose and mouth and travels through the trachea into the lungs. This is made possible by the movement of the diaphragm and muscles attached to the ribs. As the chest expands, air is drawn into the body. Within the lungs, oxygen present in the air passes to the blood and carbon dioxide waste present in the blood passes to the air (i.e., gas exchange). Relaxation of the diaphragm and the muscles attached to the ribs cause the chest cavity to contract and squeeze the lungs. This forces the waste air out of the body.

The air expelled from the body has more carbon dioxide and less oxygen than the air breathed in. Inhaled air has about 21% oxygen, 78% nitrogen, and 1% other gases. Exhaled air contain 16% oxygen, 78% nitrogen, 5% carbon dioxide, and 1% other gases.

Students should also carry out an activity to measure their lung capacity. Students could, for example, exhale into an empty plastic bag and twist the bag shut. Measured amounts of water could be added to an identical plastic bag to obtain a relative measurement of air volume. Students should repeat their lung volume measurement to ensure they are getting relatively consistent results.

The activity could lead to new questions for students to investigate (e.g., Does age affect lung capacity?, SCO 24.0).

Attitude

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

Sample Performance Indicator

Identify the major organs of the respiratory system in a provided diagram and describe how those organs function to help us breathe.

How Does Our Respiratory System Help Us Breathe?

Sample Teaching and Assessment Strategies

Activation

Teachers may

- Create a model lung and diaphragm. Stretch a cut balloon over the bottom of a cut 2 L bottle, and tape the balloon in place. Stretch a second balloon over the mouth of the bottle. Push and pull on the bottom balloon (diaphragm) to suck the top balloon (lung) into and out of the bottle.

Students may

- Measure their respiration rate (i.e., breathing rate) by counting the number of breaths they take in one minute.

Connection

Teachers may

- Ask students to focus on the movement of their diaphragm and the muscles attached to their ribs as they breathe normally, breathe deeply, breathe through a straw, and cough.

Students may

- Sketch the structure of the respiratory system and describe how air enters and is expelled from the body.
- Design and carry out an investigation to identify the affect of exercise on respiration rate.
- Read *How You're Different From a Shark* on pages 8-9 of *Work It!* (ELA 5) and identify differences in their respiratory systems.

Consolidation

Students may

- Carry out a procedure to determine their personal lung capacity. Students could fully exhale into a plastic bag, twist it shut, and measure the volume. Students could compare their capacities with classmates which may lead to new questions to investigate (e.g., Do synchronized swimmers have larger lung capacities? Do taller students have larger lung capacities?).
- Discuss how the functioning of the respiratory system relies on the muscular and skeletal systems.
- Brainstorm respiratory-related medical conditions (e.g., allergies, asthma, pneumonia, respiratory tract infections) and discuss how they may affect the functioning of the respiratory system.

Extension

Students may

- Research and explain what hiccups are and how they relate to the respiratory system.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 22-25

NL Science 5: Body Systems (SR)

- pp. 14-15

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Respiratory system resources (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 5* (ELA 5)
 - *How You're Different From a Shark* in *Work It!*

How Do Our Digestive and Excretory Systems Work?

Outcomes

Students will be expected to

68.0 describe the structure and function of the major organs of human body systems [GCO 3]

68.3 describe the structure and function of the major organs of the digestive and excretory systems

Focus for Learning

Students are expected to describe the structure and function of the major organs of the digestive and excretory system.

Students should describe the digestive system as the system that provides the body with water and nutrients. The major organs of the system include the mouth, esophagus, stomach, small intestine, large intestine, and rectum. For the purpose of this course, inclusion of the pancreas, gallbladder, and liver is optional. Food enters the body through the mouth where it is broken down and moistened. When swallowed, food enters the esophagus and is pushed to the stomach. Stomach muscles, acids, and other chemicals liquefy the food. In the small intestine nutrients are removed and enter the blood stream. Water is removed in the large intestine and what remains is turned into solid waste. The waste is stored in the rectum and eventually pushed out through the anus.

To aid student understanding of the structure and function of the digestive system, students should, follow an engineering design process to construct a model of the system. This modelling activity provides another opportunity to assess numerous skill outcomes (e.g., 4.0, 6.0, 7.0, 8.0, 9.0, 15.0, 16.0, 22.0, 26.0, 28.0). Refer to the *Integrated Skills* unit for elaboration.

Students should describe the excretory system as the system that cleans the body's blood and gets rid of waste. The major organs include the kidneys and bladder. When the body uses the nutrients provided by the digestive system, waste is created and carried away by the blood. As the blood circulates through the kidneys, waste (i.e., urea) and excess water are removed, and urine forms. Urine is stored in the bladder until it can be released.

Students should also recognize that both the digestive and excretory systems rely on other body systems to achieve their function. The nervous, skeletal, muscular, and circulatory systems, for example, all have roles to play in digestion. Similarly, the digestive and circulatory systems work together with the excretory system.

Attitude

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

Sample Performance Indicator

Using a model of the digestive system as a visual prompt, describe the process of digestion, from mouth to anus. Include the names and function of major organs in the description.

Describe the function of the kidneys in the excretory system.

How Do Our Digestive and Excretory Systems Work?

Sample Teaching and Assessment Strategies

Teachers may choose to address the circulatory system (SCO 68.4, p. 178) before addressing the digestive and excretory systems.

Activation

Teachers may

- Ask students to consider and discuss why their body needs food and why they need to urinate.

Connection

Students may

- Model the digestive functions of the mouth by placing a cracker inside a sealed zip top bag. They should squeeze the bag with their fingers (teeth and tongue). Students could continue squeezing, after a small amount of water (saliva) has been added, using an eyedropper, to moisten the food.
- Model food digestion by following the procedure found in *Digest It!* on pages 12-13 of *Dive In!* (ELA 5).
- Model the filtration function of the kidneys by pouring red coloured water (blood) mixed with a solid (e.g., ground coffee or pepper, sand) through a filter (e.g., coffee filter, filter paper). The material captured by the filter represents cellular wastes.
- Model the dilution of urea and formation of urine by mixing one drop of yellow food colouring into a larger volume of water.
- Read *How You're Different From a Cow* on pages 8-9 of *Take Off!* (ELA 5) and identify differences in their digestive systems.

Consolidation

Students may

- Construct, in small collaborative groups, a model of the human digestive system.
- Create a multi-tab foldable to communicate the main function of the parts of the major organs of the digestive system.
- Brainstorm digestive and excretory-related medical conditions (e.g., acid reflux, Crohn's disease, colitis, kidney failure, kidney stones, ulcers, urinary tract infections) and discuss how they may affect the functioning of these systems.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 26-33

NL Science 5: Body Systems (SR)

- pp. 16-21

NL Science 5: Online Teaching Centre

- Science Skills Toolkit
- Skills and Processes for Design and Problem Solving rubric builder (BLM)
- IWB Activity 4
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Digestive and excretory system resources (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 5* (ELA 5)
 - *How You're Different From a Cow* in *Take Off!*
 - *Digest It!* in *Dive In!*

How Does Our Circulatory System Work?

Outcomes

Students will be expected to

68.0 describe the structure and function of the major organs of human body systems [GCO 3]

68.4 describe the structure and function of the major organs of the circulatory system

Focus for Learning

Students are expected to describe the structure and function of the major organs of the circulatory system.

Students should describe the circulatory system as the system that carries blood around the body, delivering oxygen, nutrients, and water to cells. The circulatory system includes the heart, arteries, veins, and capillaries. The right side of the heart pumps blood to the lungs, where it picks up oxygen. The blood returns to the left side of the heart, which then pumps the oxygen-rich blood through arteries to all other parts of the body. Veins carry oxygen-poor blood back to the right side of the heart. This blood is high in carbon dioxide waste. Arteries and veins connect through microscopic capillaries which carry blood to and from every cell of the body. As blood moves from arteries through the capillaries, oxygen, nutrients (obtained from the small intestine), water (obtained from the large intestine), and other substances pass into the cells and waste passes into the blood. This waste-filled blood then travels back through veins to eventually reach the lungs and kidneys for waste removal.

Additional functions of the circulatory system include

- temperature regulation (i.e., carrying heat through the body); and
- carrying the cells (i.e., white blood cells) and antibodies of the immune system to fight infections (While not a focus of SCO 38.0, aspects of the immune system are explored later in the unit).

Students are expected to be able to locate and measure their own pulse. They should understand that a pulse is felt as blood is pushed through an artery. Each pulse is one heartbeat. The importance of accuracy and honesty when measuring and recording pulse should be discussed. Discourage students from “making up” data when they lose their pulse during measurement or when their measured pulse is not what they expected or hoped for. Teachers should monitor for this type of measurement bias. Bias may be evident if student data falls outside average values (i.e., 60-100 beats/minute for ages 10 and up) or if their repeated measurements vary significantly.

Students should recognize that the circulatory system works with all other body systems.

Attitude

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

Sample Performance Indicator

Describe how the heart, arteries, veins, and capillaries work together as a system to provide the cells of the body what they require to function.

How Does Our Circulatory System Work?

Sample Teaching and Assessment Strategies

Activation

Students may

- Use a stethoscope to listen to their heart beat.

Connection

Teachers may

- Ask students to observe the veins which may be visible on their forearms. Some veins are close to the surface of the body and appear blue in colour.
- Ask students to locate their pulse using two fingers placed on their inner wrist or below their ear and describe what they are feeling.
- Practice measuring their pulse for 15, 20, 30, or 60 seconds and calculating pulse rate.
- Determine their resting pulse rate. Multiple measurements should be taken to confirm the rate. Discrepancies identified in measurements should be discussed.
- View a sphygmomanometer being used to measure blood pressure and collaboratively discuss how it might work and what it might measure.
- Read *How You're Different From a Grasshopper* on pages 8-9 of *Gear Up!* (ELA 5) and identify differences in their circulatory systems.

Consolidation

Students may

- List the materials that are transported around the body by the circulatory system and identify which other body systems each material involves.
- Discuss ways in which the circulatory system helps other body systems.
- Brainstorm circulatory-related medical conditions (e.g., aneurysm, atherosclerosis, coronary artery disease, heart attack, high blood pressure, stroke) and discuss how they may affect the circulation of the blood.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 34-37

NL Science 5: Body Systems (SR)

- pp. 22-23

NL Science 5: Online Teaching Centre

- Image bank

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Circulatory system resources (websites and videos)

Other curriculum resources

- *Moving Up with Literacy Place 5* (ELA 5)
 - *How You're Different From a Grasshopper in Gear Up!*

Does Physical Activity Affect Our Heart Rate?

Outcomes

Students will be expected to

68.0 describe the structure and function of the major organs of human body systems [GCO 3]

68.4 describe the structure and function of the major organs of the circulatory system

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

1.0 propose a question to investigate and practical problem to solve [GCO 2]

2.0 rephrase questions in a testable form [GCO 2]

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

14.0 record observations [GCO 2]

18.0 compile and display data [GCO 2]

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

Focus for Learning

Students are expected, in small collaborative groups, to carry out an open inquiry investigation to determine the effect of physical activity on heart rate. Open inquiry allows students to demonstrate proficiency in applying science inquiry processes and related skills to find answers to their questions.

Students should

- propose their own question to investigate and phrase it in a testable form;
- state a prediction and a hypothesis;
- define physical activity (e.g., Will the test subject do push ups, jumping jacks, or climb stairs?, How long will they exercise? How many times will they repeat the activity?) and heart rate (e.g., Will pulse be found on the neck or wrist? Will it be measured for 30 or 60 seconds? What unit of measure will be used?);
- identify the major variables (i.e., independent, dependent, and control variables);
- devise and carry out procedures to ensure a fair test, controlling major variables;
- select and use tools for measuring time and pulse rate;
- record observations;
- compile and display the data;
- identify and suggest explanations for patterns and discrepancies in their data; and
- draw a conclusion that answers the initial question.

These investigations provide an opportunity to readdress the concept of fairness in scientific testing (e.g., Were activities done at the same speed or intensity? Was pulse rate always measured as soon as the subject stopped exercising? Was pulse allowed to return to normal before a second trial was completed? What was done if pulse could not be found immediately or was “lost” during measurements?).

While students may already be aware that physical activity causes an increase in heart rate, they may not understand the relationship between exercise and the oxygen demand of muscle cells, and the role of the circulatory system to provide the oxygen.

In addition to SCOs 1.0, 2.0, 4.0, 14.0, 18.0, and 19.0, teachers could assess SCOs 3.0, 5.0, 6.0, 8.0, 11.0, 12.0, 21.0, 24.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration.

Attitude

Encourage students to

- work collaboratively while exploring and investigating,
- consider their own observations and ideas as well as those of others during investigations and before drawing conclusions, and
- appreciate the importance of accuracy and honesty. [GCO 4]

Does Physical Activity Affect Our Heart Rate?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Revisit the concept of fairness by acting out unfair tests (e.g., measure resting pulse rate then measure active pulse rate after putting on a winter coat, intensely exercising for one trial and slowing down for a second trial).
- Discuss the importance of multiple trials in science testing to ensure the reliability of measurements.

Students may

- Keep a daily activity/pulse rate journal. They should measure their pulse at various times during the day, and record it along with a description of the activity in which they were engaged (e.g., eating lunch, playing outside, reading, singing, walking). Inquiry questions to investigate could arise from analysis of their completed journal.
- Determine their resting pulse rate, if not previously done. Multiple measurements should be taken to confirm the reliability of their measurement. Resting pulse rate may be used for comparison when investigating the effects of physical activity on heart rate.

Consolidation

Students may

- View video of group members carrying out investigations to determine if procedures were fairly carried out over multiple trials. If the testing was not fair, identify the variable(s) that was not controlled, modify the procedure, and repeat the investigation.
- Create before and after bar graphs to compare their resting pulse rate with their active pulse rate.
- Present to their classmates; communicating the question investigated, procedures followed, problems encountered, and conclusions drawn.
- Discuss other factors that may affect pulse rate and propose new questions to investigate.

Extension

Students may

- Devise and carry out open inquiry investigations to determine the effect of other factors (e.g., age, body temperature, gender, time since last meal) on pulse rate.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 38-41

NL Science 5: Body Systems (SR)

- pp. 24-25

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

What Does Our Skin Do?

Outcomes

Students will be expected to

70.0 describe the role of the skin
[GCO 3]

1.0 *propose a question to investigate and practical problem to solve*
[GCO 2]

Focus for Learning

Students should describe skin as an organ covering the entire body. Skin has many functions:

- Skin is a sense organ. It sends information to the brain regarding pain, pressure, temperature, and the texture of surfaces.
- Skin protects the body from injury. It produces a pigment (melanin) to block harmful UV rays and produces vitamin D (an essential nutrient for health).
- Skin helps regulate body temperature. When cold, skin triggers shivering to increase blood flow. When warm, glands in the skin release sweat which have a cooling effect.
- Skin helps the body remain hydrated by keeping water inside.
- Skin is the first line of defense against infection.

To enhance awareness and understanding of some of these functions, students should, in small collaborative groups, propose, devise, and carry out investigations to test how various conditions affect peeled and unpeeled apples. The apple peel is a model for human skin.

Students could choose to

- place a peeled and unpeeled apple in fresh water, salt water, vinegar water, or water coloured with food colouring;
- place the apples under direct, artificial lighting or in different temperature environments; or
- gently rub the apples with sand paper or drop them repeatedly.

Depending on the condition chosen, observations could be made immediately or over a period of one or more days. Observations may be quantitative (e.g., change in mass) or qualitative (e.g., flesh of the apple absorbs the food colouring).

In addition to SCO 1.0, teachers could assess SCOs 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 12.0, 14.0, 18.0, 21.0, 24.0, and 26.0. Refer to the *Integrated Skills* unit for elaboration.

Students should also recognize, through a directed inquiry investigation, that the sensitivity of the skin varies. Some parts of our skin are more sensitive than others.

Attitude

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

Sample Performance Indicator

Predict what skin-related roles might be affected if a person suffers large burns to their body.

What Does Our Skin Do?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Have students place a small drop of hand lotion, vegetable oil, and water onto a paper towel, wax paper, and their forearm. Ask them to observe the drops without disturbing them and compare the results for different materials. What can be learned about our skin from these observations?
- Encourage students to hypothesize how Band-Aids™ help protect infections and encourage healing.

Students may

- Place a drop of rubbing alcohol on their skin or wipe with an alcohol swab and describe how their skin feels. This activity models the evaporative cooling effect sweat has on the body.
- Model the UV blocking role of the skin by rubbing sunscreen into the front of their hands and carefully placing them palm down onto a piece of dark coloured construction paper. When placed in sunlight, UV light will cause the colour of the construction paper to fade in untouched areas. While skin contains natural UV protection, the routine use of sunscreen is recommended when outdoors.
- Model the skin's role in maintaining hydration by covering a slice of bread in plastic wrap and comparing with an unwrapped slice.

Consolidation

Students may

- Propose questions to investigate or problems to solve related to the ability of an apple skin to protect the apple, keep materials out, and keep moisture in.
- Devise and carry out guided inquiry investigations, to determine how various conditions affect peeled and unpeeled apples.
- Devise and test procedures to prevent apple slices from losing moisture and decomposing.
- Discuss how skin-related technologies (adhesive bandages, artificial skin, skin care products, skin grafts, stitches, sunscreen) may help meet needs and solve problems.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 46-53

NL Science 5: Body Systems (SR)

- pp. 30-33

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Skin resources (websites and videos)

What Are Our Body's Defenses?

Outcomes

Students will be expected to

71.0 describe the body's defenses against infections [GCO 3]

Focus for Learning

Students should describe the body's two primary lines of defence against infection:

- The first line of defense consists of physical and chemical barriers. Skin provides a physical barrier. Tears, ear wax, saliva, mucus, and stomach acids are some of the liquids the body produces to protect vulnerable surfaces. These liquids either trap and sweep germs away or contain chemicals which destroy them.
- The second line of defense is the body's immune system. White blood cells detect germs that get past the first line of defence and make antibodies which attach to and destroy them.

Note that "germ" is used in this curriculum to represent infection causing organisms (e.g., some bacteria and viruses).

Students should describe active immunity; the ability of the immune system to rapidly respond to a reinfection by a previously encountered germ. The antibodies made by white blood cells to destroy a specific germ, remain in the blood long after the infection. As a result, the body retains a "memory" of the specific germ. This enables rapid response to reinfection by the same germ.

Student understanding of active immunity should be applied to explain how vaccines work. Vaccines contain partially destroyed germs that are incapable of causing illness. When inoculated with them, the body makes and retains "memories" of antibodies to destroy. If the body is ever infected by these live germs, the immune "knows" how to destroy them and rapidly responds.

Students should engage in a directed activity to model how easily germs can spread. Small amounts of different coloured glitter, for example, could be placed on the hands of selected students. These "infected" students could then be asked to shake hands with three classmates. Those classmates could shake hands with three other students, and so on, until all students have participated. All students should examine their hands and record the different colours present prior to washing the glitter off.

Cross curricular connections can be made to Health outcomes related to personal hygiene and prevention of disease.

Attitude

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

Sample Performance Indicator

- Describe how skin, mucus, stomach acid, and white blood cells affect germs.

What Are Our Body's Defenses?

Sample Teaching and Assessment Strategies

Activation

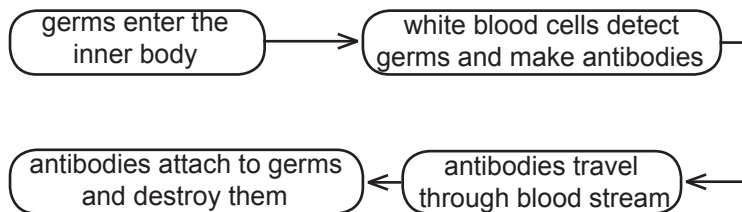
Teachers may

- Ask students to share experiences when they had an infection and infer how they developed it.

Connection

Teachers may

- Facilitate a discussion regarding possible routes germs may enter the body (e.g., abrasions and cuts in the skin, ear canal, eyes, mouth, nasal passages) and the physical (e.g., skin, membranes of the digestive and respiratory systems) and chemical barriers (e.g., ear wax, mucus, saliva, stomach acids, tears) which prevent infection.
- Present the function of white blood cells as a flow chart



Students may

- Collaboratively discuss and infer how tears, ear wax, mucus, and saliva may help defend against infections.
- Describe how the body defends against germs ingested with food.
- Describe how the immune system “remembers” germs that previously entered the body.

Consolidation

Teachers may

- Provide examples of and discuss diseases covered by vaccinations available in Newfoundland and Labrador.

Students may

- Brainstorm practices that may help prevent the spread of germs (e.g., avoid touching eyes, nose, and mouth, clean surfaces, wash hands, get vaccinated).
- Represent a white blood cell as an infection fighting “superhero”. Annotate a sketch of their superhero with a description of its superpowers.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 54-57

NL Science 5: Body Systems (SR)

- pp. 34-37

NL Science 5: Online Teaching Centre

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

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Immune system resources (websites and videos)
- Vaccination resources (websites and videos)

How Does Our Body Change?

Outcomes

Students will be expected to
 72.0 relate bodily changes during puberty to growth and development [GCO 3]

Focus for Learning

Body systems, working together, allow the human body to grow and develop.

The human body grows and develops in a relatively uniform way until the onset of puberty. This period of change is triggered and controlled by the endocrine system. The endocrine system produces hormones which act on different parts of the body, causing a variety of developmental changes.

Students should relate growth spurts, changes in body shape, final development of reproductive organs, development of pubic, body, and facial hair, deepening of the voice, and the onset of body odour and acne, as body changes typical of puberty.

Teachers should treat this topic with sensitivity and relate to students that the onset of puberty and the rate of change is unique to each individual.

Cross curricular connections may be made to Health outcomes related to growth, development, puberty, reproduction, body image, and mental health.

Attitude

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

How Does Our Body Change?

Sample Teaching and Assessment Strategies

Connection

Students may

- Discuss how their body systems have changed since they were an infant.
 - How has your nervous system changed?
 - How has your skeletal system changed?
 - How has your muscular system changed?
 - How has your respiratory system changed?
 - How has your digestive system changed?
 - How has your circulatory system changed?
 - How has your immune system changed?

Students could be divided into small groups with each group discussing a different question and reporting back the main points of their conversation.

- Analyze bar graphs depicting how an individual's height changed with age from birth to adulthood. Identify periods of rapid change in height (i.e., growth spurts) and the age at which height stopped changing.

Connection

Students may

- Identify typical body changes that occur during puberty.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 58-61

NL Science 5: Body Systems (SR)

- pp. 38-39

NL Science 5: Online Teaching Centre

- Image bank

Supplementary

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Puberty resources (websites and videos)

How Can We Keep Our Body Systems Healthy?

Outcomes

Students will be expected to

73.0 describe nutritional and other requirements for maintaining a healthy body [GCO 3]

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

37.0 *describe and compare tools, techniques, and materials used by different people in their community and region to meet their needs* [GCO1]

38.0 *identify individuals in their community who work in science and technology related areas* [GCO 1]

Focus for Learning

The digestive system provides the body with the nutrients it requires to grow, develop, and maintain health:

- Carbohydrates (starchy and sweet foods) provide energy to cells.
- Proteins (from meat, beans, and dairy) are needed for important cell functions and are a major component of muscles.
- Fats and oils (from both plants and animals) provide energy to the body, are used to build new cells, and are important for brain growth and development.
- Vitamins (e.g., vitamin D) perform many functions, however, they are only needed in small amounts.
- Minerals (e.g., calcium, iron) are important for bone growth and the operation of muscles and nerves.
- Water is required for the functioning of every cell, tissue, and organ in the body.

Some nutrients are needed in large amounts and some in very small amounts. To meet these nutritional requirements, students should recognize that they need to eat a variety of foods from different food groups (i.e., vegetables and fruit, grain products, milk and alternatives, meat and alternatives). Students should review healthy eating recommendations from different information sources, including Canada’s Food Guide, and evaluate their usefulness.

In addition to balanced nutrition, students should identify physical activity, adequate sleep, good hygiene, and personal injury protection, as other requirements to maintain a healthy body.

Cross curricular connections may be made to Health outcomes related nutrition, active living, self care, injury prevention and safety, and mental health.

Students should brainstorm and describe examples of technologies, both products and processes, used in their community or region to help people maintain their health (e.g., breast feeding, flu shots, hand sanitizer, iodized salt, medical checkups, nutritional drinks, medications, personal protective equipment, sports safety equipment, seat belts, soap dispensers, sunblock, vaccines, water bottle refilling stations, water treatment and fluoridation).

Students should identify careers that help people maintain their health. Students should be encouraged to identify as many relevant careers as possible.

Attitude

Encourage students to

- show interest in the activities of individuals working in scientific and technological fields,
- become aware of potential dangers. [GCO 4]

How Can We Keep Our Body Systems Healthy?

Sample Teaching and Assessment Strategies

Connections

Teachers may

- Present objects from a mystery box (e.g., apple, bag of potato chips, salt, children’s vitamins, skipping rope, video game, bar of soap, pillow). Ask students to suggest how the objects relate to keeping body systems healthy.
- Present the *Canada’s Food Guide* as a source of nutritional information that recommends the number of servings of vegetables and fruit, grain products, milk and alternatives, and meat and alternatives.

Students may

- Identify and locate age-appropriate sources of information related to nutrition. They should evaluate the usefulness of different resources in helping answer the question, “What are the recommended food choices and number of servings for someone my age?”.
- Collaboratively brainstorm products and processes used in their community to help people maintain their health.
- Collaboratively brainstorm a diverse list of individuals in their community or region whose career helps people to maintain their health.

Consolidation

Teachers may

- Present daily food intake information for fictitious individuals. Ask students to analyze and compare the information with recommended servings from the *Canada’s Food Guide*, and make recommendations for improvement.
- Invite a community member with a health-related career to present to class; sharing what they do and the tools, techniques, and materials they use in their job.

Students may

- Keep a journal of foods eaten and the number of servings for one day and compare with recommendations from the *Canada’s Food Guide*.

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 62-65

NL Science 5: Body Systems (SR)

- pp. 40-43

NL Science 5: Online Teaching Centre

- IWB Activities 6 and 7
- Image bank

NL Science 5: Online Student Centre

- Science Skills Toolkit

Suggested

Resource Links: www.k12pl.nl.ca/curr/k-6/sci/sci-5/resource-links.html

- Nutritional resources (websites)

Other curriculum resources

- *Good Enough to Eat*, (Science 3 Science Library)

How Do We Use Science and Technology to Stay Healthy?

Outcomes

Students will be expected to

36.0 identify examples of scientific questions and technological problems addressed in the past
[GCO 1]

31.0 describe examples of tools and techniques that have contributed to scientific discoveries
[GCO 1]

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

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

43.0 identify scientific discoveries and technological innovations of people from different cultures
[GCO 1]

Focus for Learning

Students should be introduced to traditional, local remedies for common ailments (e.g., cough drops made from kerosene, ginger, liniment, and molasses, bread poultice for infected cuts and sores, mustard plaster for chest congestion). They should recognize that, in the past, people turned to materials in their kitchen cupboards and local environment to find cures for health-related problems. The technologies used in the past to address these ailments are likely very different from those used today.

Students should recognize that science and technology have a reciprocal relationship; technologies contribute to scientific discoveries and these discoveries lead to new inventions and applications. Students should describe how technologies such as the microscope, stethoscope, x-ray, surgery, and dissection have contributed to medical knowledge and discoveries. They should also describe how scientific knowledge led to various new inventions and applications such as exercise machines, hearing-related technologies, and prosthetic limbs.

Students should recognize that these scientific discoveries and technological innovations can be made by individuals of different cultures. They should provide examples of

- Canadians who have made significant contributions to health science (e.g., Charles Banting and Frederick Best developed insulin to treat diabetes, Wilfred Bigelow was the first surgeon to use hypothermia as a procedure during heart surgery and his work led to the development of cardiac pacemaker);
- contributions by non-Canadians (e.g., Alexander Fleming discovered penicillin, Chinese acupuncture, Louis Pasteur discovered the principles of vaccination, Wilhelm Röntgen's research led to the development of the x-ray machine); and
- contributions by indigenous peoples (e.g., use of willow bark to treat pain and fever which led to the development of Aspirin, use of leaves and bark of evergreen trees in teas to prevent illnesses caused by vitamin C deficiencies).

Attitude

Encourage students to

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

How Do We Use Science and Technology to Stay Healthy?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- As part of a cooperative jigsaw activity, present student groups with familiar health-related problems (e.g., allergic reaction, broken bone, cough and cold, infected cut, sunburn, toothache, vision problem) and ask them to brainstorm how these problems might have been addressed in the past (research may be involved). Students should then identify modern technologies (i.e., products and processes) that could be used to address the same problems today.
- Present images of old medical tools and ask students to predict what they might have been used for. Then, present images of modern medical tools for comparison.
- Present time lines that depict how medical technologies has evolved over time.

Students may

- List medical technologies they are familiar with, explain what they do, and how they help people stay healthy.
- Choose a health-related profession and brainstorm technologies (i.e., tools and techniques) they might use in treating clients or patients.

Consolidation

Students may

- Discuss what scientific knowledge and discoveries may have resulted from development of antibiotics, blood pressure monitors, blood tests, clinical thermometers, eye charts, microscopes, ophthalmoscope, otoscopes, reflex hammer, stethoscopes, ultrasound, and x-rays.
- Brainstorm significant medical-related discoveries and/or inventions and debate which one has had the greatest impact on helping people stay healthy.
- Brainstorm a tool that could lead to new scientific discoveries, if engineers could design and build it.
- Create trading cards of significant contributors to health science.
- Design a backpack that addresses health and safety concerns related to student use of heavy backpacks.

Extension

Students may

- Research alternative medicines (e.g., ancient Chinese medicine, Ayurvedic medicine, homeopathy, traditional medicine)

Resources and Notes

Authorized

NL Science 5: Body Systems (TR)

- pp. 66-67

NL Science 5: Body Systems (SR)

- pp. 44-47

NL Science 5: Online Teaching Centre

- IWB Activity 8
- Image bank

How Can Technologies Improve Living Conditions?

Outcomes

Students will be expected to

40.0 provide examples of how science and technology have been used to solve problems in their community and region
[GCO 1]

49.0 describe examples of technologies that have been developed to improve living conditions
[GCO 1]

Focus for Learning

Students should explore and provide examples of technologies used in their community, or by members of their community, to solve health-related problems or improve quality of life.

Examples may include, but should not be limited to,

- chiropractic medicine, massage therapy, physiotherapy;
- diagnostic imaging (e.g., X-ray, MRI, CT or PET scanners);
- dental devices and procedures;
- dialysis, insulin pumps, pace maker;
- dietetics, feeding tubes, nutritional supplements;
- first aid kits and training, medical alert bracelets, automated external defibrillator;
- hearing technologies (e.g., cochlear implants, hearing aids, sign language);
- mental health counselling;
- mobility aids (e.g., accessible transportation, grab bars, orthotics, prosthetics, lifts, walkers, wheelchairs);
- physical activity equipment;
- prescription medications, EpiPens™;
- public health programs (e.g., vaccinations), telemedicine;
- surgery, joint replacement, organ transplant; and
- vision correction (e.g., contacts, glasses, laser surgery).

Attitude

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

How Can Technologies Improve Living Conditions?

Sample Teaching and Assessment Strategies

Connection

Teachers may

- Provide fictitious examples of individuals with different health-related problems (e.g., a person with kidney failure). Then, create a list of technologies each individual may use to help solve their problem or improve their quality of life. Ensure the list of technologies includes both devices and processes.
- Compile a master list of health-related technologies.
- Invite the public health nurse to present to the class on current public-health issues and the technologies available to help solve the problem or improve conditions.

Students may

- Consider a health-related problem of a family or community member and list technologies used to help solve their problem.
- Classify technologies according to the body system they support.

Consolidation

Teachers may

- Provide a short list of unfamiliar health-related technologies (e.g., compression stockings, kinesio tape). Ask students to select and research one technology to determine the health-related problem it addresses.

Resources and Notes

Authorized

NL Science 5: Body Systems
(TR)

- pp. 68-71

NL Science 5: Body Systems
(SR)

- pp. 48-49

NL Science 5: Online Teaching Centre

- Image bank

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