Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* and in *Kindergarten Science Curriculum Guide* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the science framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Rationale

The aim of science education in the Atlantic provinces is to develop scientific literacy. Scientific literacy is an evolving combination of 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 opportunity to explore, analyse, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their futures.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science.
- designing effective learning experiences that help students achieve designated outcomes.
- stimulating and managing classroom discourse in support of student learning.
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching.
- analysing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions.
- selecting teaching strategies from a wide repertoire.

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment which reflects a constructive, active view of the learning process. Learning occurs not by passive absorption, but as students actively construct their own meaning and assimilate new information to develop new understandings.

The development of scientific literacy in students is a function of the kinds of tasks they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum and instruction.

Learning experiences in science education should vary and include opportunities for group and individual work, discussion among students, as well as between teacher and students, and hands-on/minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations, and the evaluation of the evidence accumulated, provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

The Three Processes of Scientific Literacy

Individuals can be considered scientifically literate when they are familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific 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, analysing data, and interpreting data are fundamental to engaging in science. These activities provide students opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of the proposing, creating, and testing of prototypes, products, and techniques in an attempt to reach an optimum solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are not only important in their own right; they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equal opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of and make adaptations to accommodate the diverse range of learners in their classes. In order to adapt to the needs of all learners, teachers must create opportunities that permit students to have their learning styles addressed.

As well, teachers must not only remain aware of and avoid gender and cultural biases in their teaching, they must strive to actively address cultural and gender stereotyping with respect to student interest and success in science and mathematics. Research supports the position that, when the science curriculum is made personally meaningful, and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science, and, indeed, for all students.

When making instructional decisions, teachers must consider individual learning needs, preferences, and strengths, and the abilities, experiences, interests, and values that learners bring to the classroom. Ideally, every student should find learning opportunities maximized in the science classroom.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and validate students when they achieve the outcomes to the maximum of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equal opportunities to experience success as they work toward the achievement of designated outcomes. A teacher should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

The terms assessment and evaluation are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms for the processes described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information, and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students, now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible, and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

Regional curriculum in science suggests experiences that support learning within STSE (Science, Technology, Society, and the Environment), skills, knowledge, and attitudes. It also reflects the three major processes of science learning: inquiry, problem solving and decision making. When assessing student progress, it is helpful for teachers to know some activities/skills/actions that are associated with each process of science learning. Examples of these are illustrated in the following lists. Student learning may be described in terms of ability to perform these tasks.

Inquiry

- define questions related to a topic
- refine descriptors/factors that focus practical and theoretical research
- select an appropriate way to find information
- make direct observations
- perform experiments, record and interpret data, and draw conclusions
- design an experiment which tests relationships and variables
- write lab reports that meet a variety of needs (limit the production of "formal" reports) and place emphasis on recorded data
- recognize that the quality of both the process and the product are important

Problem Solving

- clearly define a problem
- produce a range of potential solutions for the problem
- appreciate that several solutions should be considered
- plan and design a product or device intended to solve a problem, construct a variety of acceptable prototypes, pilot test, evaluate, and refine to meet a need
- present the refined process/product/device and support why it is "preferred"
- recognize that the quality of both the process and the product are important

Decision Making

- gather information from a variety of sources
- evaluate the validity of the information source
- evaluate which information is relevant
- identify the different perspectives that influence a decision
- present information in a balanced manner
- use information to support a given perspective
- recommend a decision and provide supporting evidence
- communicate a decision and provide a "best" solution

Assessment Techniques

Assessment techniques should match the style of learning and instruction employed. Several options are suggested in this curriculum guide from which teachers may choose depending on the curriculum outcomes, the class and school/district policies. Assessment techniques relevant to kindergarten are provided in the kindergarten curriculum guide. It is important that students know the purpose of an assessment, the method used, and the marking scheme being used. Formative assessment supports learning when the results reported to students indicate the improvements expected.

Observation (formal or informal)

This technique provides a way of gathering information fairly quickly while a lesson is in progress. When used formally the student(s) would be made aware of the observation and the criteria being assessed. Informally, it could be a frequent, but brief, check on a given criterion. Observation may offer information about the participation level of a student for a given task, use of a piece of equipment or application of a given process. The results may be recorded in the form of checklists, rating scales, or brief written notes. It is important to plan in order that specific criteria are identified, suitable recording forms are ready, and that all students are observed in a reasonable period of time.

Performance

This curriculum encourages learning through active participation. Many of the curriculum outcomes found in the guide promote skills and their application. There is a balance between scientific processes and content. In order that students appreciate the importance of skill development, it is important that assessment provide feedback on the various skills. These may be the correct manner in which to use a piece of equipment, an experimental technique, the ability to interpret and follow instructions, or to research, organize and present information. Assessing performance is most often achieved through observing the process.

Journal

Although not assessed in a formal manner, journals provide an opportunity for students to express thoughts and ideas in a reflective way. By recording feelings, perceptions of success, and responses to new concepts, students may be helped to identify their most effective learning style. Knowing how to learn in an effective way is powerful information. Journal entries also give indicators of developing attitudes to science concepts, processes and skills, and how these may be applied in the context of society. Self-assessment, through a journal, permits a student to consider strengths and weaknesses, attitudes, interests and new ideas. Developing patterns may help in career decisions and choices of further study.

Interview

This curriculum promotes understanding and applying scientific concepts. Interviewing a student allows the teacher to confirm that learning has taken place beyond simply factual recall. Discussion allows a student to display an ability to use information and clarify understanding. Interviews may be a brief discussion between teacher and student or they may be more extensive and include student, parent and teacher. Such conferences allow a student to be proactive in displaying understanding. It is helpful for students to know which criteria will be used to assess formal interviews. This assessment technique provides an opportunity to students whose verbal presentation skills are stronger than their written skills.

Presentation

The curriculum includes outcomes that require students to analyse and interpret information, to identify relationships between science, technology, society and environment (STSE), to be able to work in teams, and to communicate information. Although it can be time consuming, these activities are best displayed and assessed through presentations. These can be given orally, in written/pictoral form, by project summary (science fair), or by using electronic systems such as video or computer software. Whatever the level of complexity, or format used, it is important to consider the curriculum outcomes as a guide to assessing the presentation. The outcomes indicate the process, concepts, and context for which and about which a presentation is made.
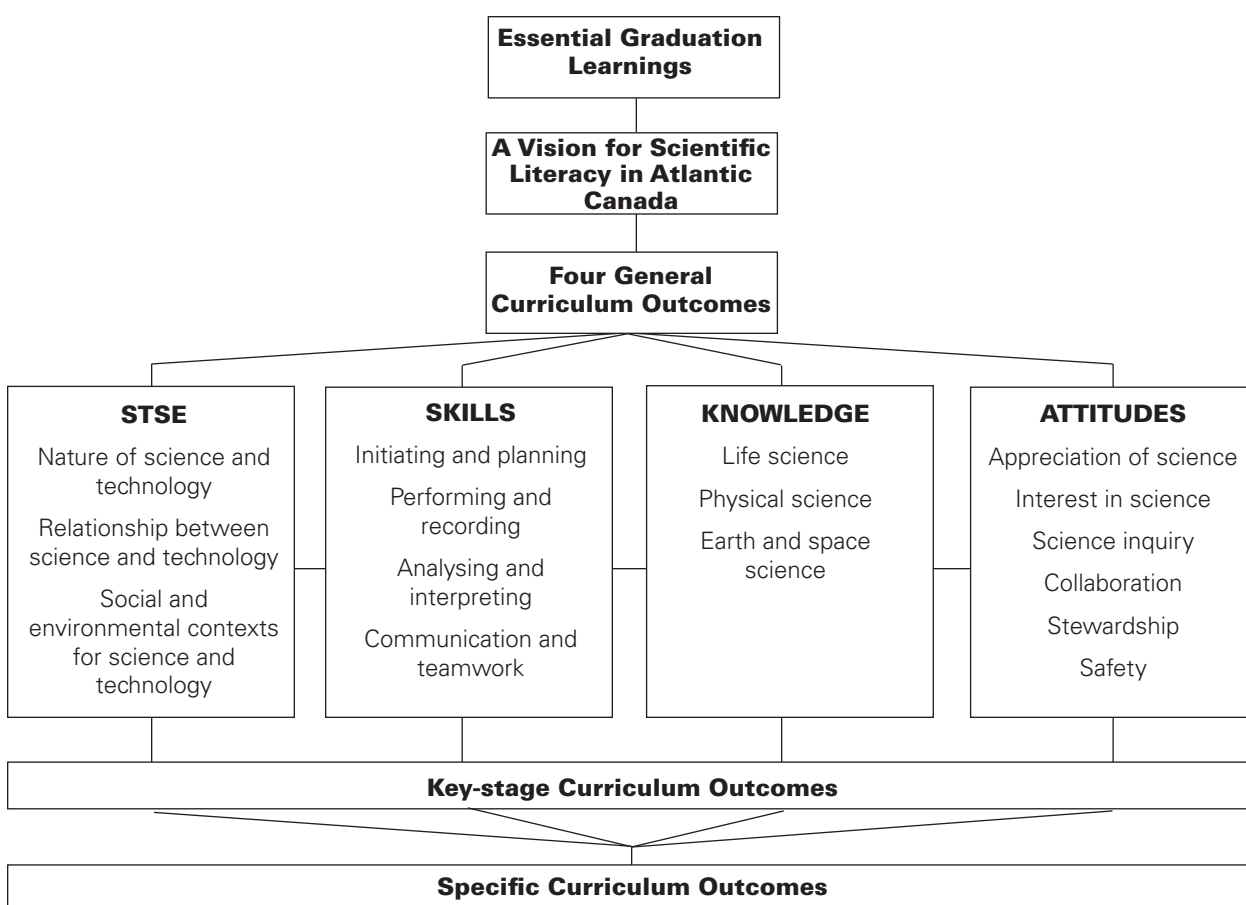
Portfolio

Portfolios offer another option for assessing student progress in meeting curriculum outcomes over a more extended period of time. This form of assessment allows the student to be central to the process. There are decisions about the portfolio, and its contents, which can be made by the student. What is placed in the portfolio, the criteria for selection, how the portfolio is used, how and where it is stored, how it is evaluated, are some of the questions to consider when planning to collect and display student work in this way. The portfolio should provide a long-term record of growth in learning and skills. This record of growth is important for individual reflection and self-assessment, but it is also important to share with others. For all students, but particularly younger students, it is exciting to review a portfolio and see the record of development over time.

Outcomes

Outcomes Framework

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The conceptual map shown in Figure 1 provides the blueprint of the outcomes framework.

FIGURE 1

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            ┌──────────────────────────┐
            │  Essential Graduation    │
            │       Learnings          │
            └──────────────────────────┘
                         │
            ┌──────────────────────────┐
            │  A Vision for Scientific │
            │  Literacy in Atlantic    │
            │         Canada           │
            └──────────────────────────┘
                         │
            ┌──────────────────────────┐
            │     Four General         │
            │  Curriculum Outcomes     │
            └──────────────────────────┘
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STSE	SKILLS	KNOWLEDGE	ATTITUDES
Nature of science and technology	Initiating and planning	Life science	Appreciation of science
Relationship between science and technology	Performing and recording	Physical science	Interest in science
Social and environmental contexts for science and technology	Analysing and interpreting	Earth and space science	Science inquiry
	Communication and teamwork		Collaboration
			Stewardship
			Safety

Key-stage Curriculum Outcomes

Specific Curriculum Outcomes

This curriculum guide outlines course-specific curriculum outcomes, and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult the *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and to be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are:

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) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

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

Problem Solving

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

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.

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.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

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.

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.

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.

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 are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K-12*.

Specific Curriculum Outcomes

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each grade level.

Curriculum Guide Organization

Specific curriculum outcome statements 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. Specific curriculum outcomes represent a reasonable framework for assisting students to achieve the key-stage, and the general curriculum outcomes, and ultimately the essential graduation learnings.

Specific curriculum outcomes are organized in units for each course. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a course appear in the guide is meant to suggest a sequence. In some cases the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit may introduce a concept which is then extended in a subsequent unit. Likewise, it is possible that one unit focusses on a skill or context which will then be built upon later in the year.

It is also possible that units or certain aspects of units can be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. The intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful, and socially and culturally relevant, contexts.

Unit Organization

All units comprise a two-page layout of four columns as illustrated in Figure 2. In some cases the four-column spread continues to the next two-page layout. Each unit comprises outcomes grouped by a topic which is indicated at the top of the left hand page.

Column One: Specific Curriculum Outcomes

The first column lists a group of related specific curriculum outcome statements. These are written in the context of Newfoundland and Labrador Kindergarten Science and based on the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in brackets after the outcome statement. Some STSE and skills outcomes have been written in an age-appropriate context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary in order to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column Two: Suggestions for Learning and Teaching

The second column provides suggestions for the learning environment and experiences that will support students' achievement of the outcomes listed in the first column. Elaborations of the outcomes are included in this column, as well as background information, and related play possibilities.

The suggestions in this column are intended to provide a holistic approach to instruction. In some cases, the suggestions in this column address a single outcome; in other cases, they address a group of outcomes.

Column Three: Suggestions for Assessment

The third column provides suggestions for ways that students' achievement of the outcomes may be assessed. These suggestions reflect a variety of assessment techniques which include, but are not limited to, informal/formal observation, performance, journal, writing and representing, interview, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources

The fourth column identifies sources of materials and ideas, including home activities, which may assist in the learning and teaching of the outcomes. These resources do not address the entire scope of the science curriculum. Since a resource-based learning philosophy is espoused, teachers are encouraged to use other appropriate resources, which will contribute to the achievement of the outcomes.

FIGURE 2
Curriculum Outcomes Organization:
The Four-Column, Two-Page Spread

TOPIC Outcomes	Suggestions for Learning and Teaching	Suggestions for Assessment	Resources
Outcome based on pan-Canadian outcomes, for example, 100-1	Suggested activities and elaborations of outcome	**Informal/Formal Observation**	Authorized and recommended resources that address outcomes
- clarification outcomes	Suggested activities and elaborations of outcome	**Performance** - sample assessment item, for example 100-1	
Outcome based on pan-Canadian outcomes, for example 100-2		**Journal**	
- clarification outcomes - clarification outcomes		**Paper and Pencil**	
		Interview - sample assessment item, for example 100-2	
		Presentation	
		Portfolio	

Unit Overview

At the beginning of each unit, there is a two-page synopsis. On the first page, introductory paragraphs give a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, and/or decision making) and possible contexts for the unit. Finally, a curriculum-links paragraph specifies how this unit relates to science concepts and skills that will be addressed at later grades so teachers will understand how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that will be addressed in the unit. The numbering system used is the one followed in the pan-Canadian document:

100s - Science-Technology-Society-Environment (STSE) outcomes

200s - Skills outcomes

300s - Knowledge outcomes

400s - Attitude outcomes (see pages 17-19)

These code numbers appear in brackets after each specific curriculum outcome (SCO).

Within each unit pan-Canadian outcomes are written in the context of Newfoundland and Labrador's Kindergarten Science curriculum.

FIGURE 3
Unit Overview

Unit Title: Unit Overview		Unit Title: Curriculum Outcomes		
Introduction	Synopsis of the unit	**STSE**	**Skills**	**Knowledge**
Focus and Contexts	Focus: inquiry, decision making, or problem solving. Possible contexts suggested	100-1 Science-Technology-Society-Environment outcomes from *Common Framework of Science Learning Outcomes K to 12*	100-1 Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	100-1 Knowledge outcomes from *Common Framework of Science Learning Outcomes K to 12*
Curriculum Links	Links to concepts studied within the K to 12 science curriculum			

Attitude Outcomes

It is expected that certain attitudes will be fostered and developed throughout the entire science program, entry to grade 12. The STSE, skills, and knowledge outcomes contribute to the development of attitudes and opportunities for fostering these attitudes are highlighted in the *Suggestions for Learning and Teaching* secion of each unit.

Attitudes refer to generalized aspects of behaviour that are modelled for students by example and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. 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.

Since attitudes are not acquired in the same way as skills and knowledge, outcomes statements for attitudes are written for the end of grades 3, 6, 9, and 12. These outcomes statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12.*

Common Framework of Science Learning Outcomes K to 3
Attitude Outcome Statements

From entry through grade 3 it is expected that students will be encouraged to . . .

Appreciation of science

400 recognize the role and contribution of science in their understanding of the world

Evident when students, for example,

- give examples of science in their own lives

- give examples of how objects studied and investigations done in class relate to the outside world

- recognize that scientific ideas help us to explain how or why events occurred

Interest in science

401 show interest in and curiosity about objects and events within the immediate environment

402 willingly observe, question, and explore

Evident when students, for example,

- ask "why" and "how" questions about observable events

- ask many questions related to what is being studied

- participate in show-and-tell activities, bringing objects from home or sharing a story or an observation

- ask questions about what scientists do

- express enjoyment from being read to from science books

- seek out additional information from library books and digital discs

- express enjoyment in sharing science-related information gathered from a variety of sources, including discussions with family members and friends

- ask to use additional science equipment to observe objects in more detail

- express the desire to find answers by exploring and conducting simple experiments

Scientific inquiry

403 consider their observations and their own ideas when drawing a conclusion

404 appreciate the importance of accuracy

405 be open-minded in their explorations

Evident when students, for example,

- raise questions about the world around them

- willingly record observations in a given format

- compare results of an experiment with other classmates

- use observations to draw a conclusion or verify a prediction

- take the time to measure with care

- willingly explore a change and its effects

- choose to follow directions when they complete a simple investigation

- express the desire to find answers by conducting simple experiments

Common Framework of Science Learning Outcomes K to 3
Attitude Outcome Statements

From entry through grade 3 it is expected that students will be encouraged to . . .

Collaboration

406 work with others in exploring and investigating

Evident when students, for example,

- willingly share ideas and materials
- respond positively to others' questions and ideas
- take on and fulfil a variety of roles within the group
- participate in science-related activities with others, regardless of their age or their physical or cultural characteristics
- respond positively to other people's views of the world

Stewardship

407 be sensitive to the needs of other people, other living things, and the local environment

Evident when students, for example,

- ensure that living things are returned to an adequate environment after a study is completed
- demonstrate awareness of the need for recycling and willingness to take action in this regard
- show concern for other students' feelings or needs
- care for living things that are kept in their classroom
- clean reusable materials and store them in a safe place
- willingly suggest how we can protect the environment

Safety

408 show concern for their safety and that of others in carrying out activities and using materials

Evident when students, for example,

- are attentive to the safe use of materials
- insist that classmates use materials safely
- act with caution in touching or smelling unfamiliar materials, refrain from tasting them, and encourage others to be cautious
- point out to others simple and familiar safety symbols
- put materials back where they belong
- follow given directions for set-up, use, and clean-up of materials
- wash hands before and after using materials, as directed by teacher
- seek assistance immediately for any first aid concerns such as cuts, burns, and unusual reactions
- keep the work station uncluttered, with only appropriate materials present