Senior 1 Science

Manitoba Curriculum
Framework of Outcomes

Manitoba
Education
and Training

SENIOR 1 SCIENCE

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Introduction

Background

The ***Senior 1 Science: Manitoba Curriculum Framework of Outcomes*** (2000) (hereinafter referred to as the *Science Framework*) presents student learning outcomes for Senior 1 science. These learning outcomes are the same for students in English, French Immersion, Français, and Senior Years Technology Education programs and result from a partnership involving two divisions of Manitoba Education and Training: School Programs and Bureau de l'éducation française. Manitoba's science student learning outcomes are based on those found within the *Common Framework of Science Learning Outcomes K to 12* (Council of Ministers of Education, Canada, 1997). The latter, commonly referred to as the *Pan-Canadian Science Framework*, was initiated under the Pan-Canadian Protocol for Collaboration on School Curriculum (1995), and was developed by educators from Manitoba, Saskatchewan, Alberta, British Columbia, the Northwest Territories, the Yukon Territory, Ontario, and the Atlantic Provinces.

> Student learning outcomes are concise descriptions of the knowledge and skills [and attitudes] that students are expected to learn in a course or grade level in a subject area. *(A Foundation for Excellence,* 1995)

This *Science Framework* provides the basis for teaching, learning, and assessing science, and is mandated for use in all schools (*A Foundation for Excellence*, 1995). In addition, this *Science Framework* serves as a starting point for future development of curriculum documents, support materials, learning resources, assessment tools, and professional learning for teachers. *Senior 1 Science: A Foundation for Implementation* (2000) will complement this *Science Framework*, providing support for its implementation, including suggestions for instruction and assessment.

This *Science Framework* is organized into three sections:

- **Introduction** – describes the background, vision, goals, and beliefs upon which this *Science Framework* is based.
- **Manitoba Foundations for Scientific Literacy** – describes Manitoba foundations for scientific literacy, presents the conceptual organizer for Manitoba science education, and states the general learning outcomes that are broad descriptors of what Manitoba students are expected to know and be able to do as a result of their Early, Middle, and Senior Years science education.
- **Specific Learning Outcomes** – presents specific learning outcomes that describe the knowledge, skills, and attitudes that students are expected to demonstrate with increasing competence and confidence in science by the end of Senior 1.

Vision for Scientific Literacy

Global interdependence; rapid scientific and technological innovation; the need for a sustainable environment, economy, and society; and the pervasiveness of science and technology in daily life reinforce the importance of scientific literacy. Scientifically literate individuals can more effectively interpret information, solve problems, make informed decisions, accommodate change, and create new knowledge. Science education is a key element in developing **scientific literacy** and in building a strong future for Canada's young people.

This *Science Framework* is designed to support and promote the vision for scientific literacy as articulated in the *Pan-Canadian Science Framework*.

> The [Pan-Canadian Science] Framework is guided by the vision that all Canadian students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge 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.
>
> Diverse learning experiences based on the [Pan-Canadian Science] Framework will provide students with many opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, careers, and their future. (*Common Framework of Science Learning Outcomes K to 12*, 1997)

Goals for Canadian Science Education

To promote scientific literacy, the following goals for Canadian science education were developed as part of the *Pan-Canadian Science Framework* and are addressed through Manitoba science curricula.

Science education will...

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

Beliefs about Learning, Teaching, and Assessing Science

To promote scientific literacy among future citizens, it is crucial to recognize how students learn, how science can best be taught, and how learning can be assessed. Students are curious, active learners who have individual interests, abilities, and needs. They come to school with various personal and cultural experiences and prior knowledge that generate a range of attitudes and beliefs about science and life.

Students learn most effectively when their study of science is rooted in concrete learning experiences, related to a particular context or situation, and applied to their world where appropriate. Ideas and understandings that students develop should be progressively extended and reconstructed as students grow in their experiences and in their ability to conceptualize. Learning involves the process of linking newly constructed understandings with prior knowledge and adding new contexts and experiences to current understandings.

Development of scientific literacy is supported by instructional environments that engage students in the following processes:

- **scientific inquiry:** students address questions about natural phenomena, involving broad explorations as well as focussed investigations
- **technological problem solving (design process):** students seek answers to practical problems requiring the application of their science knowledge in various ways
- **decision making:** students identify issues and pursue science knowledge that will inform the issues

It is through these processes that students discover the significance of science in their lives and come to appreciate the interrelatedness of science, technology, society, and the environment.

Each of these processes is a potential starting point for approaching science learning. These processes may encompass a variety of learning approaches for exploring new ideas, for developing specific investigations, and for applying the ideas that are learned.

To achieve the vision of scientific literacy, students must increasingly become engaged in the planning, development, and evaluation of their own learning experiences. They should have the opportunity to work cooperatively with other students, to initiate investigations, to communicate their findings, and to complete projects that demonstrate their learning. To assist teachers in planning for instruction, assessment, evaluation, and reporting, Manitoba Education and Training recommends the following:

At the beginning of a block of instruction, teachers and students identify expected student learning outcomes and establish performance criteria. It is important that these criteria correspond with provincial student learning outcomes. This communication between students and teachers helps to identify clearly what needs to be accomplished, thereby assisting in the learning process.

When students are aware of expected outcomes, they will be more focussed on the learning and more likely to assess their own progress. Furthermore, they can participate in creating appropriate assessment and evaluation criteria. Assessment methods must be valid, reliable, and fair to students.

Senior 1
Manitoba Foundations for Scientific Literacy

Manitoba Foundations for Scientific Literacy

The Five Foundations

To develop scientifically literate students, science learning experiences must incorporate the essential aspects of science and related applications. These essential aspects, the foundations for scientific literacy, have been adapted from the *Pan-Canadian Science Framework* to address the needs of Manitoba students. Manitoba science curricula are built upon the following five foundations for scientific literacy:

A. Nature of Science and Technology

B. Science, Technology, Society, and the Environment (STSE)

C. Scientific and Technological Skills and Attitudes

D. Essential Science Knowledge

E. Unifying Concepts

In the following pages each foundation is described and accompanied by general learning outcomes, which further define expectations for student learning. These general learning outcomes represent the goals of science learning in Kindergarten to Senior 4.

A. Nature of Science and Technology

Students must learn that science and technology are creative human activities with long histories in all cultures of the world.

Science is a way of learning about the universe. This learning stems from curiosity, creativity, imagination, intuition, exploration, observation, replication of experiments, interpretation of evidence, and debate over the evidence and its interpretations. Scientific activity involves predicting, interpreting, and explaining natural and human-made phenomena. Many historians, sociologists, and philosophers of science argue that there is no set procedure for conducting a scientific investigation. Rather, they see science as driven by a combination of theories, knowledge, experiments, and processes anchored in the physical world.

> Producing science knowledge is an intrinsically collective endeavour. There is no such thing as stand-alone science. Scientists submit models and solutions to the assessment of their peers who judge their logical and experimental soundness by reference to the body of existing knowledge. (*Larochelle, M. and J. Désautels,* 1992)

Scientific theories are being tested, modified, and refined continuously as new knowledge and theories supersede existing ones. Scientific debate on new observations and hypotheses that challenge accepted knowledge involves many participants with diverse backgrounds. This highly complex interplay, which has occurred throughout history, is fuelled by theoretical discussions, experimentation, social, cultural, economic, and political influences, personal biases, and the need for peer recognition and acceptance. Students will realize that while some of our understandings about how the world works are due to revolutionary scientific developments, many of our understandings result from the steady and gradual accumulation of knowledge.

Technology is concerned mainly with proposing solutions to problems arising from attempts by humans to adapt to the environment. Technology may be regarded as "...a tool or machine; a process, system, environment, epistemology, and ethic; the systematic application of knowledge, materials, tools, and skills to extend human capabilities...." (*Technology As a Foundation Skill Area: A Journey Toward Information Technology Literacy*, 1998). Technology includes much more than the knowledge and skills related to computers and their applications. Technology is both a form of knowledge that uses concepts and skills from other disciplines (including science) and the application of this knowledge to meet an identified need or solve a problem using materials, energy, and tools (including computers). Technology also has an impact on processes and systems, on society, and on the ways people think, perceive, and define their world.

This *Science Framework* is designed to emphasize both the distinctions and relationships between science and technology. Figure 1 illustrates how science and technology differ in purpose, procedure, and product, while at the same time interacting with each other.

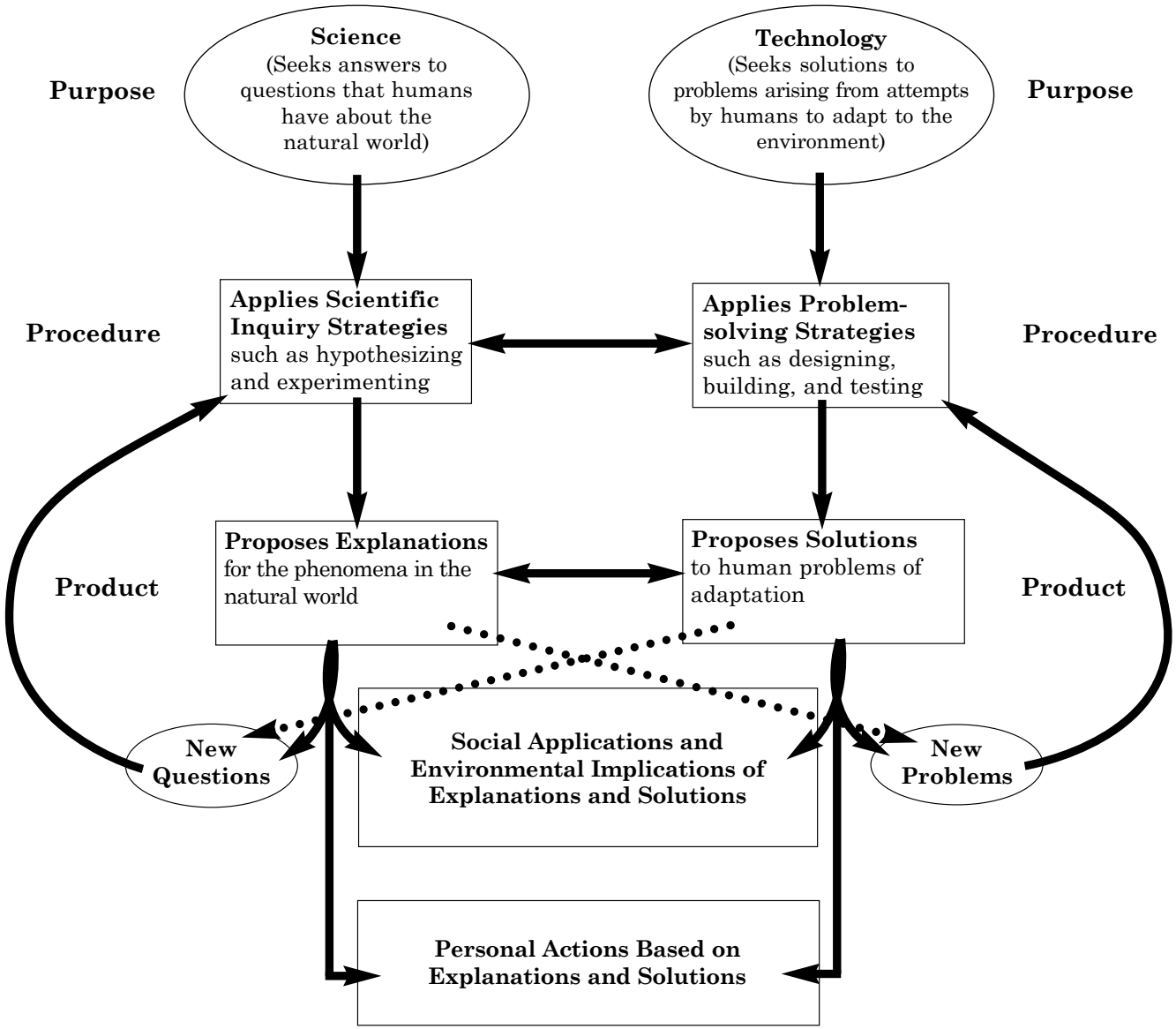


Figure 1: Science and Technology: Their Nature and Relationship

Adapted with permission from Bybee, Rodger W. *Science and Technology Education for the Elementary Years: Frameworks for Curriculum and Instruction.* ©The NETWORK, Inc.

The following general learning outcomes (GLOs) have been developed to further define expectations related to this foundation area. (For a complete listing of Science GLOs, see Appendix.)

Nature of Science and Technology General Learning Outcomes

As a result of their Early, Middle, and Senior Years science education, students will...

A1. recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena

A2. recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop

A3. distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values

A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations

A5. recognize that science and technology interact with and advance one another

B. Science, Technology, Society, and the Environment (STSE)

STSE understandings are an essential component of scientific literacy. By studying the historical context, students come to appreciate ways in which cultural and intellectual traditions have influenced the questions and methodologies of science, and how science, in turn, has influenced the wider world of ideas.

Today, most scientists work in industry, where projects are more often driven by societal and environmental needs than by pure research. Many technological solutions have evoked complex social and environmental issues. Students, as future citizens, must recognize the potential of scientific literacy to inform and empower decision making of individuals, communities, and democratic society as a whole.

Scientific knowledge is necessary, but is not in itself sufficient for understanding the relationships among science, technology, society, and the environment. To understand these relationships, it is essential that students understand the values related to science, technology, society, and the environment.

> There can be no greater contribution or more essential element to long-term environmental strategies leading to sustainable development that respects the environment…than the education of future generations in matters relating to the environment. (*UNESCO,* 1988)

To achieve scientific literacy, students must develop an appreciation for the importance of sustainable development. To this end, this *Science Framework* integrates the Sustainable Development Strategy developed by the Province of Manitoba (see Figure 2).

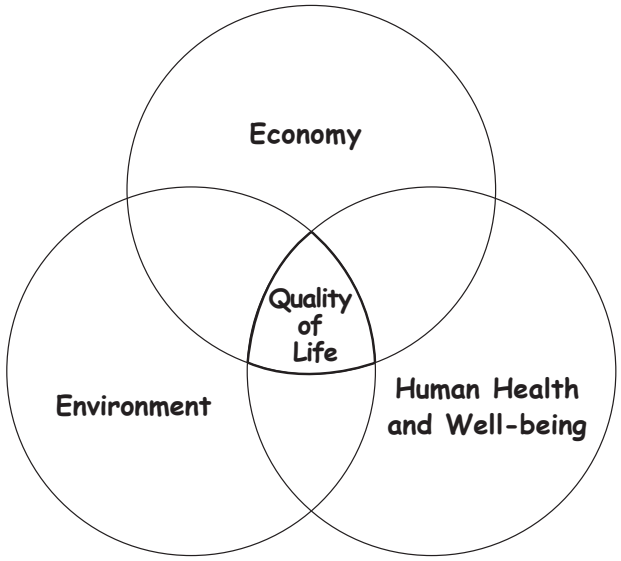


Figure 2: Sustainable Development

Sustainable development is a decision-making model that considers the needs of both present and future generations, and integrates and balances the **impact of economic activities**, the **environment**, and the **health and well-being of the community**.

> Public awareness and understanding of the concept of sustainable development and its practices are essential. If we are to change our way of life we must equip present and future generations with the knowledge and training to put sustainable development into effect. (*Sustainable Development Strategy for Manitoba,* 1994)

As students advance from grade to grade, they identify STSE interrelationships and apply decision-making skills in increasingly demanding contexts, as shown below:

- **complexity of understanding** — from simple, concrete ideas to abstract ideas; from limited knowledge of science to more in-depth and broader knowledge of science and the world
- **applications in context** — from contexts that are local and personal to those that are societal and global
- **consideration of variables and perspectives** — from one or two that are simple to many that are complex
- **critical judgement** — from simple right or wrong assessments to complex evaluations
- **decision making** — from decisions based on limited knowledge, made with the teacher's guidance, to decisions based on extensive research, involving personal judgement and made independently

The following general learning outcomes (GLOs) have been developed to further define expectations related to this foundation area. (For a complete listing of Manitoba's Science GLOs, see Appendix.)

Science, Technology, Society, and the Environment (STSE) General Learning Outcomes

As a result of their Early, Middle, and Senior Years science education, students will...

B1. describe scientific and technological developments, past and present, and appreciate their impact on individuals, societies, and the environment, both locally and globally

B2. recognize that scientific and technological endeavours have been and continue to be influenced by human needs and the societal context of the time

B3. identify the factors that affect health, and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social

B4. demonstrate a knowledge of and personal consideration for a range of possible science- and technology-related interests, hobbies, and careers

B5. identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally

C. Scientific and Technological Skills and Attitudes

A science education that strives for scientific literacy must engage students in answering questions, solving problems, and making decisions. These processes are referred to as Scientific Inquiry, Technological Problem Solving (Design Process), and Decision Making (see Figure 3: Processes for Science Education). While the skills and attitudes involved in these processes 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.

Each of these processes is described on the following page. Attitudes, an important element of each process, are also examined.

	Scientific Inquiry	**Technological Problem Solving (Design Process)**	**Decision Making**
Purpose:	Satisfying curiosity about events and phenomena in the natural world.	Coping with everyday life, practices, and human needs.	Identifying different views or perspectives based on different or the same information.
Procedure:	What do we know? What do we want to know?	How can we do it? Will it work?	What alternatives or consequences are there? Which choice is best at this time?
Product:	Knowledge about events and phenomena in the natural world.	An effective and efficient way to accomplish a task or meet a need.	A defensible decision in the particular circumstances.

	Scientific Question	**Technological Problem**	**STSE Issue**
Example:	Why does my coffee cool so quickly?	How can I keep my coffee hot?	Should we use styrofoam cups or ceramic mugs for our meeting?
	An Answer: Heat energy is transferred by conduction, convection, and radiation.	*A Solution:* A styrofoam cup will keep liquids warm for a long time.	*A Decision:* Personal health, the environment, cost, and availability must be considered along with science and technology information.

Figure 3: Processes for Science Education

Adapted with permission of the Minister of Education, Province of Alberta, Canada, 1999.

Scientific Inquiry

Scientific inquiry is a way of learning about the universe. It involves posing questions and searching for explanations of phenomena. Although no single "scientific method" exists, students require certain skills to participate in science-related experiences.

Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting, analyzing, and interpreting data are fundamental to scientific inquiry; as are attitudes such as curiosity, skepticism, and creativity. These skills are often represented as a cycle. This cycle involves posing questions, generating possible explanations, and collecting and analyzing evidence to determine which of these explanations is most useful and accurate in accounting for the phenomena under investigation. New questions may arise to re-ignite the cycle. It must be noted, however, that many scientific inquiries, past and present, do not necessarily follow a set sequence of steps nor do they always start at the "beginning" of the cycle: scientists can be creative and responsive to scientific challenges as they arise.

Technological Problem Solving

Technological problem solving seeks solutions to problems arising from attempts by humans to adapt to the environment. In Kindergarten to Grade 8 science, students have been developing these skills using a cycle of steps called the design process. This design process includes the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimal solution to a given problem. Feedback and evaluation are built into this cycle. In Senior Years science, technological problem-solving skills are incorporated into a decision-making process.

STSE Issues and Decision Making

Students, as individuals and global citizens, are required to make decisions. Increasingly, the type of issues they face demand an ability to apply scientific and technological processes and products as they relate to Science, Technology, Society, and the Environment (STSE). The decision-making process involves a series of steps which may include:

- clarification of the issue
- critical evaluation of all available research
- generating possible courses of action
- making a thoughtful decision
- examining the impact of the decision
- reflecting on the process

Students should be actively involved in decision-making situations as they progress through their science education. Not only are decision-making situations important in their own right, but they also provide a relevant context for engaging in scientific inquiry, problem solving, and the study of STSE relationships (see Figure 4: Decision-making Model for STSE Issues, p. 2.11).

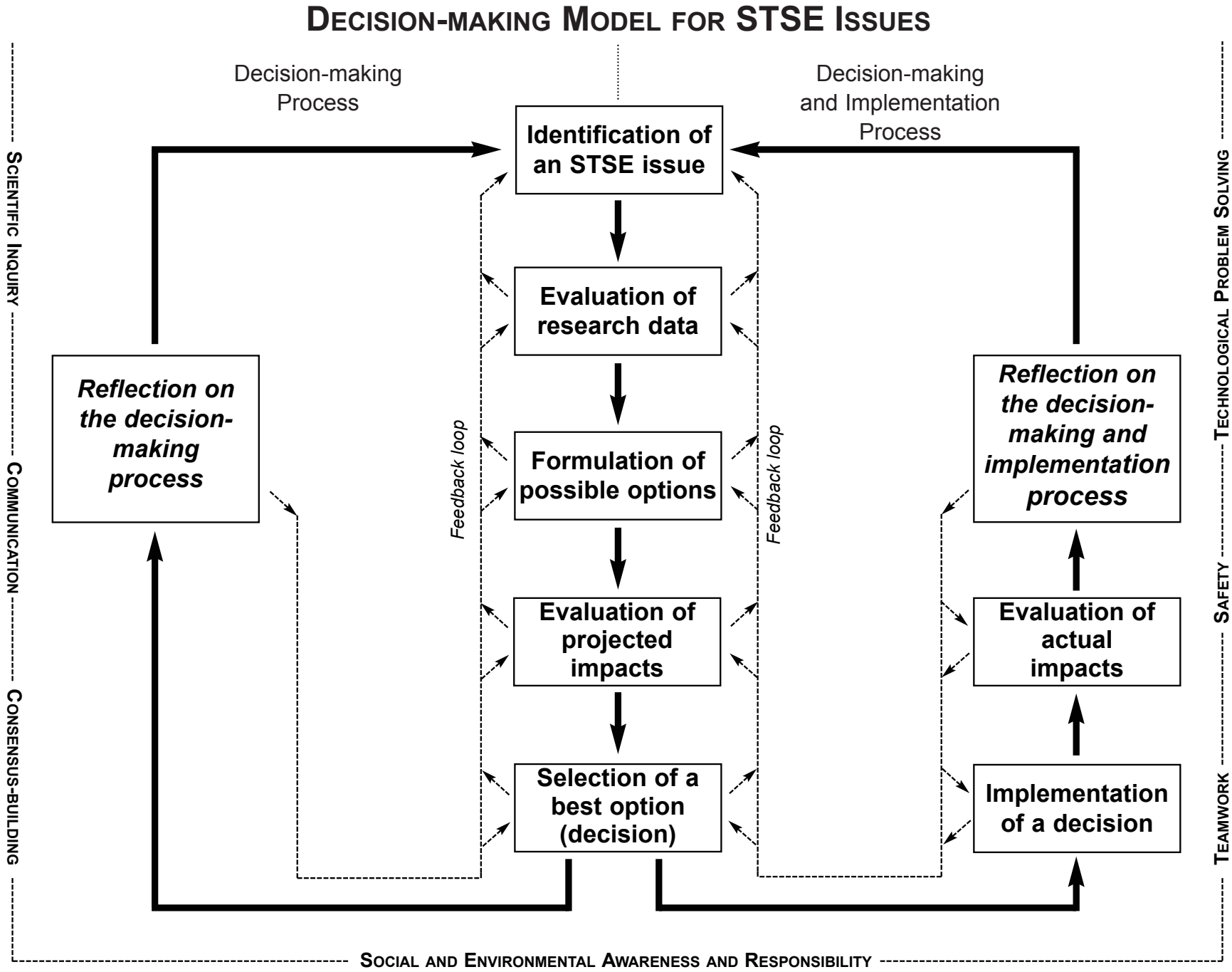


Figure 4: Decision-making Model for STSE Issues

Attitudes

Attitudes refer to generalized aspects of behaviour that are modelled for students and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. They cannot be observed at any particular moment, but are evidenced by regular, unprompted manifestations over time. Development of attitudes is a lifelong process that involves the home, the school, the community, and society at large. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn.

The following General Learning Outcomes (GLOs) have been developed to further define expectations related to this foundation area. (For a complete listing of Manitoba's Science GLOs, see Appendix.)

Scientific and Technological Skills and Attitudes General Learning Outcomes

As a result of their Early, Middle, and Senior Years science education, students will...

C1. recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations

C2. demonstrate appropriate scientific inquiry skills when seeking answers to questions

C3. demonstrate appropriate problem-solving skills while seeking solutions to technological challenges

C4. demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information

C5. demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind

C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data

C7. work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities

C8. evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life

D. Essential Science Knowledge

The subject matter of science includes theories, models, concepts, and principles that are essential to an understanding of life science, physical science, and Earth and space science. While this *Science Framework* is not strictly aligned with these disciplines, the learning outcomes are intended to help develop important concepts from each of these areas.

Life science deals with the growth and interactions of life forms within their environment in ways that reflect their uniqueness, diversity, genetic continuity, and changing nature. Life science includes fields of study such as the study of organisms (including humans), ecosystems, biodiversity, and the study of the cell, biochemistry, and biotechnology.

Physical science, which encompasses chemistry and physics, deals with matter, energy, and forces. Matter has structure and interactions exist among its components. Energy links matter to gravitational, electromagnetic, and nuclear forces of the universe. The laws of conservation of mass and energy, momentum, and charge are addressed by physical science.

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

The following General Learning Outcomes (GLOs) have been developed to further define expectations related to this foundation area. (For a complete listing of Manitoba's Science GLOs, see Appendix.)

Essential Science Knowledge General Learning Outcomes

As a result of their Early, Middle, and Senior Years science education, students will...

D1. understand essential life structures and processes pertaining to a wide variety of organisms, including humans

D2. understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole

D3. understand the properties and structures of matter as well as various common manifestations and applications of the actions and interactions of matter

D4. understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts

D5. understand the composition of the Earth's atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them

D6. understand the composition of the universe, the interactions within it, and the impacts of humankind's continued attempts to understand and explore it

E. Unifying Concepts

An effective way to create linkages within and among science disciplines is to use unifying concepts; these are key ideas that underlie and integrate all science knowledge and extend into areas such as mathematics and social studies. Consequently, unifying concepts help students to construct a holistic understanding of science and its role in society. The following four unifying concepts were used in the development of this *Science Framework*.

Similarity and Diversity

The concepts of similarity and diversity provide tools for organizing our experiences with the world. Beginning with informal experiences, students learn to recognize attributes of materials, organisms, and events that help to make useful distinctions between and among them. Over time, students adopt accepted procedures and protocols for describing and classifying objects, organisms, and events they encounter, thus enabling them to share ideas with others and to reflect on their own experiences.

Systems and Interactions

An important part of understanding and interpreting the world is the ability to think about the whole in terms of its parts and, alternately, about parts in terms of how they relate to one another and to the whole. A system is a collection of components that interact with one another so that the overall effect is often greater than that of the individual parts, even when these are considered together. Students will study both natural and technological systems.

Change, Constancy, and Equilibrium

The concepts of constancy and change underlie most understandings of the natural and technological world. Through observations, students learn that some characteristics of living things, materials, and systems remain constant over time, whereas others change. Through formal and informal studies, students develop an understanding of the processes and conditions in which change, constancy, and equilibrium take place.

Energy

The concept of energy provides a conceptual tool that brings together many understandings about natural phenomena, materials, and the processes of change. Energy, whether transmitted or transformed, is the driving force of both movement and change. Students learn to describe energy in terms of its effects and, over time, develop a concept of energy as something inherent within the interactions of materials, the processes of life, and the functioning of systems.

The following General Learning Outcomes (GLOs) have been developed to further define expectations related to this foundation area. (For a complete listing of Manitoba's Science GLOs, see Appendix.)

Unifying Concepts General Learning Outcomes

As a result of their Early, Middle, and Senior Years science education, students will...

E1. describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world

E2. describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems

E3. recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved

E4. recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them

Conceptual Organizer

The following Conceptual Organizer (Figure 5) provides a graphic representation of the different components of the science curriculum. It summarizes the relationships among the Manitoba Foundations for Scientific Literacy, and shows how they are transformed into both general and specific student learning outcomes in Kindergarten to Senior 4.

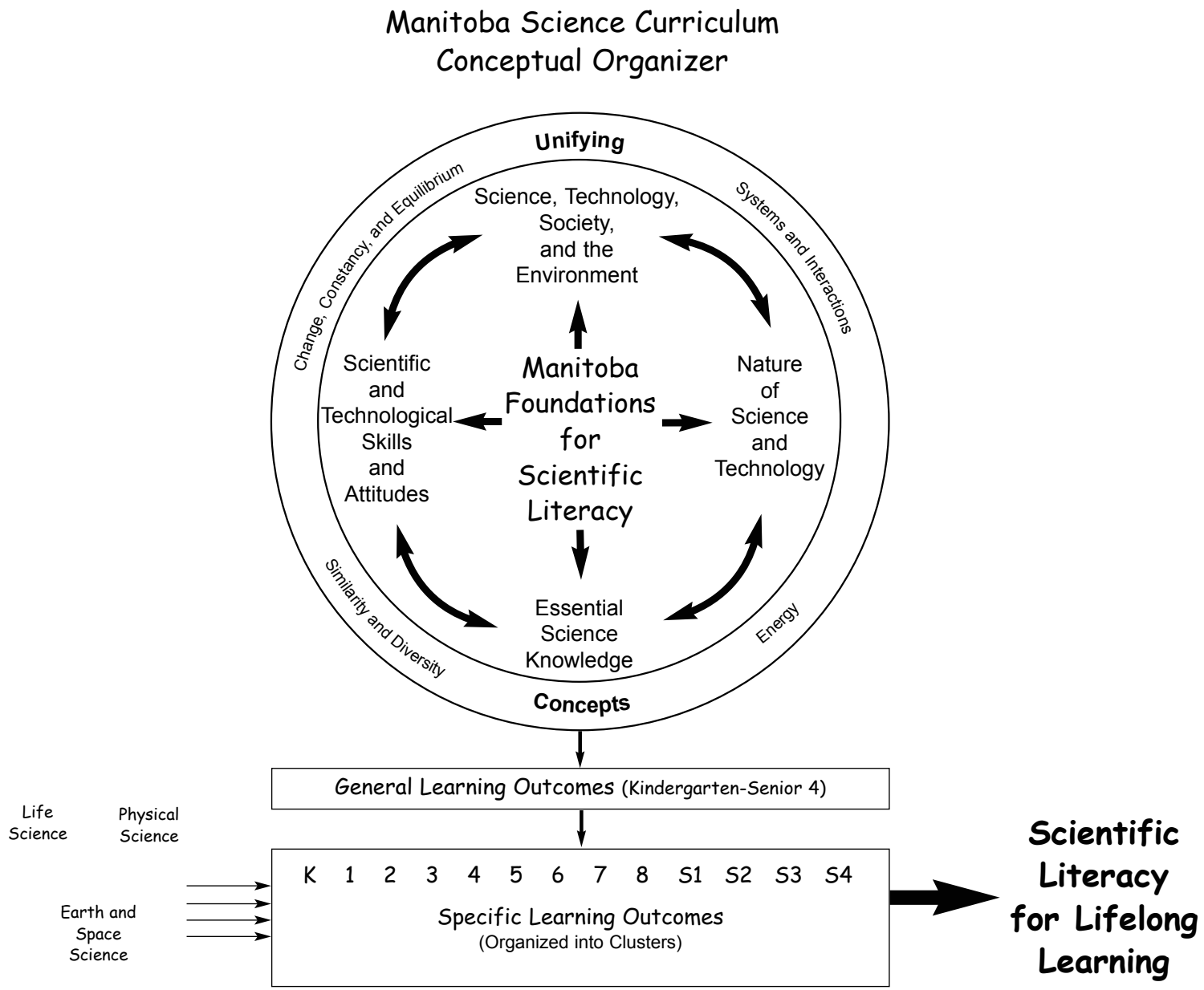


Figure 5: Manitoba Science Curriculum Conceptual Organizer

Senior 1
Specific Learning Outcomes

Specific Learning Outcomes

Organization into Clusters

This *Science Framework* presents specific learning outcomes (SLOs) for Senior 1 science. SLOs are arranged into groupings, referred to as clusters. Clusters 1 to 4 are thematic and generally relate to the three science disciplines (Life, Physical, Earth and Space) discussed earlier in the *Science Framework*. Cluster 0 comprises Overall Skills and Attitudes which are to be integrated into Clusters 1 to 4. (See Figure 6: Cluster Titles for Senior 1 Science and Figure 7: Cluster Titles for Grades 5 to Senior 1 Science.)

Whereas the SLOs themselves are mandatory, the order in which they are addressed is not. Teachers are encouraged to plan their instruction based on student needs, individual contexts, learning resources, and other pertinent considerations. This may involve organizing the SLOs into new groupings and a new order. *Senior 1 Science: A Foundation for Implementation* will provide planning tools, as well as suggestions for instruction and assessment. It is expected that each of the clusters (1–4) presented in this framework be given equal time.

The Overall Skills and Attitudes SLOs for Senior 1 are also presented in a *Senior 1 Science at a Glance* poster (separate attachment). The purpose of this poster is to provide teachers with a grade view of skills and attitudes outcomes that need to be achieved. Additional copies of this poster are available from the Manitoba Text Book Bureau (MTBB stock #80367).

A *Grades 5 to 8 Overall Skills and Attitudes Chart,* along with Grade-at-a-Glance posters, are also available (MTBB stock #80366).

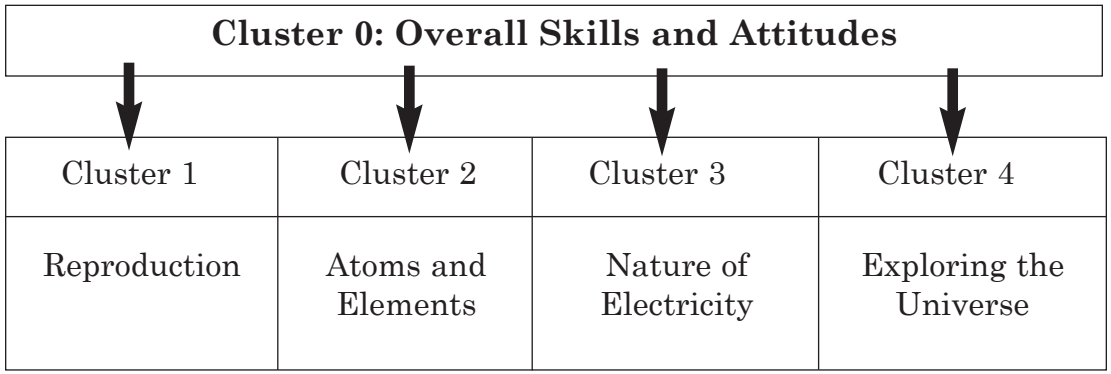
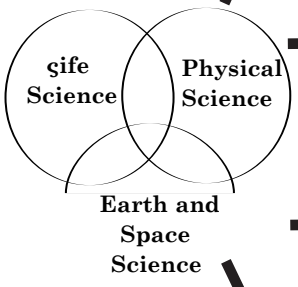


Figure 6: Cluster Titles for Senior 1 Science

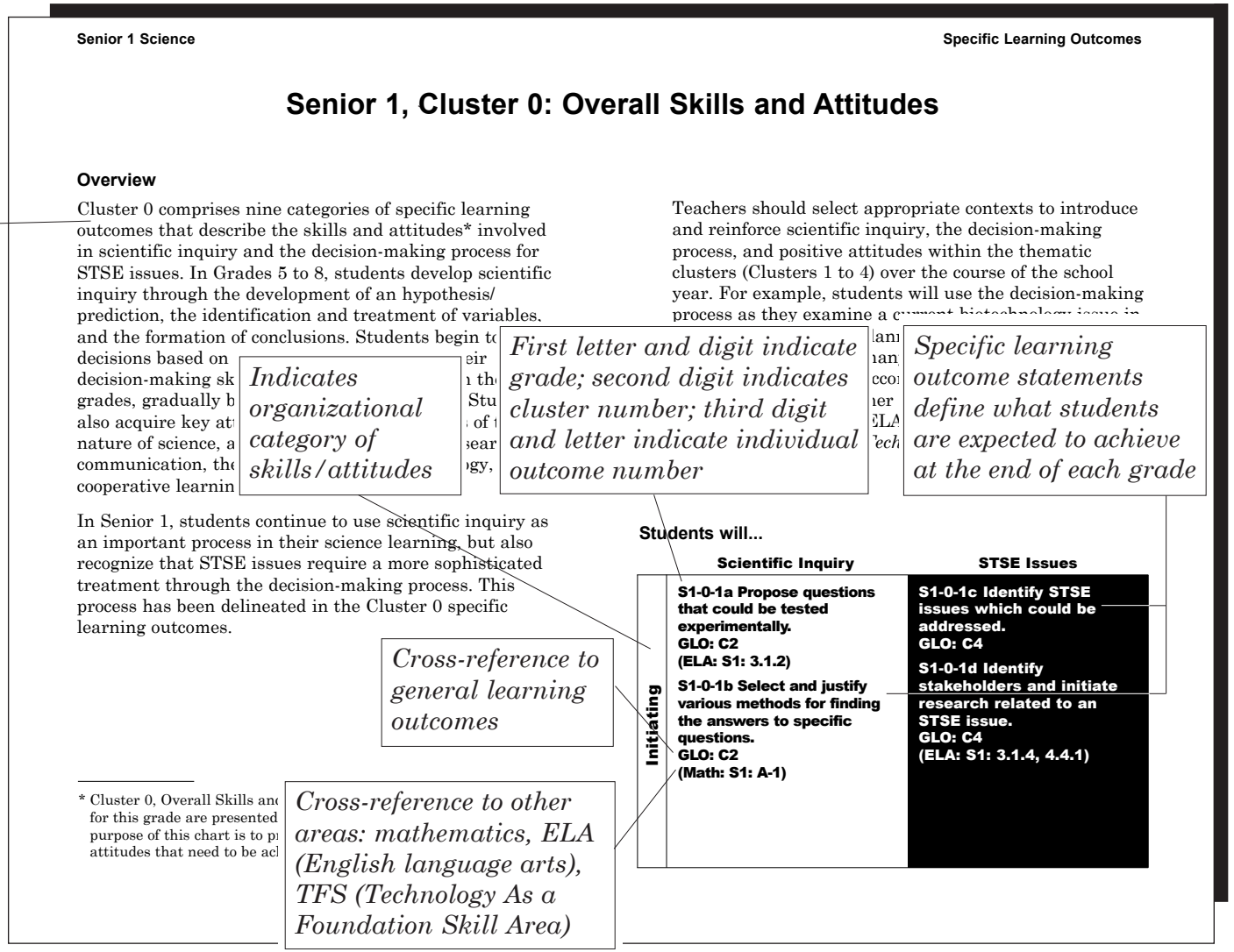


Grades / Clusters	Grade 5	Grade 6	Grade 7	Grade 8	Senior 1
Cluster 0	Overall Skills and Attitudes (to be integrated into Clusters 1 to 4)				
Cluster 1	Maintaining a Healthy Body	Diversity of Living Things	Interactions Within Ecosystems	Cells and Systems	Reproduction
Cluster 2	Properties of and Changes in Substances	Flight	Particle Theory of Matter	Optics	Atoms and Elements
Cluster 3	Forces and Simple Machines	Electricity	Forces and Structures	Fluids	Nature of Electricity
Cluster 4	Weather	Exploring the Solar System	Earth's Crust	Water Systems	Exploring the Universe

Figure 7: Cluster Titles for Grades 5 to Senior 1 Science

Guide to Reading Science Specific Learning Outcomes

Each cluster is presented on two facing pages. The following pages provide examples of the Cluster 0 format and the Clusters 1 to 4 format.



Senior 1 Science Specific Learning Outcomes

Senior 1, Cluster 0: Overall Skills and Attitudes

Overview

Cluster 0 comprises nine categories of specific learning outcomes that describe the skills and attitudes* involved in scientific inquiry and the decision-making process for STSE issues. In Grades 5 to 8, students develop scientific inquiry through the development of an hypothesis/prediction, the identification and treatment of variables, and the formation of conclusions. Students begin t… decisions based on … decision-making sk… grades, gradually b… also acquire key at… nature of science, a… communication, th… cooperative learnin…

In Senior 1, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process. This process has been delineated in the Cluster 0 specific learning outcomes.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the thematic clusters (Clusters 1 to 4) over the course of the school year. For example, students will use the decision-making process as they examine a …

Students will...

	Scientific Inquiry	STSE Issues
Initiating	S1-0-1a Propose questions that could be tested experimentally. GLO: C2 (ELA: S1: 3.1.2)	S1-0-1c Identify STSE issues which could be addressed. GLO: C4
	S1-0-1b Select and justify various methods for finding the answers to specific questions. GLO: C2 (Math: S1: A-1)	S1-0-1d Identify stakeholders and initiate research related to an STSE issue. GLO: C4 (ELA: S1: 3.1.4, 4.4.1)

* Cluster 0, Overall Skills an… for this grade are presented … purpose of this chart is to p… attitudes that need to be acl…

Describes general content and emphasis of cluster

Indicates organizational category of skills/attitudes

First letter and digit indicate grade; second digit indicates cluster number; third digit and letter indicate individual outcome number

Specific learning outcome statements define what students are expected to achieve at the end of each grade

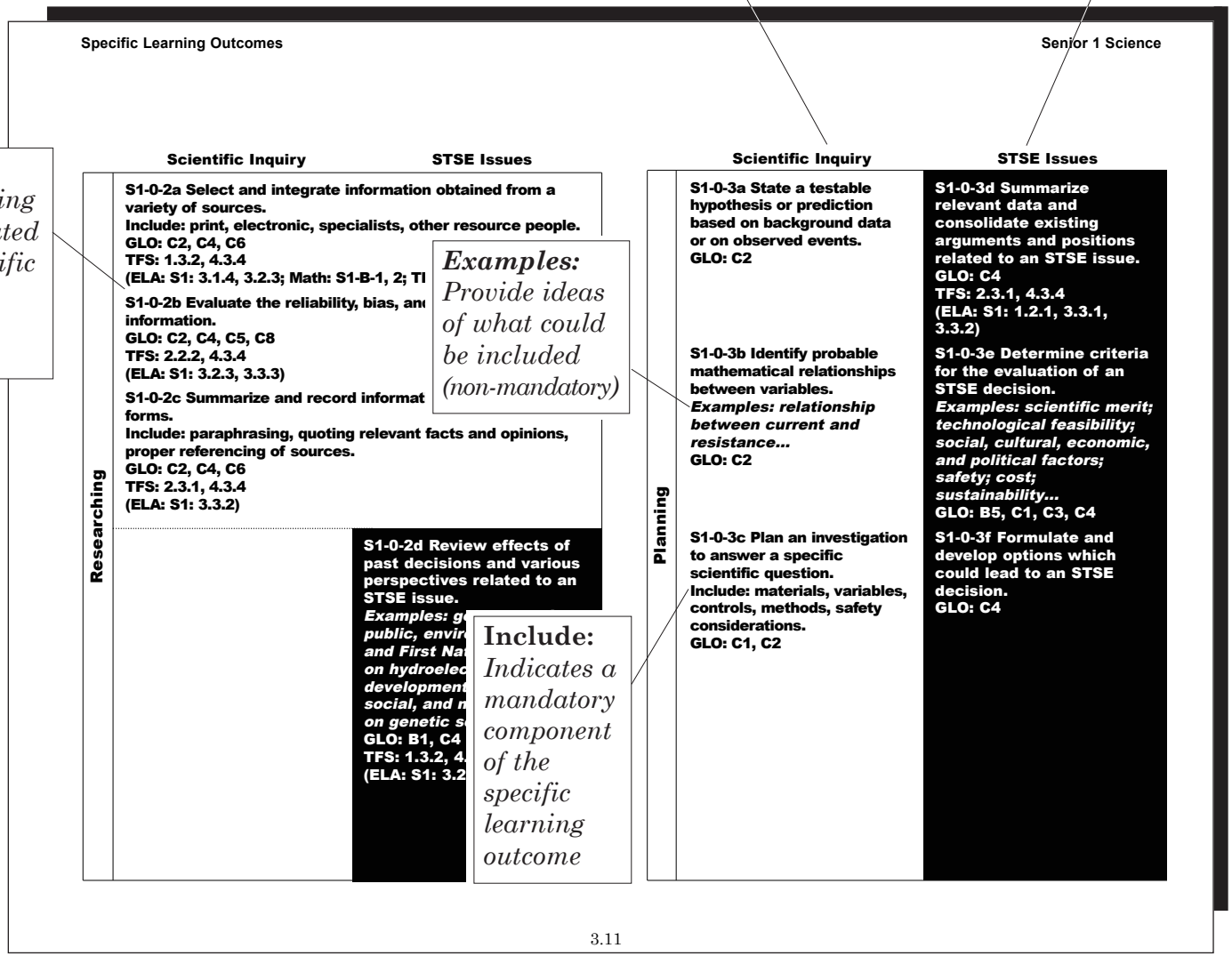
Cross-reference to general learning outcomes

Cross-reference to other areas: mathematics, ELA (English language arts), TFS (Technology As a Foundation Skill Area)

Indicates specific learning outcomes related to scientific inquiry

Indicates specific learning outcomes related to STSE issues

Indicates specific learning outcomes related to both scientific inquiry and STSE issues



Specific learning outcome statements define what students are expected to achieve at the end of each grade

Describes general content and emphasis of cluster

Senior 1, Cluster 1: Reproduction

Overview

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students compare sexual and asexual methods of reproduction in this cluster. They learn how the human reproductive system functions and describe the major stages of human development from conception to birth. Students recognize that the nucleus of a cell contains genetic information and is responsible for the transmission of traits from one generation to the next. They also discuss factors that may change a cell's genetic information, including environmental factors. Using the knowledge they have gained, students also address a current biotechnology issue.

First letter and digit indicate grade; second digit indicates cluster number; third digit and letter indicate individual outcome number

Students

S1-1-01 Illustrate and explain the process of mitotic cell division in plants and animals.

Include: chromos on, cell cycle.

GLO: D1, E1, E2

Cross-reference to general learning outcomes

S1-1-02 Observe and expl division.

GLO: C2, D1, E3

S1-1-03 Describe various types of asexual reproduction that occur in plant and animal species.

Examples: fission, budding, sporulation, vegetative propagation, regeneration...

GLO: D1, E1

S1-1-04 Investigate and describe agricultural applications of asexual reproduction.

Examples: cloning, cuttings, grafting, bulbs...

GLO: A5, B1, B2, D1

S1-1-05 Illustrate and explain the production of male and female gametes by meiosis.

GLO: D1, E1, E2

S1-1-06 Compare and contrast the function of mitosis to that of meiosis.

Include: diploid cells, haploid cells.

GLO: D1, E1

S1-1-07 Compare sexual and asexual reproduction in terms of their advantages and disadvantages for plant and animal species.

GLO: D1, E1

S1-1-08 Investigate and explain adaptations of plant and animal species which enhance reproductive success.

Examples: appearance, behaviour, number of gametes or offspring, chemical cues...

GLO: D2, E1, E2

3.16

S1-1-09 Describe the structure and function of the male and female human reproductive systems.
Include: role of hormones.
GLO: D1, E1, E2

S1-1-10 Outline human development from conception through birth.
Include: X and Y chromosomes, zygote, embryo, fetus.
GLO: D1, E1, E2, E3

S1-1-11 Observe, collect, and analyze class data of single trait inheritance.
Examples: hand clasping, earlobe attachment, tongue rolling...
GLO: C2, D1

S1-1-12 Differentiate between dominant and recessive genes.
Include: genotype, phenotype.
GLO: D1, E1, E2

S1-1-13 Describe the relationships among DNA, chromosomes, genes, and the expression of traits.
Include: genetic similarity among all humans.
GLO: A2, D1, E1, E2

S1-1-14 Explain the inheritance of sex-linked traits in humans and use a pedigree to track the inheritance of a single trait.
Examples: colour blindness, hemophilia...
GLO: D1, E1, E2

S1-1-15 Investigate and describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development.
Examples: fetal exposure to alcohol, overexposure to sunlight, toxins, hormone mimics, food additives, radiation...
GLO: B1, B3, D1, D2

S1-1-16 Investigate Canadian and international contributions to research and technological development in the field of genetics and reproduction.
Example: Human Genome Project...
GLO: A3, A4, B1, B2

S1-1-17 Discuss current and potential applications and implications of biotechnologies including their effects upon personal and public decision making.
Include: genetic engineering, genetic screening, cloning, DNA fingerprinting.
GLO: B1, B2, C4, C8

S1-1-18 Use the decision-making process to address a current biotechnology issue.
GLO: C4, C6, C7, C8

Examples: *Provides ideas of what could be included (non-mandatory)*

Include: *Indicates a mandatory component of the specific learning outcome*

Notes

Senior 1, Cluster 0: Overall Skills and Attitudes

Overview

Cluster 0 comprises nine categories of specific learning outcomes that describe the skills and attitudes* involved in scientific inquiry and the decision-making process for STSE issues. In Grades 5 to 8, students develop scientific inquiry through the development of an hypothesis/ prediction, the identification and treatment of variables, and the formation of conclusions. Students begin to make decisions based on scientific facts and refine their decision-making skills as they progress through the grades, gradually becoming more independent. Students also acquire key attitudes, an initial awareness of the nature of science, and other skills related to research, communication, the use of information technology, and cooperative learning.

In Senior 1, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process. This process has been delineated in the Cluster 0 specific learning outcomes.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the thematic clusters (Clusters 1 to 4) over the course of the school year. For example, students will use the decision-making process as they examine a current biotechnology issue in Cluster 1. To assist in planning and to facilitate curricular integration, many specific learning outcomes within this cluster are accompanied by links to specific learning outcomes in other subject areas, specifically English language arts (ELA) and mathematics (Math). There are also links to *Technology As a Foundation Skill Area* (TFS).

Students will...

	Scientific Inquiry	STSE Issues
Initiating	**S1-0-1a Propose questions that could be tested experimentally.** **GLO: C2** **(ELA: S1: 3.1.2)** **S1-0-1b Select and justify various methods for finding the answers to specific questions.** **GLO: C2** **(Math: S1: A-1)**	**S1-0-1c Identify STSE issues which could be addressed.** **GLO: C4** **S1-0-1d Identify stakeholders and initiate research related to an STSE issue.** **GLO: C4** **(ELA: S1: 3.1.4, 4.4.1)**

* Cluster 0, Overall Skills and Attitudes, specific learning outcomes for this grade are presented as a chart (separate attachment). The purpose of this chart is to provide a full grade overview of skills and attitudes that need to be achieved.

	Scientific Inquiry	STSE Issues
Researching	**S1-0-2a Select and integrate information obtained from a variety of sources.** **Include: print, electronic, specialists, other resource people.** **GLO: C2, C4, C6** **TFS: 1.3.2, 4.3.4** **(ELA: S1: 3.1.4, 3.2.3; Math: S1-B-1, 2; TFS 2.2.1)** **S1-0-2b Evaluate the reliability, bias, and usefulness of information.** **GLO: C2, C4, C5, C8** **TFS: 2.2.2, 4.3.4** **(ELA: S1: 3.2.3, 3.3.3)** **S1-0-2c Summarize and record information in a variety of forms.** **Include: paraphrasing, quoting relevant facts and opinions, proper referencing of sources.** **GLO: C2, C4, C6** **TFS: 2.3.1, 4.3.4** **(ELA: S1: 3.3.2)**	
		S1-0-2d Review effects of past decisions and various perspectives related to an STSE issue. ***Examples: government's, public, environmentalists', and First Nations' positions on hydroelectric development; religious, social, and medical views on genetic screening...*** **GLO: B1, C4** **TFS: 1.3.2, 4.3.4** **(ELA: S1: 3.2.2)**

	Scientific Inquiry	STSE Issues
Planning	**S1-0-3a State a testable hypothesis or prediction based on background data or on observed events.** **GLO: C2**	**S1-0-3d Summarize relevant data and consolidate existing arguments and positions related to an STSE issue.** **GLO: C4** **TFS: 2.3.1, 4.3.4** **(ELA: S1: 1.2.1, 3.3.1, 3.3.2)**
	S1-0-3b Identify probable mathematical relationships between variables. ***Examples: relationship between current and resistance...*** **GLO: C2**	**S1-0-3e Determine criteria for the evaluation of an STSE decision.** ***Examples: scientific merit; technological feasibility; social, cultural, economic, and political factors; safety; cost; sustainability...*** **GLO: B5, C1, C3, C4**
	S1-0-3c Plan an investigation to answer a specific scientific question. **Include: materials, variables, controls, methods, safety considerations.** **GLO: C1, C2**	**S1-0-3f Formulate and develop options which could lead to an STSE decision.** **GLO: C4**

	Scientific Inquiry	STSE Issues
Implementing a Plan	**S1-0-4a Carry out procedures that comprise a fair test.** **Include: controlling variables, repeating experiments to increase accuracy and reliability of results.** **GLO: C1, C2** **TFS: 1.3.1** **S1-0-4b Demonstrate work habits that ensure personal safety, the safety of others, as well as consideration for the environment.** **Include: knowledge and use of relevant safety precautions, WHMIS regulations, emergency equipment.** **GLO: B3, B5, C1, C2** **S1-0-4c Interpret relevant WHMIS regulations.** **Include: symbols, labels, Material Safety Data Sheets (MSDS).** **GLO: C1, C2**	**S1-0-4d Use various methods for anticipating the impacts of different options.** ***Examples: test run, partial implementation, simulation, debate...*** **GLO: C4, C5, C6, C7**
	S1-0-4e Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. **GLO: C2, C4, C7** **(ELA: S1: 3.1.3, 5.2.2)** **S1-0-4f Assume the responsiblities of various roles within a group and evaluate which roles are most appropriate for given tasks.** **GLO: C2, C4, C7** **(ELA: S1: 5.2.2)**	

	Scientific Inquiry	STSE Issues
Observing, Measuring, Recording	**S1-0-5a Select and use appropriate methods and tools for collecting data or information.** **GLO: C2** **TFS: 1.3.1** **S1-0-5b Estimate and measure accurately using Système International (SI) and other standard units.** **Include: SI conversions.** **GLO: C2** **S1-0-5c Record, organize, and display data using an appropriate format.** **Include: labelled diagrams, graphs, multimedia.** **GLO: C2, C5** **TFS: 1.3.1, 3.2.2** **(ELA: S1: 4.1.1, 4.1.2)**	**S1-0-5d Evaluate, using pre-determined criteria, different STSE options leading to a possible decision.** **Include: scientific merit; technological feasibility; social, cultural, economic, and political factors; safety; cost; sustainability.** **GLO: B5, C1, C3, C4** **TFS: 1.3.2, 3.2.3** **(ELA: S1: 3.3.3)**

	Scientific Inquiry	STSE Issues
Analyzing and Interpreting	**S1-0-6a Interpret patterns and trends in data, and infer and explain relationships.** **GLO: C2, C5** **TFS: 1.3.1, 3.3.1** **(ELA: S1: 3.3.1)** **S1-0-6b Identify and suggest explanations for discrepancies in data.** ***Examples: sources of error...*** **GLO: C2** **(ELA: S1: 3.3.3)** **S1-0-6c Evaluate the original plan for an investigation and suggest improvements.** ***Examples: identify strengths and weaknesses of data collection methods used...*** **GLO: C2, C5**	**S1-0-6d Adjust STSE options as required once their potential effects become evident.** **GLO: C3, C4, C5, C8**

	Scientific Inquiry	STSE Issues
Concluding and Applying	**S1-0-7a Draw a conclusion that explains the results of an investigation.** **Include: cause and effect relationships, alternative explanations, supporting or rejecting the hypothesis or prediction.** **GLO: C2, C5, C8** **(ELA: S1: 3.3.4)**	**S1-0-7b Select the best option and determine a course of action to implement an STSE decision.** **GLO: B5, C4** **S1-0-7c Implement an STSE decision and evaluate its effects.** **GLO: B5, C4, C5, C8** **S1-0-7d Reflect on the process used to arrive at or to implement an STSE decision, and suggest improvements.** **GLO: C4, C5** **(ELA: S1: 5.2.4)**
	S1-0-7e Reflect on prior knowledge and experiences to develop new understanding. **GLO: C2, C3, C4** **(ELA: S1: 4.2.1)**	

	Scientific Inquiry	STSE Issues
Reflecting on Science and Technology	**S1-0-8a Distinguish between science and technology.** **Include: purpose, procedures, products.** **GLO: A3** **S1-0-8b Explain the importance of using precise language in science and technology.** **GLO: A2, A3, C2, C3** **(ELA: S1: 4.4.2)** **S1-0-8c Describe examples of how scientific knowledge has evolved in light of new evidence, and the role of technology in this evolution.** **GLO: A2, A5** **S1-0-8d Describe examples of how technologies have evolved in response to changing needs and scientific advances.** **GLO: A5** **S1-0-8e Discuss how peoples of various cultures have contributed to the development of science and technology.** **GLO: A4, A5** **S1-0-8f Relate personal activities and possible career choices to specific science disciplines.** **GLO: B4** **S1-0-8g Discuss social and environmental effects of past scientific and technological endeavours.** **Include: major shifts in scientific world views, unintended consequences.** **GLO: B1**	

	Scientific Inquiry	STSE Issues
Demonstrating Scientific and Technological Attitudes and Habits of Mind	**S1-0-9a Appreciate and respect that science and technology have evolved from different views held by women and men from a variety of societies and cultural backgrounds.** **GLO: A4** **S1-0-9b Express interest in a broad scope of science- and technology-related fields and issues.** **GLO: B4** **S1-0-9c Demonstrate confidence in their ability to carry out investigations in science and to address STSE issues.** **GLO: C2, C4, C5** **S1-0-9d Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.** **GLO: C2, C3, C4, C5** **S1-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.** **GLO: B5, C4** **S1-0-9f Demonstrate personal involvement and be proactive with respect to STSE issues.** **GLO: B5, C4**	

Notes

Senior 1, Cluster 1: Reproduction

Overview

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students compare sexual and asexual methods of reproduction in this cluster. They learn how the human reproductive system functions and describe the major stages of human development from conception to birth. Students recognize that the nucleus of a cell contains genetic information and is responsible for the transmission of traits from one generation to the next. They also discuss factors that may change a cell's genetic information, including environmental factors. Using the knowledge they have gained, students also address a current biotechnology issue.

Students will…

S1-1-01 Illustrate and explain the process of mitotic cell division in plants and animals.

Include: chromosomes, mitosis, cytoplasmic division, cell cycle.

GLO: D1, E1, E2

S1-1-02 Observe and explain the dynamic nature of cell division.

GLO: C2, D1, E3

S1-1-03 Describe various types of asexual reproduction that occur in plant and animal species.

Examples: fission, budding, sporulation, vegetative propagation, regeneration...

GLO: D1, E1

S1-1-04 Investigate and describe agricultural applications of asexual reproduction.

Examples: cloning, cuttings, grafting, bulbs...

GLO: A5, B1, B2, D1

S1-1-05 Illustrate and explain the production of male and female gametes by meiosis.

GLO: D1, E1, E2

S1-1-06 Compare and contrast the function of mitosis to that of meiosis.

Include: diploid cells, haploid cells.

GLO: D1, E1

S1-1-07 Compare sexual and asexual reproduction in terms of their advantages and disadvantages for plant and animal species.

GLO: D1, E1

S1-1-08 Investigate and explain adaptations of plant and animal species which enhance reproductive success.

Examples: appearance, behaviour, number of gametes or offspring, chemical cues...

GLO: D2, E1, E2

S1-1-09 Describe the structure and function of the male and female human reproductive systems.

Include: role of hormones.

GLO: D1, E1, E2

S1-1-10 Outline human development from conception through birth.

Include: X and Y chromosomes, zygote, embryo, fetus.

GLO: D1, E1, E2, E3

S1-1-11 Observe, collect, and analyze class data of single trait inheritance.

Examples: hand clasping, earlobe attachment, tongue rolling...

GLO: C2, D1

S1-1-12 Differentiate between dominant and recessive genes.

Include: genotype, phenotype.

GLO: D1, E1, E2

S1-1-13 Describe the relationships among DNA, chromosomes, genes, and the expression of traits.

Include: genetic similarity among all humans.

GLO: A2, D1, E1, E2

S1-1-14 Explain the inheritance of sex-linked traits in humans and use a pedigree to track the inheritance of a single trait.

Examples: colour blindness, hemophilia...

GLO: D1, E1, E2

S1-1-15 Investigate and describe environmental factors and personal choices that may lead to a genetic mutation or changes in an organism's development.

Examples: fetal exposure to alcohol, overexposure to sunlight, toxins, hormone mimics, food additives, radiation...

GLO: B1, B3, D1, D2

S1-1-16 Investigate Canadian and international contributions to research and technological development in the field of genetics and reproduction.

Example: Human Genome Project...

GLO: A3, A4, B1, B2

S1-1-17 Discuss current and potential applications and implications of biotechnologies including their effects upon personal and public decision making.

Include: genetic engineering, genetic screening, cloning, DNA fingerprinting.

GLO: B1, B2, C4, C8

S1-1-18 Use the decision-making process to address a current biotechnology issue.

GLO: C4, C6, C7, C8

Senior 1, Cluster 2: Atoms and Elements

Overview

This cluster builds on the particle theory of matter learned in previous grades. Students become familiar with the basic constituents of matter by learning about the historical development of the atomic model and the periodic table. Various investigations of the properties of elements and compounds will acquaint students with chemical symbols and families, as well as with natural phenomena and everyday technologies that demonstrate chemical change.

Students will…

S1-2-01 Describe how historical ideas and models furthered our understanding of the nature of matter.

Include: Greek ideas, alchemy, Lavoisier.

GLO: A1, A2, A4

S1-2-02 Investigate the historical progression of the atomic model.

Include: Dalton, Thompson, Rutherford, Bohr, quantum model.

GLO: A1, A2, A4, D3

S1-2-03 Define element and identify symbols of some common elements.

Include: the first 18 elements and K, Ca, Fe, Ni, Cu, Zn, I, Ag, Sn, Au, W, Hg, Pb, U.

GLO: C2, D3

S1-2-04 Explain the atomic structure of an atom in terms of the number of protons, electrons, and neutrons and explain how these numbers define atomic number and atomic mass.

GLO: D3, E2

S1-2-05 Assemble or draw Bohr atomic models for the first 18 elements and group them according to the number of outer shell electrons.

GLO: A2, C2, D3

S1-2-06 Investigate the development of the periodic table as a method of organizing elements.

Include: periods, families (groups).

GLO: A2, A4, B2, E1

S1-2-07 Investigate the characteristic properties of metals, non-metals, and metalloids and classify elements according to these properties.

Examples: ductility, conductivity of heat and electricity, lustre, reactivity...

GLO: D3, E1

S1-2-08 Relate the reactivity and stability of different families of elements to their atomic structure.

Include: alkali metals, alkaline earths, chalcogens, halogens, noble gases.

GLO: D3, D4, E1, E3

S1-2-09 Compare elements to compounds.

Include: atoms, molecules.

GLO: D3, E1, E2

S1-2-10 Interpret chemical formulas of elements and compounds in terms of the number of atoms of each element.

Examples: He, H_2, O_2, H_2O, CO_2, NH_3...

GLO: C2, D3

S1-2-11 Investigate properties of substances and explain the importance of knowing these properties.

Examples: usefulness, durability, safety...

GLO: A5, B2, D3, E1

S1-2-12 Differentiate between physical and chemical changes.

GLO: D3, E1, E3

S1-2-13 Experiment to determine indicators of chemical change.

Examples: colour change, production of heat and/or light, production of a gas or precipitate or new substance...

GLO: C2, D3, E3

S1-2-14 Investigate technologies and natural phenomena that demonstrate chemical change in everyday situations.

Examples: photography, rusting, photosynthesis, combustion, baking...

GLO: A3, A5, B1, B2

Senior 1, Cluster 3: Nature of Electricity

Overview

The conceptual development of the particle model of electricity underlies an understanding of electrostatics and current electricity. To develop and test this model, students construct simple devices like an electrophorous and investigate electrostatic phenomena. A transition from static to current electricity enables the learner to investigate circuits and make connections to daily applications like the cost of electrical energy and the safety and efficiency of electrical appliances. Additionally, students investigate hydroelectric power and address sustainability issues associated with the generation and transmission of electricity in Manitoba.

Students will…

S1-3-01 Demonstrate evidence for the existence of two types of charge.

GLO: A1, C2, C5

S1-3-02 Discuss early models of electricity to support the premise that models in science change.

Include: one-fluid model, two-fluid model, particle model.

GLO: A1, A2, A5, C8

S1-3-03 Explain how a discrepant event can be used to evaluate the particle model of electricity.

Include: the attraction of neutral objects to charged objects.

GLO: A1, A2, A3, C8

S1-3-04 Relate the particle model of electricity to atomic structure.

GLO: A1, A2, D3

S1-3-05 Investigate and explain electrostatic phenomena using the particle model of electricity.

Include: conservation of charge, conduction, grounding, attraction of a neutral insulator, induction.

GLO: A2, D3, D4, E4

S1-3-06 Investigate common electrostatic technologies and phenomena and describe measures which reduce dangers associated with electrostatics.

Examples: photocopying, static straps to reduce charge buildup, lightning, electrostatic spray-painting, electrostatic precipitator...

GLO: A5, B1, C1, D4

S1-3-07 Construct one or more electrostatic apparatus and explain how they function using the particle model of electricity.

Include: pie-plate electrophorus.

GLO: A2, C3, D3, D4

S1-3-08 Demonstrate and explain the like nature of electrostatics and current electricity.

Include: discharge an electrophorus through a neon bulb.

GLO: C3, D4, E4

S1-3-09 Define electric current as charge per unit time and solve related problems.

Include: $I = \frac{Q}{t}$.

GLO: C2, C3, D4

S1-3-10 Define voltage (electric potential difference) as the energy per unit charge between two points along a conductor and solve related problems.

Include: $V = \frac{E}{Q}$.

GLO: C2, C3, D4

S1-3-11 Identify the five sources of electrical energy and some associated technologies.

Include: chemical, photo, thermo, electromagnetic, piezo.

GLO: B1, D4, E4

S1-3-12 Describe resistance in terms of the particle model of electricity.

GLO: A2, D3, E2

S1-3-13 Construct electric circuits using schematic diagrams.

Include: series, parallel.

GLO: C3, D4, E4

S1-3-14 Use appropriate instruments and units to measure voltage (electric potential difference), current, and resistance.

GLO: C2, C3, D4

S1-3-15 Compare and contrast voltage (electric potential difference) and current in series and parallel circuits.

Include: cells, resistance.

GLO: C3, D4

S1-3-16 Investigate and describe qualitatively the relationship among current, voltage (electric potential difference), and resistance in a simple electric circuit.

GLO: C2, D4, E4

S1-3-17 Relate the energy dissipated in a circuit to the resistance, current, and brightness of bulbs.

GLO: D4

Senior 1, Cluster 3: Nature of Electricity (continued)

S1-3-18 Explain the parallel circuits, the components, and the safety aspects of household wiring.

Include: switches, fuses, circuit breakers, outlets.

GLO: A5, B1, B2, C1

S1-3-19 Explain safety considerations of some common household electrical appliances.

Examples: kettle, heater, toaster...

GLO: A5, B1, C1, D4

S1-3-20 Define electrical power as energy per unit time, and solve related problems.

Include: $P = \frac{E}{t}$.

GLO: C2, C3, D4

S1-3-21 Develop a formula for domestic power consumption costs, and solve related problems.

Include: $\text{Cost} = \frac{\text{Power x time x unit price}}{\text{kWh}}$.

GLO: B2, C2, C3, D4

S1-3-22 Analyze the electrical energy consumption of a household appliance.

Include: calculate consumption using Energuide labels, read hydro meter, interpret monthly hydro bill.

GLO: B5, C4, C5, C8

S1-3-23 Recognize and explain the importance of incorporating principles of electrical energy conservation into the decision-making process.

GLO: B2, B5, C4, C8

S1-3-24 Use the decision-making process to address an issue associated with the generation and transmission of electricity in Manitoba.

Include: hydroelectric power, sustainability.

GLO: B2, B5, C4, C8

Notes

Senior 1, Cluster 4: Exploring the Universe

Overview

This cluster leads students through an exploration of the universe starting with some basic hands-on astronomy and ending with a critical look at issues surrounding space science and technology. Students observe and locate visible celestial objects. This knowledge provides them with an appreciation for the relevance of astronomy to various peoples. Students develop an understanding of the origin, evolution, and components of the universe. They concurrently research and study Canada's involvement in international space exploration and evaluate the impact of space science and technologies in terms of their benefits and risks to the human race.

Students will…

S1-4-01 Use a coordinate system to locate visible celestial objects, and construct an astrolabe to determine the position of these objects.

Include: altitude, azimuth.

GLO: C2, C3, D6

S1-4-02 Observe the motion of visible celestial objects and organize collected data.

Examples: graph sunrise and sunset data, track the position of the Moon and planets over time, maintain a log of changes in the night sky...

GLO: C2, C5, C6, D6

S1-4-03 Investigate how various cultures used knowledge of the position and motion of visible celestial objects for navigation.

GLO: A4, B1, B2, D6

S1-4-04 Compare and contrast historical perspectives on the relationship between Earth and space.

Include: geocentric model, heliocentric model.

GLO: A2, A4, B2, E2

S1-4-05 Explain the apparent motion of the Sun, stars, planets, and the Moon as seen from Earth.

Include: daily rising and setting, seasonal constellations, retrograde motion.

GLO: D4, D6, E2

S1-4-06 Differentiate between units of measure used for astronomical distances, and perform simple calculations using these units.

Include: astronomical unit, light year.

GLO: C2, D6

S1-4-07 Compare and contrast scientific and cultural perspectives on the origin and evolution of the universe.

GLO: A1, A2, A4, D6

S1-4-08 Differentiate between the major components of the universe.

Include: planets, moons, comets and asteroids, nebulae, stars, galaxies, black holes.

GLO: D6, E1, E2

S1-4-09 Explain how various technologies have extended our ability to explore and understand space.

Examples: robotics, Canadarm, Hubble telescope, Lunar Rover, shuttle, space station, Sojourner Rover, Pathfinder and Galileo space probes...

GLO: A5, B1, B2, D6

S1-4-10 Investigate ways in which Canada participates in space research and in international space programs, and then use the decision-making process to address a related issue.

Examples: International Space Station, Canadarm...

GLO: A3, A4, B2, C4

S1-4-11 Evaluate the impact of space science and technologies in terms of their benefits and risks to humans.

Examples: search for extraterrestrial life and habitat, remote sensing, predictions of potentially catastrophic impacts, colonization of space by only a few countries...

GLO: A3, B1, B2, B5

Appendix

General Learning Outcomes

The purpose of Manitoba science curricula is to impart to students a measure of scientific literacy that will assist them in becoming informed, productive, and fulfilled members of society. As a result of their Early, Middle, and Senior Years science education, Manitoba students will be able to:

Nature of Science and Technology

A1. recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena

A2. recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop

A3. distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values

A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations

A5. recognize that science and technology interact with and advance one another

Science, Technology, Society, and the Environment (STSE)

B1. describe scientific and technological developments, past and present, and appreciate their impact on individuals, societies, and the environment, both locally and globally

B2. recognize that scientific and technological endeavours have been and continue to be influenced by human needs and the societal context of the time

B3. identify the factors that affect health and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social

B4. demonstrate a knowledge of, and personal consideration for, a range of possible science- and technology-related interests, hobbies, and careers

B5. identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally

Scientific and Technological Skills and Attitudes

C1. recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations

C2. demonstrate appropriate scientific inquiry skills when seeking answers to questions

C3. demonstrate appropriate problem-solving skills while seeking solutions to technological challenges

C4. demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information

C5. demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind

C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data

C7. work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities

C8. evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life

Essential Science Knowledge

D1. understand essential life structures and processes pertaining to a wide variety of organisms, including humans

D2. understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole

D3. understand the properties and structures of matter as well as various common manifestations and applications of the actions and interactions of matter

D4. understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts

D5. understand the composition of the Earth's atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them

D6. understand the composition of the universe, the interactions within it, and the impacts of humankind's continued attempts to understand and explore it

Unifying Concepts

E1. describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world

E2. describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems

E3. recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved

E4. recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them

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