Introduction

Background

The curriculum described *Earth Systems 3209 Curriculum Guide* was planned and developed collaboratively by teacher committees. The outcomes delineated within this document are based on 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 the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences which provide 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.

Earth Systems 3209 will address science-related attitudes, skills, knowledge, and STSE connections and offer students an opportunity to integrate their experiences into a complete understanding of the planet and our relationship to it. This province is rich in geological phenomena. As examples, consider that we are located at the boundary of two ancient tectonic plates, that we have a designated UNESCO World Heritage Site in the province (the Tablelands located in the Gros Morne National Park), and that we have significant exploration and development of our Earth resources (e.g., Voiseys Bay, offshore oil and gas). It is important that students know how these events and others are relevant to them in their day-to-day lives. Furthermore, as students deal with local, regional, and global issues related to the Earth and its resources, it is critical that they develop an understanding of their relationship to the Earth's systems, and appropriate skills and attitudes which will foster a more positive relationship.

Program Design and Components

Learning and Teaching Science

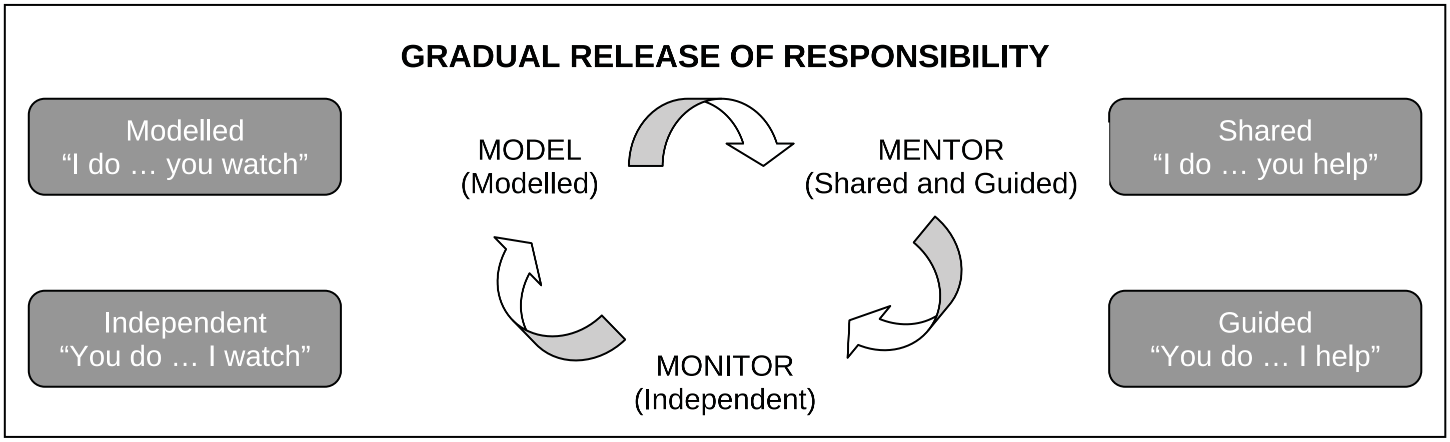
What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- 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
- challenging students to develop strategies to increase scientific literacy

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 rather as students actively construct their own meaning and assimilate new information to develop new understanding.

Teachers must determine when students can work independently and when they require assistance. In an effective science program, teachers choose their instructional activities to model and scaffold inquiry, problem solving and decision making that is just beyond the student's independence level. In the gradual release of responsibility approach, students move from a high level of teacher support to independent practice, as students become more skilled at using the new strategies. If necessary, the teacher increases the level of support when students need further assistance.

The goal is to empower students to make the strategies their own, and to know how, when, and why to apply them when faced with a problem. Guided practice supports student independence. As a student demonstrates success, the teacher gradually decreases his or her support.



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. Consequently, the aim of developing scientific literacy requires careful attention to all of these facets of curriculum. Students' disposition towards science is also shaped by these facets of the curriculum.

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.

Contexts for Teaching and Learning

The science curriculum provides students with opportunities to become scientifically literate citizens who will be contributing members of society. By drawing upon personal experiences students experience the nature of science and develop a sense of wonder about the world around them.

Students learn through purposeful and powerful learning strategies designed around stimulating ideas, concepts, issues, and themes that are meaningful to them. Students learn best when they are aware of the strategies and processes they use to construct meaning and to solve information-related problems.

Learners must have opportunities to communicate their learning through various modes in addition to frequent opportunities to self-assess their learning, strengths, needs and performance. Descriptive feedback from peers, teachers and others at home and in the community provides direction for student learning and achievement.

The development of scientific literacy is the underlying principle of the science curriculum.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he/she is 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.

Considerations for Program Delivery

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.

By using differentiated instruction teachers can work towards meeting the needs of all learners. Ideally, every student should find his/her learning opportunities maximized in the science classroom.

Differentiated Instruction

Differentiated instruction is instruction that responds to students of different abilities, interests or learning needs so they may acquire appropriate ways to learn, use, develop and present concepts. It involves actively planning for student differences in a learning situation in terms of the core concepts and skills being taught, the process by which the content is delivered, and the product that students will create based on their readiness and interests.

Teachers continuously make decisions about how to select teaching strategies and structure learning activities to meet the diverse learning styles of their students. Given the changing nature of adolescents' development, creating such a responsive environment will provide all students with a safe place to grow and succeed in a dynamic and personalized space.

Differentiating instruction is an essential tool for engaging students and addressing their individual needs. Teachers can differentiate in the content, process, product or environment of the classroom.

Differentiating the Content

Content can be described as the knowledge, skills and attitudes we want students to learn. Differentiating content requires teachers to pre-assess students to identify those who do not require direct instruction. Students who demonstrate an understanding of the concept may move past the instruction step and proceed to apply the concepts to the task of solving a problem. Another way to differentiate content is simply to permit the apt student to accelerate their rate of progress. They can work ahead independently on some projects, i.e. they cover the content faster than their peers.

Teachers should consider the following examples of differentiating by content:

- using reading materials at varying readability levels
- presenting ideas through both auditory and visual means
- meeting with small groups to re-teach an idea or skill or to extend the thinking or skills when necessary

Differentiating the Process

Differentiating the process means varying learning activities or strategies to provide appropriate methods for students to explore the concepts and make sense of what they are learning. The content and product is kept consistent for all students, but activities that lead to task completion will vary depending on the learner. A teacher might assign all students the same product (giving a presentation, for example) but the process students use to create the presentation will differ, with some students working in groups to peer critique while others meet with the teacher alone. The same assessment criteria is used for all students.

Teachers should consider flexible groupings of students which include whole class, small group or individual instruction. Students can be grouped according to their learning needs and the requirements of the content or activity presented. It may be necessary to form short-term groups of students for specific purposes.

Teachers should consider the following examples of differentiating by process:

- using activities through which all learners work with the same important understandings and skills, but proceed with different levels of support, challenge, or complexity
- providing activities and resources that encourage students to further explore a topic of particular interest to them
- providing students with activities that contain both in-common work for the whole class and work that addresses individual needs and interests of learners
- offering manipulatives or other supports for students who need them
- varying the length of time a student may take to complete a task in order to provide additional support for a struggling learner or to encourage an advanced learner to pursue a topic in greater depth

Differentiating the Product

Differentiating the product means varying the complexity of the product that students create to demonstrate learning outcomes. Teachers provide several opportunities for students to demonstrate and show evidence of what they have learned. When students have a choice in what the end product can be, they will become more engaged in the activity.

Teachers should consider the following examples of differentiating by product:

- giving students options of how to express required learning (*e.g.*, create an online presentation, write a letter, or develop a mural)
- using rubrics that match and extend students' varied skills levels
- allowing students to work alone or in small groups on their products
- encouraging students to create their own product assignments as long as the assignments contain required elements.

Offering students a choice in how they demonstrate their understanding is a powerful way to engage students. It is important to offer students learning activities that are appropriate to their learning needs, readiness, and interests. When learning goals are clearly defined, it is easier to determine whether students should have free choice, a guided choice, or no choice at all.

Examples of free choice in learning activities include allowing students to

- choose whether or not to work with a partner, and with whom to work
- choose an assessment task they wish to complete
- choose topics for independent study projects

Examples of guided choice in learning activities might include allowing students to

- choose from teacher selected options (for example, the teacher identifies three articles on a topic, and students choose which one to read based on what their interests are)
- demonstrate their understanding of new concepts by using previously developed skills (for example, a teacher may allow students who have already developed videography or Power Point presentation skills to demonstrate their understanding of new concepts using one of these mediums)

At times it is appropriate for teachers to provide no choice of learning activities for students. Students will understand and accept not having a choice about a learning activity when the teacher feels it is not in the best interest of the student to do so and if the teacher offers choice on a regular basis.

Differentiating the Learning Environment

The learning environment of a classroom is the way a classroom works and feels. It embodies the physical and affective tone or atmosphere in which teaching and learning take place, and includes the noise level in the room, whether student activities are static or mobile, and how the room is furnished and arranged. A classroom may include tables of different shapes and sizes, spots for quiet individual work, and areas for collaboration.

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

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

- making sure there are places in the room for students to work quietly and without distraction, as well as places that invite student collaboration
- providing materials that reflect a variety of cultures and home settings
- setting out clear guidelines for independent work that matches individual needs
- developing routines that allow students to get help when teachers are busy with other students and cannot help them immediately

Learning Preferences

Students have many ways of learning, knowing, understanding, and creating meaning. How students receive and process information and the ways in which they interact with peers and their environment are indicated by and contribute to their preferred learning styles. Most learners have a preferred learning style, depending on the situation and the type of information the student is dealing with, just as most teachers have a preferred teaching style. Learning experiences and resources that engage students’ multiple ways of understanding allow them to focus on their learning processes and preferences.

Teachers should...

Recognize teaching styles and strengths	▪ present authentic and relevant communication situations ▪ manage routines and class organization ▪ provide realistic and motivating classroom experiences
Vary teaching strategies	▪ allow students to construct meaning and connect, collaborate and communicate with each other in a positive learning community ▪ form essential links between the worlds of texts and the students' worlds
Recognize differences in student preferences	▪ allow students to make contemporary, relevant and meaningful choices ▪ give students a sense of ownership of learning goals and empowering a gradual increase of responsibility ▪ allow students multiple ways to demonstrate their learning

Preparing students means engaging them with texts and with people from whom they can learn more about themselves and their world. Prior knowledge and experience has a large impact on their ability to make meaning, and what they will take away from the experience. The learning environment must be structured in such a way that all students can gain access to information and to the community, while developing confidence and competence in applying science to real-life situations. Through the science curriculum, students must be encouraged to question their assumptions and attitudes, and to develop a deeper understanding of the nature of science.

The Inclusive Classroom

Valuing Equity and Diversity

In addition to differentiating instruction, 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 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.

An inclusive classroom values the social and ethno-cultural backgrounds of all students while creating opportunities for community building. Students can learn much from the diverse backgrounds, experiences, and perspectives of their classmates in a community of learners where participants discuss and explore their own and others' customs, histories, traditions, values, beliefs and ways of seeing and making sense of the world. Students from different social and cultural backgrounds can come to understand each other's perspectives, to realize that their ways of seeing and knowing are not the only ones possible, and to probe the complexity of the ideas and issues they are examining. Learning resources should include a range of materials that allows students to hear diverse social and cultural voices and to broaden their understanding of social and cultural diversity.

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

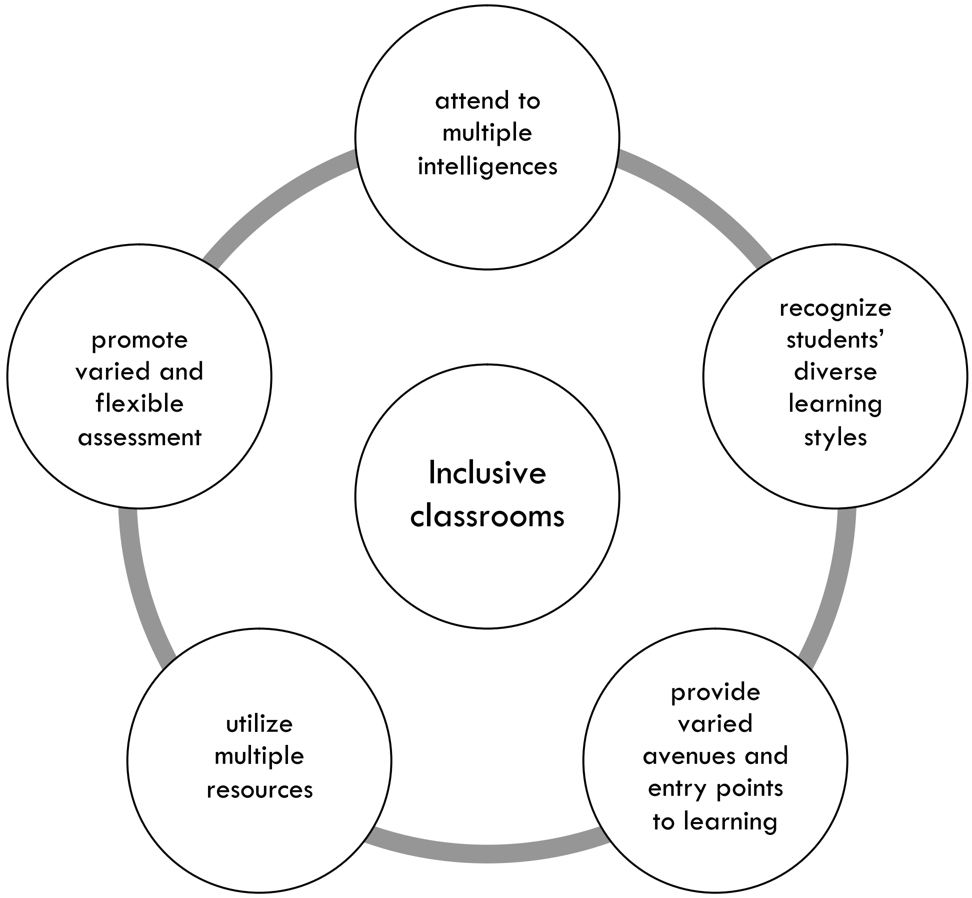
Science activities can provide opportunities in a safe and caring environment for students to express feelings, to think critically about problem solving, or to simply reflect on current issues. All students need to see their lives and experiences reflected in their school community. It is important that the curriculum reflect the experiences and values of both genders and that learning resources include and reflect the interests, achievements, and perspectives of all students. The promotion of inclusive attitudes builds respect for one another, creates positive interdependence and allows for varied perspectives.

Students with Language and Communication Exceptionalities

Some students may need specialized equipment such as braillers, magnification aids, word processors with spell checkers, and other computer programs and peripherals such as voice synthesizers or large print to help achieve outcomes.

Teachers should adapt learning contexts to provide support and challenge for all students, using the continuum of curriculum outcomes statements in a flexible way to plan learning experiences appropriate to students' learning needs. When specific outcomes are not attainable or appropriate for individual students, teachers can use statements of general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes for previous and subsequent grade levels as reference points in setting learning goals for individual students.

Meeting the Needs of Students with Exceptionalities



Students with Advanced Abilities

Advanced learners need experiences working in a variety of grouping arrangements, including partnering, mixed-ability and similar-ability cooperative learning groups, and interest groups. Many of the suggestions for teaching and learning in this curriculum guide provide contexts for acceleration and enrichment (for example, the emphasis on inquiry, problem solving and decision making). The flexibility with regard to the choice of learning resources also offers opportunity for challenge and extension to advanced learners.

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.

Communicating in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways to learn. Students, at all grade levels, should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science journals are useful for such expressive and reflective writing. Purposeful note-making is also an intrinsic part of learning in science that can help students better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in and demonstration of the strategies they need to develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they need to develop and apply in selecting, constructing, and using various forms for communicating in science.

Assessment and Evaluation

What learning is assessed and evaluated, how it is assessed and evaluated, and how results are communicated send clear messages to students and others about what is really valued—what is worth learning, how it should be learned and what elements or qualities are considered important.

Assessment techniques are used to gather information for evaluation. Information gathered through assessment helps teachers determine students' strengths and needs in their achievement of science and guides future instructional approaches. Practices must meet the needs of diverse learners in classrooms and should accept and appreciate learners' linguistic and cultural diversity.

Teachers are encouraged to be flexible in assessing the learning success of all students and to seek diverse ways in which students might demonstrate what they know and are able to do. Assessment criteria and the methods of demonstrating achievement may vary from student to student depending on strengths, interests and learning styles.

Evaluation involves the weighing of the assessment information against a standard in order to make an evaluation or judgment about student achievement. Assessment can be a preliminary phase in the evaluation process.

Regional curriculum in science suggests experiences that support learning within Science-Technology-Society and the Environment (STSE), 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. It is important that students know the purpose of an assessment, the method used, and the marking scheme being used. In order that formative assessment supports learning, the results, when reported to students, should indicate the improvements expected. Assessment techniques suggested in column three of the guide include:

- observation
- paper and pencil
- performance
- presentation
- journal
- portfolio
- interview

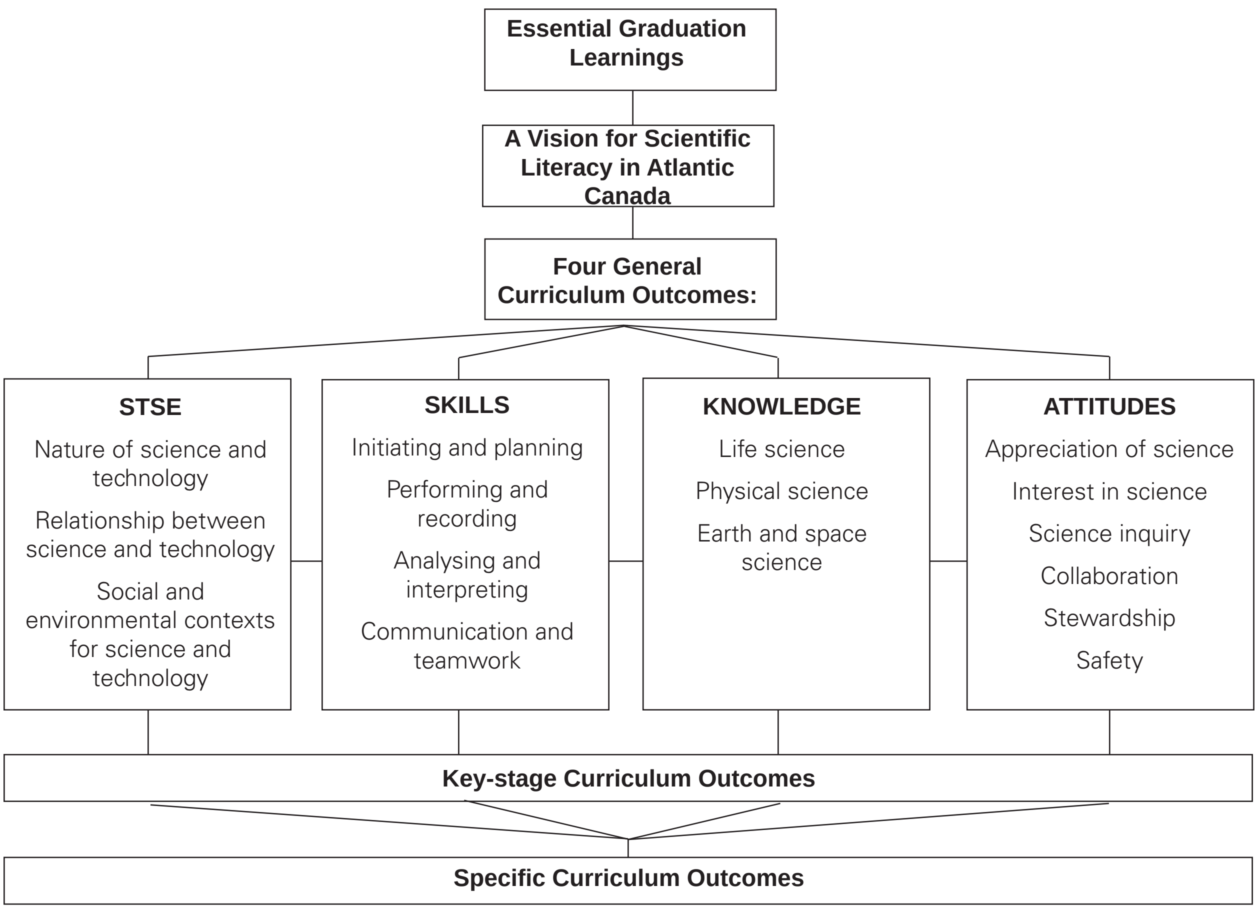
For a description of these techniques and a detailed discussion on assessment and evaluation refer to Appendix D.

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



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 categories of 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 to 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 focuses 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, p. 20. 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's Earth Systems 3209 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: Elaborations - 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 may also be included in this column, as well as background information. 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, paper and pencil, 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, 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 (###,###) – clarification outcomes • Outcome based on pan-Canadian outcomes (###) – clarification outcomes – clarification outcomes	Suggested activities and elaborations of outcome Suggested activities and elaborations of outcome	**Informal/Formal Observation** **Performance** • sample assessment item (###) **Journal** **Paper and Pencil** **Interview** • sample assessment item (###) **Presentation** **Portfolio**	Authorized and recommended resources that address outcomes

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 18-19)

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 Earth Systems 3209 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	###Science-Technology-Society-Environment outcomes from C*ommon Framework of Science Learning Outcomes K to 12*	###Skills outcomes from *Common Framework of Science Learning Outcomes K to 12*	###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* section 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 12
Attitude Outcome Statements

For grades 10 to 12 it is expected that students will be encouraged to . . .

Appreciation of science

436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not

437 appreciate that the applications of science and technology can raise ethical dilemmas

438 value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds

Evident when students, for example,

- consider the social and cultural contexts in which a theory developed
- use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on an STSE issue
- recognize the usefulness of being skilled in mathematics and problem solving
- recognize how scientific problem solving and the development of new technologies are related
- recognize the contribution of science and technology to the progress of civilizations
- carefully research and openly discuss ethical dilemmas associated with the applications of science and technology
- show support for the development of information technologies and science as they relate to human needs
- recognize that western approaches to science are not the only ways of viewing the universe
- consider the research of both men and women

Interest in science

439 show a continuing and more informed curiosity and interest in science and science-related issues

440 acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research

441 consider further studies and careers in science- and technology-related fields

Evident when students, for example,

- conduct research to answer their own questions
- recognize that part-time jobs require science- and technology-related knowledge and skills
- maintain interest in or pursue further studies in science
- recognize the importance of making connections between various science disciplines
- explore and use a variety of methods and resources to increase their own knowledge and skills
- are interested in science and technology topics not directly related to their formal studies
- explore where further science- and technology-related studies can be pursued
- are critical and constructive when considering new theories and techniques
- use scientific vocabulary and principles in everyday discussions
- readily investigate STSE issues

Scientific inquiry

442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations

443 use factual information and rational explanations when analysing and evaluating

444 value the processes for drawing conclusions

Evident when students, for example,

- insist on evidence before accepting a new idea or explanation
- ask questions and conduct research to confirm and extend their understanding
- criticize arguments based on the faulty, incomplete, or misleading use of numbers
- recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen
- expend the effort and time needed to make valid inferences
- critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation
- critically assess their opinion of the value of science and its applications
- criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist
- insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged
- seek new models, explanations, and theories when confronted with discrepant events or evidence

Collaboration

445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

For grades 10 to 12 it is expected that students will be encouraged to . . .

Evident when students, for example,

- willingly work with any classmate or group of individuals, regardless of their age, gender, or physical and cultural characteristics
- assume a variety of roles within a group, as required
- accept responsibility for any task that helps the group complete an activity
- give the same attention and energy to the group's product as they would to a personal assignment
- are attentive when others speak
- are capable of suspending personal views when evaluating suggestions made by a group
- seek the points of view of others and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the persons
- evaluate the ideas of others objectively
- encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making
- contribute to peaceful conflict resolution
- encourage the use of a variety of communication strategies during group work
- share the responsibility for errors made or difficulties encountered by the group

Stewardship

446 have a sense of personal and shared responsibility for maintaining a sustainable environment

447 project the personal, social, and environmental consequences of proposed action

448 want to take action for maintaining a sustainable environment

Evident when students, for example,

- willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation
- assume part of the collective responsibility for the impact of humans on the environment
- participate in civic activities related to the preservation and judicious use of the environment and its resources
- encourage their peers or members of their community to participate in a project related to sustainability
- consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors
- participate in social and political systems that influence environmental policy in their community
- examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans
- willingly promote actions that are not injurious to the environment
- make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations
- are critical-minded regarding the short- and long-term consequences of sustainability

Safety

449 show concern for safety and accept the need for rules and regulations

450 be aware of the direct and indirect consequences of their actions

Evident when students, for example,

- read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood
- criticize a procedure, a design, or materials that are not safe or that could have a negative impact on the environment
- consider safety a positive limiting factor in scientific and technological endeavours
- carefully manipulate materials, cognizant of the risks and potential consequences of their actions
- write into a laboratory procedure safety and waste-disposal concerns
- evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms
- use safety and waste disposal as criteria for evaluating an experiment
- assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place
- seek assistance immediately for any first aid concerns like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present