Foundation for the Atlantic Canada Technology Education Curriculum

Newfoundland and Labrador
Department of Education
Primary, Elementary and Secondary Education Branch

Technology Education

FOUNDATION

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Contents

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Vision

Technology education for Atlantic Canada fosters the development of all learners as technologically literate and capable citizens who can develop, implement, and communicate practical, innovative, and responsible technological solutions to problems.

Introduction

A Common Approach

In 1993, work began on the development of common curricula in specific programs, and has since expanded into other curricular areas. The Atlantic ministers' primary purposes for collaborating in curriculum development are to

- improve the quality of education for all students through shared expertise and resources
- ensure that the education students receive across the region is equitable
- meet the needs of both students and society

Under the auspices of the Atlantic Provinces Education Foundation, development of Atlantic curricula follows a consistent process. Each project requires consensus by a regional committee at designated decision points; all provinces have equal weight in decision making. Each province has established procedures and mechanisms for communicating and consulting with education partners, and it is the responsibility of the provinces to ensure that stakeholders have input into regional curriculum development.

Each foundation document includes statements of essential graduation learnings, general curriculum outcomes for that program, and key-stage curriculum outcomes (entry-grade 3, grades 4-6, grades 7-9, grades 10-12). Essential graduation learnings and curriculum outcomes provide a consistent vision for the development of a rigorous and relevant curriculum.

Purpose of this Document

This document, which provides a vision for technology education in Atlantic Canada,

- provides curriculum designers, other educators, and members of the general public with an outline of the philosophy, scope, and outcomes of technology education
- articulates a progression of technological concepts, skills, and competencies from entry to grade 12
- provides an articulation of general curriculum outcomes and key-stage curriculum outcomes to inform further curriculum development
- assists educators, students, and others to negotiate and construct meaningful learning experiences in technology education
- provides a frame of reference for discussion, by educators and others, regarding the nature and evolution of technology education

Curriculum Focus

Technology education is defined by outcomes and characterized by courses and modular curriculum components. It encompasses all technological systems, processes, resources, and consequences. For practical purposes, technology education confines itself to representative samples of technological problems and systems. Historically, these have been in areas such as construction, manufacturing, communications, and power systems. This curriculum enables students to work across a much broader range of problems and technological systems, including communications, production, sensing-control, power-energy, biotechnology, and management.

The focus of this curriculum is the development of students' technological literacy, capability, and responsibility (International Technology Education Association, 1996). Its primary strategy is to engage them in the design, development, management, and evaluation of technological systems as solutions to problems.

Technological literacy is the ability to use technological systems, manage technological activities, and make informed decisions about technological issues.

Technologically literate people

- understand the role and nature of technology
- understand how technological systems are designed, used, and controlled
- critically examine technologies
- respond rationally to ethical dilemmas caused by technology

Technological capability is an expression of ability and understanding through considered and planned action that combines technical skill and technological knowledge to achieve a desired result. Technological capability grows as a consequence of engagement in technological activity. Attitude is a significant element in transposing abilities into capabilities. Collectively, individuals' capabilities imbue organizations, companies, and countries with capability. Such entities demonstrate capability in the way they respond to or initiate change, especially in industrial and other technological ventures.

Technologically capable people

- respond in innovative and inventive ways by employing iterative technological problem-solving strategies
- exhibit attitudes and behaviours that are conducive to solving problems when the solutions are not obvious or there are multiple solutions
- rationalize decisions and predict the effects of technological action

Technological responsibility requires an understanding of the consequences of technological activity and a willingness to take appropriate action.

Technologically responsible people

- understand that technological activity consumes resources and has consequences
- assess the benefits and risks of technological actions
- take personal responsibility for their technological decisions

Key Features of the Curriculum

Technology education engages students in intellectual and physical activities in the design of technological solutions.

Technology education engages students directly in constructing technological solutions to everyday, real-world problems.

Technology education employs a wide variety of hands-on activities. Students are exposed to a broad range of technological issues, systems, and problem situations in a systemic, systematic fashion. They employ a wide range of technological resources and processes to design, fabricate, and test solutions to familiar and unfamiliar problems. Outcomes, learning experiences, and evaluation of student achievement reflect and are geared towards engagement.

Technology education builds technological knowledge in context.

Technology education provides a naturally integrative function that helps students identify contextual relationships between technological activity and principles, and the underlying scientific, mathematical, and other concepts, principles, laws, and theories. For example, designing structures such as bridges requires knowledge of the forces acting on structures (e.g., torsion, tension, compression), the structural properties of materials (e.g., tensile strength, toughness, elasticity), environmental factors (e.g., soil conditions, weather), and the effects of design aesthetics on people's perceptions (e.g., of value, usefulness, safety).

Technology education makes connections beyond school.

Technology education provides students with an understanding of the fundamental technological principles of the systems that are employed in all modern technologies, and in turn enables them to relate workplace technologies to daily life. It enables students to develop specific technical skills in the context of real-world problems and relate these skills to careers. It provides students with a broad range of capabilities for daily living and for post-secondary programs or the world of work.

The Nature of Technology

Technology is human innovation in action that involves the generation of knowledge and process to develop systems that solve problems and extend human capabilities. Technology is how humans modify the world around them to meet their needs and wants or to solve practical problems (ITEA, 2000).

Technology education curriculum is very much dependent on the nature of technology. Technology education engages students in ways that parallel technological activities in the home, community, workplace, and in post-secondary education and training.

Dimensions of Technology

Technology is a human construct that consists of knowledge, processes, and products.

Knowledge

Technical knowledge, fundamental to any technological activity, has different layers of complexity. Tacit knowledge, acquired through doing, tends to be personal, immediate, and not readily transferred to others, except in one-on-one situations in the context of doing. Prescriptive knowledge is constructed by individuals when they assess processes and strategies, and build rules and procedures, often to improve effectiveness or efficiency. Descriptive knowledge, which is based on facts, such as material properties that often have a scientific or mathematical basis, forms the framework in which a person works or operates.

Technological knowledge derives its form, meaning, and purpose from specific technological activities-tacit knowledge is fundamental to all other forms. Development of technological knowledge happens dynamically across disciplines in response to the requirements of the activity. The nature of technological knowledge has significant implications for the study of technology and for the development of technological literacy, capability, and responsibility.

Process

Technological process is the active state of technology, and it occurs at many levels of complexity. Technological activity employs all types and levels of technological knowledge, and consumes technological resources. It connects the present with future possibilities. At the highest level, technological process is characterized by multi-dimensional, decision-making strategies. At the lowest level, technological processes are learned behaviours that enable one to employ tools and other resources to perform a task or activity. Fundamental technological processes, which are the foundation of, and provide context for, all technological activity, include the following:

- communication processes of encoding/decoding, storing/retrieving, and sending/receiving
- managing processes of planning, decision making, organizing, staffing, motivating, leading, and controlling
- control processes of sensing, switching, and regulating
- energy-power processes of conserving, converting, and transmitting
- production processes of separating, combining, shaping, and finishing
- biotechnology processes of propagating, growing, adapting, treating, maintaining, harvesting, and converting

Products

Technological products, the consequence of technological activity, comprise the human-made environment. They include physical products such as cars and food, virtual products such as digital information, and services such as banking and health care. These products have cultural significance, and have social, economic, and environmental issues and consequences. In many ways they define how we live, how we communicate with one another, how we conduct business, and how we feel about ourselves.

Elements of Technology

The elements of technology are employed to organize and guide practice. They include technological concepts and principles, technological systems, and technological problem solving. Knowledge and understanding of these elements are critical if one is to function effectively in a technological society.

Technological Concepts and Principles

Technological concepts and principles, central and unique to the study of technology, include the following (ITEA, 1996):

- Technology results from human ingenuity.
- Technological activities require and consume resources.
- People create technological systems to meet basic needs and wants.
- Technological activities may have predictable and unpredictable, positive or negative effects on people and the environment.
- Technology provides opportunities and triggers requirements for careers.
- Technological sophistication is affected by cultural contributions.
- The rate of technological change is accelerating.
- Complex technological systems develop from simpler technological systems.

Technological Systems

A system comprises sub-systems and components. It performs a function that the components could not perform individually. Technological systems, which include products and environments, may be organized using a variety of classification schemes. Three basic technological systems emerge when they are classified by physical make-up:

- Informational systems (communications, management, and control) employ communications technologies to process, store, and use data. They are interfaces for human-to-human, human-to-machine, and machine-to-machine communications. New information and new knowledge are primary products.
- Physical systems employ physical materials and transformation of those materials to increase their value. They are heavily reliant on power and transportation systems, and include production, manufacturing, construction, and exploration.
- Biological systems employ living organisms and biological processes. Biotechnology is employed to create products; improve humans, plants, or animals; or develop micro-organisms for specific purposes. Biological systems include aquaculture, agriculture, silvaculture, medicine, genetics, and sports.

Systems may also be classified by underlying scientific principles (e.g., mechanical, electrical, or fluidic) or purpose (e.g., aquaculture, communications, manufacturing, or transportation).

Systems are designed to achieve specific outcomes. They have three major components-input, process, and output. Feedback is used to modify the system components to ensure that the desired outcome is achieved.

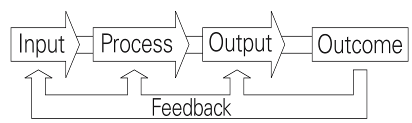


Figure 1 - Systems Model

System inputs are technological resources such as materials, time, capital, information, people, tools and machines, and energy. System processes are the actions taken on the inputs (usually on materials, energy, and/or information) to achieve the desired output. System outputs may have expected or unexpected outcomes. Outcomes may also be desirable or undesirable. System design and management always involves assessing the trade-offs in output and consequent outcomes.

Technological Problem Solving

Technological problem solving, illustrated in Figure 2, is an iterative process that often simultaneously requires such diverse responses as metacognition and technical action.

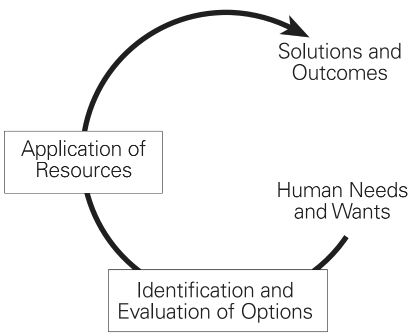


Figure 2 - Technological Problem-solving Model

Modern industry and commerce grow by invention and marketing of technological solutions to problems and opportunities. Many of the most widely used technological problem-solving strategies fall under the general rubric of design. Design practices vary with the industry, problem, and situation. The major components of the design process lend themselves to an organizational structure as illustrated below. The steps, or phases, of design serve to inform practice and provide signposts to measure progress. The process begins with the identification of problems and opportunities to meet needs and wants, and ends with a solution. Design offers a continuous process for modifying and improving the solution over time.

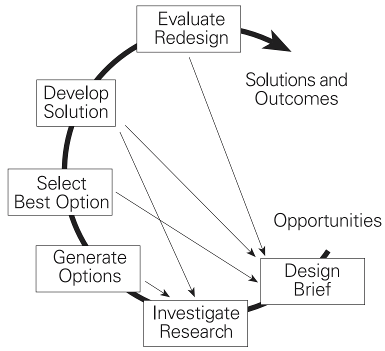


Figure 3 - Design Process Model

Solutions and outcomes often result in more problems and opportunities. Effective design practice strives to maximize the benefits (economic, social, and otherwise) while minimizing the negative impact. Employing these methodologies makes it possible, for example, to pose the same problems to entry to grade 12 students as are posed to design professionals. Whether the problem is straightforward, such as 'There is not enough light to see this properly,' or much more complex, such as 'I need a totally automated system to grow tomatoes,' the methodology ensures that a viable solution is developed.

Technology in Context

Technology exists and evolves in the human-made world. It is affected by and affects everything we do. Understanding this context, especially the relationship of technology with individuals, society, science, and education, helps one understand the nature and evolution of technology. Developing an understanding of this context is confounded by continuous and exponential technological change. Consequences of the rate of change include changes in the nature of work, leisure, education, and most forms of social interactions. These changes, in turn, have major consequences for individuals and for society.

Consequences for individuals include

- the need for a broader range of skill sets which employ different modes of thinking and doing
- more reliance on independence of thought and action
- an understanding of and ability to use complex technological devices and systems
- the ability to troubleshoot simple malfunctions
- the ability to forecast the consequences of their technological activities
- the ability to assess and wisely choose consumer products
- the ability to adapt quickly to change
- the ability to develop novel and practical technological solutions to problems
- an understanding of the ethical and legal implications of technological actions
- an understanding of employability skills, career options, and the technology of the workplace

Consequences for society include

- technology-dependent workplaces and economies which in turn create the need for highly skilled and technologically competent workers

- effective democratic participation of citizens that requires technological literacy and access to communications tools
- new meanings and definitions for literacy and capability
- the need for systemic and systematic approaches to development of technological literacy and capability
- standards for legal, moral, and ethical decision making that continue to evolve

Technology is often associated with science. While there is a symbiotic relationship, science and technology have different origins, serve different purposes, employ different methods, and have different outcomes. Development of modern technological systems depends heavily on a thorough understanding of scientific concepts and principles. Modern scientific practice cannot be conducted without employing sophisticated technological tools and processes. While science is concerned largely with the natural world, and technology with the human-made world, both have effects that are felt in social and personal contexts.

Education is a principal vehicle by which modern societies build in their citizens the capacity to engage in meaningful discourse about the evolution of the society, its institutions and practices, and equip the younger members of the society to find a meaningful place that includes health, employment, and happiness. Technology is an integral component of education on many levels, from strategy and process to tools and resources. It is fundamentally important that education help young people acquire a sense of the nature of technology and its place in human affairs, an understanding of how to employ it effectively, and the wisdom to use technological resources responsibly.

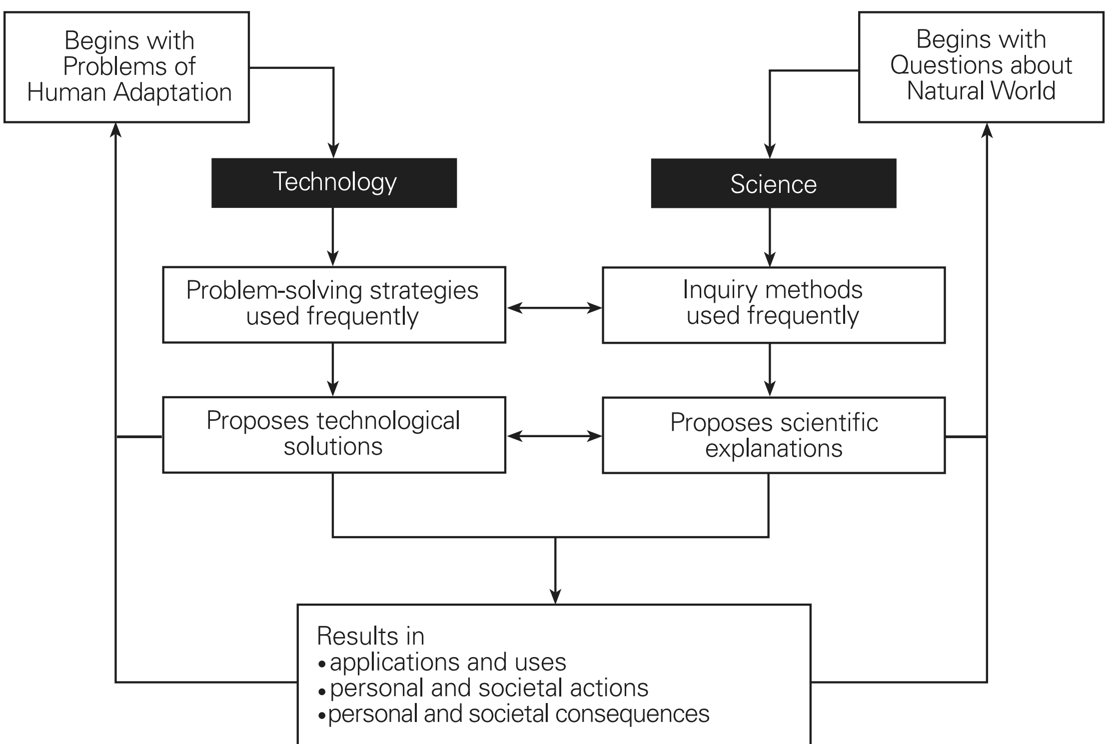


Figure 4 - Technology-Science Relationship

Outcomes

Essential graduation learnings (**EGLs**) 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 if they are to be ready to meet the shifting and continuing demands of life, work, and study today and in the future. Essential graduation learnings are cross-curricular, and curriculum in all subject areas is focussed to achieve these learnings. Essential graduation learnings serve as a framework for the curriculum development process.

Curriculum outcomes are statements articulating what students are expected to know and be able to do in particular subject areas. These outcomes statements also describe what knowledge, skills, and attitudes students are expected to demonstrate at the end of certain key stages in their education, as a result of their cumulative learning experiences in each grade level of the entry-graduation continuum. Through the achievement of curriculum outcomes, students demonstrate the essential graduation learnings.

General curriculum outcomes are statements that identify what students are expected to know and be able to do upon completion of study in a curriculum area.

Key-stage curriculum outcomes are statements that identify what students are expected to know and be able to do by the end of grades 3, 6, 9, and 12, as a result of their cumulative learning experiences in a curriculum area.

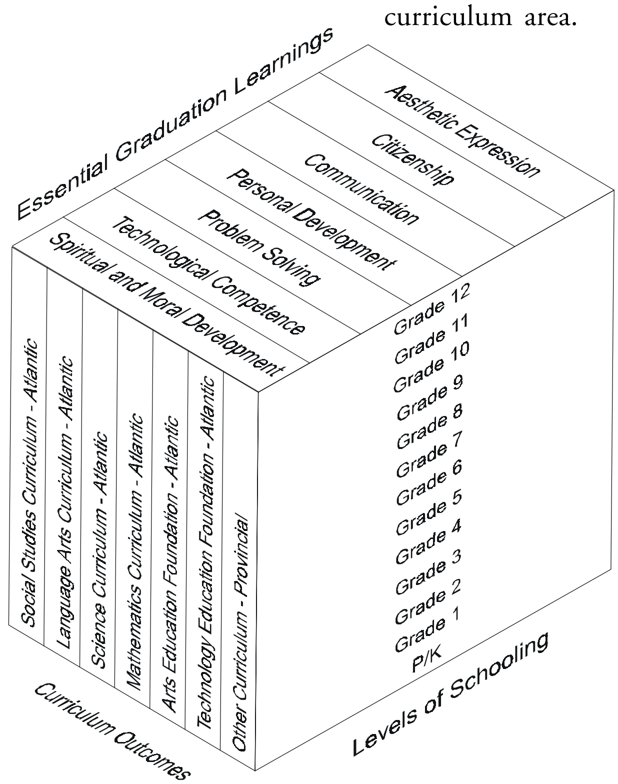


Figure 5 - Relationship among Essential Graduation Learnings, Curriculum Outcomes and Levels of Schooling

Essential Graduation Learnings (EGLs)

Graduates from the public schools of Atlantic Canada will be able to demonstrate knowledge, skills, and attitudes in the following essential graduation learnings. Provinces may add additional essential graduation learnings as appropriate. More information on the EGLs and the curriculum framework is attached as an appendix. For each EGL there are five statements that refer to each of the five GCO's for technology education.

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.

Technology education develops students' capabilities in this EGL

- by engaging them in the application of a wide variety of visual and graphic design principles and elements to create physical and virtual products (GCO 1)
- through the use of technological systems that encourage analysis of issues and situations and creative expression of ideas in a variety of media (GCO 2)
- by examining the historical and evolving connections between technology, technical skill, and artistic expression in diverse fields such as architecture, product design, and the arts (GCO 3)
- by building understanding of invention and innovation as a fundamental component of technological industries (GCO 4)
- by encouraging responsible attitudes and practices related to the use of technology in creative activities, including assessing the works of others (GCO 5)

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Technology education develops students' capabilities in this EGL by

- requiring them to evaluate and act on the consequences of their technological solutions to problems (GCO 1)
- requiring them to assess and make decisions regarding the impact and consequence of emerging technological systems on self, society, and the environment (GCO 2)
- building understanding of the symbiotic relationships of diverse areas such as technology, culture, and education (GCO 3)
- building understanding of the role and impact of technology in economic growth and competitiveness (GCO 4)
- fostering involvement, for example, in assessing the ethical and social consequence of new and evolving technologies (GCO 5)

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s), and mathematical and scientific concepts and symbols, to think, learn, and communicate effectively.

Technology education develops students' capabilities in this EGL by

- engaging them in comprehensive research, evaluation, and reporting processes as fundamental components of design (GCO 1)
- providing a wide variety of opportunities and experiences with communications systems, processes, and techniques (GCO 2)
- engaging them in a critical examination of the history, evolution, and impact of communications technologies on individuals, society, and on technology itself (GCO 3)
- engaging them in a critical examination of the role and impact of communications technologies and processes on the evolution of work and the workplace, and on the nature of work (GCO 4)
- engaging them in a critical examination of personal and group responsibility in determining the future evolution and applications of communications technologies (GCO 5)

Personal Development

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

Technology education develops students' capabilities in this EGL by

- engaging them in the practices, processes, and problem-solving strategies that relate to a variety of careers (GCO 1)
- building technological literacy and capability in the context of real-world technologies, technological issues, and consequences of technological activity (GCO 2)
- examining issues such as the historical relationship between technology and people, at home and in the workplace (GCO 3)
- building an understanding of the evolving nature of technological literacy and capability, and their impact on current and future education needs and career options (GCO 4)
- encouraging determination of short- and long-term goals and providing opportunities to plan and build strategies to achieve them (GCO 5)

Problem Solving

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

Technology education develops students' capabilities in this EGL by

- engaging them in designing technological solutions to authentic problems that require imagination and the application of a wide variety of technological resources to solve (GCO 1)
- exposing them to a wide variety of situations and issues related to the operation, troubleshooting, maintenance, and management of technological systems that range from simple to complex (GCO 2)
- building comprehension and understanding of technological consequence, and of ways to employ that understanding in decisions affecting the development of solutions to real-world problems (GCO 3)
- incorporating a variety of authentic industrial and commercial technological problem-solving strategies into their activities (GCO 4)
- encouraging intellectual honesty in their designs of technological solutions (GCO 5)

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.

Technology education develops students' capabilities in this EGL by

- requiring them to employ a variety of technological tools, technical processes, and design strategies (GCO 1)
- providing experiences with use and management of a wide variety of technological systems (GCO 2)
- building knowledge and understanding of factors affecting the development of new technologies, and of ways to adapt technologies to different situations (GCO 3)
- building capability with technological systems and tools relevant to a variety of career choices (GCO 4)
- requiring them to assess risk and take responsibility for the consequences of their technological actions (GCO 5)

Spiritual and Moral Development

Graduates will be able to demonstrate understanding and appreciation for the place of belief systems in shaping the development of moral values and ethical conduct

Technology education develops students' capabilities in this EGL by

- requiring them to account for the effects of solutions they develop (GCO 1)
- requireing them to assess the consequence of their use of technological systems (GCO 2)
- building knowledge and understanding of the historical and emerging impact of technological developments on individuals, society and the environment (GCO 3)
- building knowledge and understanding of the effects of technologival change on the nature of work and employability (GCO 4)
- building a sense of personal responsibility for their individual and social use of technology (GCO 5)

Vision for Technology Education

Technology education for Atlantic Canada fosters the development of all learners as technologically literate and capable citizens who can develop, implement, and communicate practical, innovative, and responsible technological solutions.

General Curriculum Outcomes for Technology Education: Entry-Grade 12

These five general curriculum outcomes statements articulate what students are expected to know and be able to do upon completion of study in technology education. These statements provide a concise description of the student as a technologically literate and capable citizen.

GCO 1: Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

Technological problem solving incorporates a variety of strategies and processes, consumes resources, and results in products and services. Technological problem solving constitutes one of the most important ways in which students engage in technological activity.

GCO 2: Technological Systems

Students will be expected to operate and manage technological systems.

Technological systems are the primary organizational structure for products and services. Understanding the nature of systems, and understanding how to employ, moderate, and re-structure systems are important components of technological literacy and capability.

GCO 3: History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and of its social and cultural implications.

Technology, like many other areas of human endeavour, is often best understood in its historical context. Technology has had and continues to have profound effects on individuals, society, and the environment. Understanding the origins and effects of a particular technology provides a context for resolving today's problems and issues, and often leads to better solutions.

GCO 4: Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and of the influence of technology on the nature of work.

All jobs, occupations, careers, and professions exist in technological environments. An understanding of the range of technologies in the workplace and their effects on the nature of work is critical to planning career and education paths.

GCO 5: Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

The development of technology, and by extension its impact in the future, is entirely under human control. Individually and collectively we share that responsibility. Accepting the responsibility and being empowered to take appropriate action require technological literacy and technological capability-knowledge, skills, and willingness.

Key-Stage Curriculum Outcomes (KSCOs)

Key-stage curriculum outcomes are statements that identify what students are expected to know and be able to do by the end of grades 3, 6, 9, and 12, as a result of their cumulative learning experiences in technology education.

Outcomes at the four key stages reflect a continuum of learning. While there may appear to be similarities in outcomes at different key stages, teachers will recognize the increase in expectations for students at the various key stages, according to

- the developmental nature of acquiring technological literacy and capability
- students' maturity of thinking and interests
- students' increasing independence as learners
- the increasing complexity and sophistication of ideas, technological problems, and technological systems
- the increasing complexity and sophistication of students' technological solutions
- the range and innovativeness of ideas and solutions offered in response to technological situations and issues
- increasing sophistication in the students' use of technical language and terminology to communicate ideas and information about technology

For each key stage, the ordering of outcomes is not intended to suggest any priority, hierarchy, or instructional sequence, with the exception of those related to the major sequencing of strategies for technological problem solving. While these outcomes provide a framework on which educators may base decisions concerning instruction and assessment, they are not intended to limit the scope of learning experiences in any key stage. Although it is expected that most students will be able to attain the key-stage curriculum outcomes, the needs and performance of some students will range across key stages. Teachers should take this variation into consideration as they plan learning experiences and assess students' achievement of the various outcomes. Students' attitudes, experiences, knowledge, abilities, and engagement in learning will also influence their ability to achieve the key-stage curriculum outcomes.

GCO 1: Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

By the end of grade 3, students will be expected to

[1.101] articulate problems to be solved through technological means
- identify a problem to be solved
- describe factors that might affect its solution

[1.102] conduct design studies to identify a technological solution to a problem
- examine possible ideas to solve the problem
- explore ways to put the idea into action
- record related information

[1.103] develop (prototype, fabricate, make) technological solutions to problems
- develop the solution by properly using tools and other resources
- discuss their choices and decisions and record the discussion

[1.104] critically evaluate technological solutions and report their findings
- examine how well their solutions work, and how well other people's solutions to problems work
- identify possibilities for improvement

[1.105] communicate ideas and information about technological solutions through appropriate technical means
- create drawings which employ basic technical symbols and language
- employ a variety of tools, including computers, audio, and video

By the end of grade 6, students will have achieved the outcomes for entry to grade 3 and will also be expected to

[1.201] articulate problems that may be solved through technological means
- describe specific problems
- clearly state the problem that will be solved
- describe factors that might affect the solution

[1.202] conduct design studies to identify a technological solution to a problem
- consider similar problems
- generate ideas to solve the problem
- select the preferred idea and give reasons for the choice
- examine ways to put the idea into action
- record the information in text and drawings

[1.203] develop (prototype, fabricate, make) technological solutions to problems
- develop the solution by properly using tools and other resources
- modify ideas as necessary, discussing their reasons
- document decisions and actions

[1.204] critically evaluate technological solutions and report their findings
- use established criteria to determine the effectiveness of their own and selected other solutions
- suggest ways to improve technological solutions
- record and report their conclusions

[1.205] communicate ideas and information about technological solutions through appropriate technical means
- create simple technical drawings that include views of objects
- create alternate representations, such as physical models
- properly use technical language and terminology in all forms of communications

GCO 1: Technological Problem Solving

Students will be expected to design, develop, evaluate, and articulate technological solutions.

By the end of grade 9, students will have achieved the outcomes for entry to grade 6 and will also be expected to

[1.301] articulate problems that may be solved through technological means
- examine problem situations
- construct simple design briefs that include the problem statement and conditions affecting the solution

[1.302] conduct design studies to identify a technological solution to a problem
- investigate related solutions
- document a range of options to solve the problem
- determine and justify the best option
- create a plan of action that includes technical sketches

[1.303] develop (prototype, fabricate, make) technological solutions to problems
- identify appropriate tools and resources
- employ safe practices and resource conservation
- develop the solution with redesign as necessary to ensure the design brief is satisfied
- document all activities and decisions

[1.304] critically evaluate technological solutions and report their findings
- use established and their own criteria to evaluate the effectiveness of both their own and others' technological solutions
- assess solution components and incorporate the required changes during the design activity
- document and report their changes, the rationale for change, and conclusions

[1.305] communicate ideas and information about technological solutions through appropriate technical means
- create more sophisticated orthographic and isometric views
- create alternate representations, such as computer animations and physical models

By the end of grade 12, students will have achieved the outcomes for entry to grade 9 and will also be expected to

[1.401] articulate problems that may be solved through technological means
- assess diverse needs and opportunities
- construct detailed design briefs that include design criteria and a work schedule

[1.402] conduct design studies to identify a technological solution to a problem
- investigate related solutions
- document a range of options to solve this problem
- determine and justify the best option
- determine resource requirements and availability
- develop detailed action plans, including technical drawings and sequences of action

[1.403] develop (prototype, fabricate, make) technological solutions to problems
- match resources and technical processes for specific tasks
- construct and test models and prototypes as needed
- construct the solution with adherence to the design criteria
- document activities, decisions, and milestones

[1.404] critically evaluate technological solutions and report their findings
- develop detailed evaluations of both their own and others' technological solutions, with reference to independently developed criteria
- employ a continuous assessment methodology with the purpose of continuous improvement of the design
- document and report their changes, the rationale for change, and conclusions

[1.405] communicate ideas and information about technological solutions through appropriate technical means
- accurately present technical information by using a representative sample of analog and digital tools, including, for example, two- and three-dimensional, computer-assisted drafting and modelling tools
- create accurately scaled models and prototypes

GCO 2: Technological Systems

Students will be expected to operate and manage technological systems.

By the end of grade 3, students will be expected to	*By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to*
[2.101] operate components of a variety of familiar technological systems	[2.201] operate a representative range of technological systems
[2.102] manage technological resources when engaged in an activity	[2.202] manage technological resources to improve the performance of a system
[2.103] operate familiar control systems	[2.203] operate logic and control systems
[2.104] recognize and identify common technological systems, and determine what they do and what keeps them working (e.g., a fridge cools food and it uses electricity to operate)	[1.204] identify the functions and components of common technological systems (e.g., an automobile has inputs such as fuel, processes such as human action on the controls, and outputs such as motion)
[2.105] follow a process to determine how systems work	[1.205] use tools to diagnose systems

GCO 2: Technological Systems

Students will be expected to operate and manage technological systems.

By the end of grade 9, students will have achieved the outcomes for entry-grade 6 and will also be expected to	*By the end of grade 12, students will have achieved the outcomes for entry-grade 9 and will also be expected to*
[2.301] operate, monitor, and adjust a representative range of technological systems	[2.401] operate, monitor, and adjust technological systems of increasing complexity
[2.302] manage a representative range of technological systems	[2.402] manage technological systems of increasing complexity
[2.303] employ programming logic and control systems to sense, switch, and regulate events and processes	[2.403] modify programming logic and control systems to optimize the behaviour of systems
[2.304] classify technological systems, using one or more schema, and determine their operational components and parameters (e.g., schema include general make-up, underlying principles and purposes, and sub-systems)	[2.404] deconstruct complex technological systems into their simpler systems and components
[2.305] diagnose and repair malfunctioning systems	[2.405] troubleshoot and maintain systems

GCO 3: History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and of its social and cultural implications.

By the end of grade 3, students will be expected to	*By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to*
[3.101] explore ways that specific technologies can be used to do different things	[3.201] describe ways that different technologies can be used to do the same thing
[3.102] explore things that we learn from science and things that we are able to do through technology	[3.202] explain ways that science can be used to better understand the effects of technology or to develop new technology
[3.103] explore the role that technology plays at home, in school, and in the community	[3.203] explain the role of education in helping people become knowledgeable about technology and in developing specific capabilities with technological tools and systems
[3.104] explore reasons why technologies change over time	[3.204] investigate reasons why technologies change more rapidly now than at previous times in history
[3.105] account for effects of cultural diversity on technological solutions • explore ways that different people do the same task • explore the different ways that students in their class might solve the same problem	[3.205] account for effects of cultural diversity on technological solutions • examine different forms that products and solutions take in different cultures or countries • explore the different roles that members of a design team play in developing technological solutions to problems

GCO 3: History and Evolution of Technology

Students will be expected to demonstrate an understanding of the history and evolution of technology, and of its social and cultural implications.

By the end of grade 9, students will have achieved the outcomes for entry-grade 6 and will also be expected to

[3.301] examine the historical evolution of technologies and predict future developments

[3.302] investigate ways that science activities depend on technology and that inventions in technology depend on science

[3.303] examine technological literacy and capability in modern society and their effects on citizenship and education

[3.304] evaluate the effects of rapid change in technological systems on people in their schools and communities

[3.305] account for effects of cultural diversity on technological solutions

- examine the effects of culture on traditional products, and vice versa
- explore how products are designed differently for different markets
- apply their understanding of cultural preferences when developing technological solutions

By the end of grade 12, students will have achieved the outcomes for entry-grade 9 and will also be expected to

[3.401] evaluate technological systems in the context of convergence where one system has multiple functions, or divergence where multiple systems have the same function

[3.402] evaluate the symbiotic roles of technology and science in modern society

[3.403] analyse the symbiotic relationship between technology and education, including factors that influence standards for technological literacy and capability, and ways that the community responds

[3.404] critically evaluate the effects of accelerating rates of technological change on self and society

[3.405] account for effects of cultural diversity on technological solutions

- critically examine the effects of cultural diversity on market forces and technological products, and vice versa
- incorporate knowledge of cultural diversity into development of technological solutions

GCO 4: Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and of the influence of technology on the nature of work.

By the end of grade 3, students will be expected to	*By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to*
[4.101] explore ways that technology affects the nature of work at home, in the school, and in the community	[4.201] demonstrate an understanding of the roles and applications of technology in workplaces
[4.102] recognize the need, opportunity, or problem that led to the development of specific products	[4.202] investigate local products and services to determine how they were designed, and their impact on the local economy
[4.103] demonstrate an understanding that being able to achieve a goal or complete a task often requires the development of new skills and capabilities	[4.203] determine the skills and capabilities they would need to engage in projects and activities, and plan ways to acquire them

GCO 4: Technology and Careers

Students will be expected to demonstrate an understanding of current and evolving careers and of the influence of technology on the nature of work.

By the end of grade 9, students will have achieved the outcomes for entry-grade 6 and will also be expected to

[4.301] examine the technologies of specific careers and workplaces, including the organizational structures of work environments and the effects of newer technologies

[4.302] examine the roles of design and invention in business growth and economic development

[4.303] develop strategies to assess their technological literacy/capability and plan for continuous personal growth, using external criteria

By the end of grade 12, students will have achieved the outcomes for entry-grade 9 and will also be expected to

[4.401] assess and evaluate employability profiles for a variety of workplaces and careers and determine the level of technological literacy and capability they would need to achieve for job entry

[4.402] employ design and invention as tools to create entrepreneurial activity

[4.403] envision their short- and longer-term future and develop a plan for acquiring the technological literacy/capability required to achieve their vision

GCO 5: Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

By the end of grade 3, students will be expected to	*By the end of grade 6, students will have achieved the outcomes for entry-grade 3 and will also be expected to*
[5.101] demonstrate a growing awareness of the rights and responsibilities of others and self when using technological resources	[5.201] demonstrate respect for the rights and responsibilities of others and self when using technological resources
[5.102] demonstrate an understanding of health and safety rules and standards	[5.202] demonstrate increasing awareness of healthy and safe practices when engaging in technological activity
[5.103] identify risks that might be present if specific technological actions are taken, and explore ways to manage them	[5.203] demonstrate increasing awareness of the need to take proper measures to manage technological risk

GCO 5: Technological Responsibility

Students will be expected to demonstrate an understanding of the consequences of their technological choices.

By the end of grade 9, students will have achieved the outcomes for entry-grade 6 and will also be expected to	*By the end of grade 12, students will have achieved the outcomes for entry-grade 9 and will also be expected to*
[5.301] demonstrate an understanding of the nature and purpose of legal and ethical rules and principles	[5.401] demonstrate responsible leadership in employing legal and ethical rules and principles
[5.302] develop personal rules of conduct that ensure healthy and safe practices	[5.402] demonstrate responsible leadership in employing health and safety rules and standards
[5.303] develop and demonstrate risk-management strategies for a variety of technological activities	[5.403] demonstrate responsible leadership in taking proper measures to manage current and future technological risk

Contexts for Learning and Teaching

Principles Underlying the Technology Education Curriculum

Technology education curriculum in Atlantic Canada adheres to certain principles that guide decisions shaping the continuous improvement of learning and teaching. These principles guide the design and implementation of the curriculum.

Authenticity

Technology education values and embraces the strategic links between applied learning and integrated learning.

By its nature, technology education integrates the authentic application of concepts into students' learning experiences. Therefore, while developing an understanding of abstract principles, learners develop concrete competencies relating to the world beyond school.

Unity

Technology education values and embraces meaningful connections among diverse areas of study.

For theoretical reasons, historians and educators have separated knowledge into discrete disciplines. Technology education supports and encourages strategies that emphasize the unifying concepts of related disciplines, particularly science and mathematics. Added value comes from developing an understanding of how underlying concepts, defined and explained in other disciplines, are pivotal in understanding the technological processes and concepts.

Constructivism

Technology education incorporates each individual's prior knowledge, skills, and attitudes in the design of authentic learning experiences.

Learners use their unique perspective, shaped by prior learning experiences, current beliefs, and attitudes, to construct new understandings. Technology by nature is constructivist in that it entails assessment, design, testing, implementation, and evaluation processes. Technology education is facilitated by the continuous generation of an interactive, reflective, and supportive learning environment which invites the construction of new knowledge and understanding.

Collaboration

Technology education employs learning strategies and experiences that reflect the collaborative nature of technology.

Technology by nature is collaborative in that it has a social function and context. New solutions to human concerns are created within the context of existing technological knowledge, processes, and products. The success of the design and implementation of new technological solutions is a function of the degree of meaningful collaboration that exists.

Autonomy

Technology education values an environment with the learner as its pivotal force.

Autonomous learners require a learning environment in which they have the freedom to take responsibility for their learning. In such an environment, collaboration among learners, guided by informed teachers, shapes the learning experiences. The teacher's role in this autonomous climate is to establish appropriate conditions in mediating the learning variables to facilitate success relevant to each learner.

Continuous Inquiry

Continuous inquiry is essential to technology education.

History demonstrates that technology and education must embrace, rather than resist, change. Research is an essential element in the design and problem-solving processes of technology and technology education.

Continuous Improvement

The success of technology education initiatives is a function of informed implementation and improvement practices.

Informed leadership recognizes the profound implications involved in effecting necessary change in the process of continuous improvement. Such leadership guides all members of the learning community to make informed decisions. Effective collaboration ensures that the optimum and sustainable balance of the elements essential to successful change continues to exist. These elements include the vision, skills, resources, strategies, and motivation essential to any successful implementation of systemic change.

Continuous Learning

Technology education implies strategic and distinct pre-service and in-service demands on teacher education.

Learning is the fundamental purpose of education, and educators often wisely seek technological solutions to many of the problems they face. An effective technology education gradually prepares learners to make informed decisions in designing and applying solutions to real problems. To ensure quality education for all learners, both teacher education pre-service and continuing in-service are essential to prepare teachers for the continuous and dramatic change in both technology and technology education.

The Learning Environment

Technology education challenges students to critically examine the human-made environment; to assess its function and consequence; to determine its effects on the natural environment, on themselves and society; and to design technological solutions with careful consideration to the consequences.

The technology education learning environment sets the stage and conditions in which the curriculum can challenge students and teachers alike. In appropriate conditions, students are challenged to address their pre-conceived notions about how and why we do things, examine the consequences of technological change, and build strategies to manage change. It is normal and expected for students to assess, select, and if necessary construct technological tools, physical or virtual, appropriate to the situation.

Such a learning environment cannot be confined to the physical space of the facilities or even the school. It includes the community and the workplace, physical and virtual space. It requires the involvement of teachers, parents, community organizations, and employers. It requires co-operation and collaboration not just among members of student design teams, but also between members of the education community and the larger community.

The Physical Space

Achieving the technology education curriculum outcomes places a special significance on the design of technology education facilities. Building the broad base of technological literacies and capabilities that today's students will need on school leaving requires engagement with materials, tools, and technical processes ranging across the virtual and physical worlds. Student activities require a physical space organized to accommodate both the planning and fabrication components of design.

Modular, multi-activity, and multi-modal technology education facilities accommodate diverse student needs.

Modularity is exemplified by equipment, furniture, and facilities layouts that may be rearranged and reconfigured quickly and easily to accommodate different class structures, activities, and content.

The facility should accommodate a representative array of real and simulated design and production processes. It should be wired to accommodate a variety of research, planning, documentation, and reporting needs.

Multi-activity is exemplified by engaging students, individually or in design teams, in different problems and subsequent design activities simultaneously; therefore, individual and collaborative efforts must be supported. Students engage directly in constructing their own knowledge in the context of real-world problems and resources. Students investigate, plan, prototype, and test in the same space and time.

Multi-modality is exemplified by simultaneously implementing different technological systems, technical processes, and related resources. Modality is scalable. The facility is often divided into physical spaces that accommodate planning technologies, and other spaces that accommodate fabrication and production. On another level, individual students working on the same design team will most likely require different tools, skills, and processes as they each simultaneously carry out the different tasks involved in developing a technological solution.

Although modality is often accomplished through physical separation, many technological systems do not cleanly separate. The line between planning and fabrication is continuously blurring across information, physical, and biotechnological systems. Those involved in designing, building, and using technology education facilities are afforded a variety of opportunities to develop innovative approaches.

Resources

Technology education exists only in an environment where students interact with technological problems and resources. Technological resources have a special context. In one context, students make investigations and determinations, and they select, use, and assess the effectiveness of technological resources as a major component of problem solving. In another, more general context, educators make investigations, determinations, and choices about technological resources required to deliver a quality technology education program.

Technology education activities can conceivably run the gamut of human technological activity. For practical purposes, design constraints for the program include a representative range of highly relevant technological processes and tools. Relevancy is determined by the education system, and will change with time. Problems and opportunities must be addressed within those constraints.

Information

Information fuels technological activity. It informs everything that transpires, from articulation of a problem to implementation of solutions, from analysis of technological systems to prediction of technological consequence, and from decisions about personal conduct to decisions affecting society. Information resources include technical and scientific journals, manuals, and handbooks, as well as those sources traditionally employed in entry to grade 12 education. Increasingly, technical information is found only in electronic format, and much of that is through the Web.

Knowledge

Knowledge is a resource that is constructed by individuals in response to activities and design challenges. Learning theories support the approach of engaging students in activities that enable them to construct knowledge. Educators need to ensure that students face developmentally appropriate challenges and have access to a wide range of technological resources and appropriate guidance to build sound knowledge bases as a resource to inform their decision making. It is reasonable to assume that students will, from time to time, develop specialized technological knowledge beyond that of their teachers.

People

People are the primary resource in any technological activity.

Educators and students need to identify and develop connections to knowledgeable people and experts who can serve as mentors and provide advice on technical decision making. Educators should cultivate relationships with post-secondary institutions, employers, and other partners.

Materials

All technological activity consumes resources, including physical materials.

Technology education engages students directly in the design and fabrication of solutions to problems. Many solutions require the use of natural and manufactured materials, including fabrics, woods, metals, plastics, composites, and ceramics. Proper engagement in the design process ensures that students understand and value the costs of different materials and employ solutions that minimize resource requirements. Access to these types of consumable materials is fundamental to success.

Tools and Equipment

Technological activity is 'doing' and requires tools and equipment.

Using tools and equipment requires development of technical knowledge and skills. Although one could technically and meaningfully say that students develop these in the context of the problem they are solving, there are practical constraints. If employed, an open approach to technological activity would require that almost any tool or machine be made available if the solution requires its use-this approach is neither practical nor desirable. Technology education programs typically specify a representative set of tools and equipment to accommodate solution development and systems management for most student activities. Specialized tools and equipment may be required and made available for specific applications and courses. This may be accomplished, for example, by purchase or lease, or by partnering with public/private sector colleges, universities, employers, and/or institutions.

Choices of tools and equipment are based on a consideration of program implementation related to the technological systems under study, or required for solution development, including communications, production, energy/power, biotechnology, and management systems.

Time

Time is a significant technological resource.

Planning of technological activities must consider time required for various components of the process, including time to learn new concepts and skills.

Frequently, technological activities and processes are time-sensitive-once undertaken they must be completed on a schedule. This consideration has implications for learning and teaching, affecting class scheduling, types of learning experiences, and assessment and evaluation processes.

As a major technological resource, time is an important issue for student consideration. It is a major criterion they apply when generating ideas and developing work plans.

Equity and Diversity

The society of Atlantic Canada, like all of Canada, is linguistically, racially, culturally, and socially diverse. Our society includes differences in race, ethnicity, gender, ability, values, lifestyles, and languages. Schools should foster the understanding of such diversity. *Foundation for the Atlantic Canada Technology Education Curriculum* is designed to meet the needs, values, experiences and interests of all students.

In a learning community characterized by mutual trust, acceptance, and respect, student diversity is both recognized and valued. All students are entitled to have their personal experiences and their racial and ethnocultural heritage valued within an environment that upholds the rights of each student and requires students to respect the rights of others. Teachers have a critical role in creating a supportive learning environment that reflects the particular needs of all students. Educators should ensure that classroom practices and resources positively and accurately reflect diverse perspectives and reject prejudice attitudes and discriminatory behaviours.

To contribute to the achievement of equity and quality in education, curriculum must

- reflect students' abilities, needs, interests, and learning styles
- expect that all students will be successful regardless of gender, racial and ethnocultural background, socio-economic status, lifestyle, or ability
- enable students to value individual variation among members of their classroom community

To enhance students' ability to appreciate diversity, instructional practices need to

- foster a learning environment which is free from bias and unfair practices
- promote opportunities to develop positive self-images that will enable students to transcend stereotypes and develop as individuals
- promote communication and understanding among those who differ in attitude, knowledge, points of view, and dialect, as well as among those who are similar
- encourage and enable students to question their own assumptions, and imagine, understand, and appreciate realities other than their own
- promote the equitable sharing of resources, including teacher attention and support
- encourage students to examine and critique materials, resources, and experiences for bias and prejudice
- examine historical and current equity and bias issues
- promote opportunities in non-traditional careers and occupations
- encourage students to challenge prejudice and discrimination

The Atlantic provinces, through the APEF and their departments of education, are committed to using accepted equity principles and practices in approving new curricula and resources.

Technology education curriculum outcomes provide a framework for a range of learning experiences for all students. Technology educators adapt learning contexts, including classroom organization, teaching strategies, time, and learning resources to provide support and challenge for all students, using curriculum outcomes in a flexible way to plan learning experiences appropriate to students' individual learning needs. Technology education provides opportunities for all students to develop confidence in themselves as learners and to experience learning success.

Roles within Education

Community

In addition to the school, teachers, and parents, the community includes volunteers, service and youth groups, cultural groups, business and media agencies, professional organizations, and other groups.

It is important for the community to view the education of youth as a shared responsibility. As partners, the school and community can take measures to promote student growth as technologically literate and capable citizens, including

- involving the school in the community, for example, by sponsoring design competitions that encourage students to offer solutions to community issues and problems
- creating joint-venture projects that make use of shared school and community technological facilities and resources
- providing experts and mentors who have specialized technological knowledge and capabilities
- promoting the flow and exchange of technological ideas, expertise, and resources
- providing opportunities for teachers to develop new capabilities and competencies by interacting with design and other professionals, and by participating in work-related activities with business and industry

- creating opportunities for students to explore the workplace
- creating opportunities for students to assess the roles of technology in the community and the workplace
- providing proper standards of health and safety appropriate to facilities used in technology education
- participating in the continuing conversation about education

The Education System

An education system can generally be said to include the department of education, universities and colleges, school boards/districts, and schools.

Each organization has professional staff and may have advisory councils and/or committees. These organizations have various roles and responsibilities and make important decisions that affect the teaching and learning of technology education. They employ a number of strategies and actions to positively affect student achievement in technology education, including expanding the commonly held notion of technology as product to include technology as knowledge and strategy by

- allocating personnel and other resources to ensure that students have the means and opportunity to develop technological solutions to problems and to assess and manage a representative variety of technological systems
- recognizing that technology education teachers have specific needs with respect to technological literacy and capability, and providing opportunities for relevant professional growth and the continuous development of administrators and curriculum personnel at all levels of the education system
- providing mechanisms to address, and encourage discourse on, controversial technologies
- ensuring that programs at all levels are anti-discriminatory and provide for equity of access
- ensuring that the learning environment meets standards of health and safety
- ensuring that technology education facilities accommodate the learning needs of all students and enable students to achieve the curriculum outcomes

School Administrators

Administrators have a significant impact on implementation of a quality technology education curriculum.

Principals and other administrators take specific actions to support learning and teaching of technology education, including

- ensuring that teachers have appropriate support and opportunities for continuing professional development
- working with technology education teachers to ensure that the technology education facility is adequately and safely configured to provide varied learning experiences
- working with technology education teachers to ensure that the variety of resources and experiences available meet the needs of all learners
- working with technology education teachers to ensure that the learning experiences, instructional techniques, assessment strategies, learning environment, and use of resources are consistent with those described in this document
- ensuring equitable access to technology education facilities and other learning resources
- working collaboratively with teachers to plan, facilitate, and support technology education experiences and related events

Teachers

Teachers play a significant role in implementing technology education. Teachers

- structure and organize the learning environment
- select teaching strategies from a wide repertoire
- provide appropriate instruction
- demonstrate proper selection and application of technological systems, tools, and other resources

- demonstrate safe and proper care, operation, and use of tools and equipment across information, physical, and biotechnological systems for design and fabrication of technological solutions
- ensure that students have technological problem-solving experiences with a wide range of problem situations
- provide guidance in assessing the consequence of technological choice and actions
- monitor, assess, evaluate, and report on student learning
- provide students with guidance and experience in assessing their own technological solutions
- provide students with guidance and experience in assessing their own technological literacy and capability
- provide students with opportunities to assess the role of technology in daily life, and in the workplace, and the nature of careers
- model behaviour consistent with that of a technologically literate and capable person
- demonstrate that they employ technological problem-solving and related strategies and processes in their daily life
- demonstrate capability and common sense in their technological choices and activities
- demonstrate willingness to articulate new and novel ideas, to take intellectual risks, and to critically evaluate their own ideas
- ensure that the technology education facility meets the health and safety needs of students

Parents/Guardians

Parents and guardians contribute significantly to the achievement of their children in technology education by

- building their personal technological literacy and capability
- encouraging their children to take intellectual risks
- encouraging their children to investigate their own areas of interest in existing and emerging technologies
- engaging their children in conversations about technological issues and consequences in their homes, communities, and the world around them
- sharing in their children's successes
- communicating regularly with the teacher/school
- sharing areas of technological expertise/interest with the teacher/school
- volunteering to assist with various activities in the technology facilities or school
- supporting school policies and goals
- participating in decision making by taking part in parent-teacher organizations and/or school advisory councils
- providing a positive role model with respect to safe and proper use of technological tools and processes

Students

Taking ownership and responsibility for their own learning is a significant element in the growth of a student's technological capability. Doing so implies choice and opportunities to develop responsible habits of thought and action. Students need opportunities to

- identify, assess, and make decisions about their use of technological resources
- assess their technological literacy/capability in the context of specific situations
- develop personal action plans to acquire specific technical skills and capabilities
- safely use a wide variety of technological systems, tools, and other resources
- identify and address technological issues and situations important to them
- design, develop, and articulate technological solutions to a wide range of problems
- articulate ideas and take intellectual risks
- reflect on and evaluate their learning
- reflect on, evaluate, and express ideas and opinions on the relationship between technology and education and the role of technology education
- assess technology as a force for change in a variety of workplaces, jobs, occupations, and careers

Assessing and Evaluating Student Learning

Assessment and evaluation are essential components of learning and teaching in technology education. Without effective assessment and evaluation it is impossible to know whether students have learned, whether teaching has been effective, or how best to address student learning needs. The quality of assessment and evaluation in the educational process has a profound and well-established link to student performance. Research consistently shows that regular monitoring and feedback are essential to improved student learning. What 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, what elements of quality are considered most important, and how well students are expected to perform.

Teacher-developed assessments and evaluations have a wide variety of uses, such as

- providing feedback to improve student learning
- determining whether curriculum outcomes have been achieved
- certifying that students have achieved certain levels of performance
- setting goals for future student learning
- communicating with parents about their children's learning
- providing information to teachers on the effectiveness of their teaching, the program, and the learning environment
- meeting the needs of guidance and administrative personnel

Assessment

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

To determine how well students are learning, assessment strategies have to be designed to systematically gather information on the achievement of the curriculum outcomes.

In planning assessments, teachers should use a broad range of strategies in an appropriate balance to give students multiple opportunities to demonstrate their knowledge, skills, and attitudes. Many types of assessment strategies can be used to gather such information, including, but not limited to,

- formal and informal observations
- work samples
- anecdotal records
- conferences
- teacher-made and other tests
- portfolios
- learning journals
- questioning
- performance assessment
- peer- and self-assessment

Evaluation

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

Evaluation involves teachers and others in analysing and reflecting upon information about student learning gathered in a variety of ways.

The process requires

- developing clear criteria and guidelines for assigning marks or grades to student work
- synthesizing information from multiple sources
- weighing and balancing all available information
- using a high level of professional judgment in making decisions based upon information

Reporting

Reporting on student learning should focus on the extent to which students have achieved the curriculum outcomes.

Reporting involves communicating the summary and interpretation of information about student learning to various audiences who require it. Teachers have a special responsibility to explain accurately what progress students have made in their learning and to respond to parent and student inquiries about learning.

Narrative reports on progress and achievement can provide information on student learning that letter or number grades alone cannot. Such reports might, for example, suggest ways in which students can improve their learning and identify ways in which teachers and parents can best provide support.

Effective communication with parents regarding their children's progress is essential in fostering successful home-school partnerships. Other means include the use of conferences, notes, and phone calls.

Guiding Principles

In order to provide accurate, useful information about the achievement and instructional needs of students, certain guiding principles for the development, administration, and use of assessments must be followed.

Principles for Fair Student Assessment Practices for Education in Canada (1993) articulates five basic assessment principles, as follows:

- Assessment strategies should be appropriate for and compatible with the purpose and context of the assessment.
- Students should be provided with sufficient opportunity to demonstrate the knowledge, skills, attitudes, or behaviours being assessed.
- Procedures for judging or scoring student performance should be appropriate for the assessment strategy used and be consistently applied and monitored.
- Procedures for summarizing and interpreting assessment results should yield accurate and informative representation of a student's performance in relation to the curriculum outcomes for the reporting period.
- Assessment reports should be clear, accurate, and of practical value to the audience for whom they are intended.

These principles highlight the need for assessment which ensures that

- the best interests of the student are paramount
- assessment informs teaching and/or promotes learning
- assessment is an integral and ongoing part of the learning process and is clearly related to the curriculum outcomes
- assessment is fair and equitable to all students and involves multiple sources of information

While assessments may be used for different purposes and audiences, all assessment must give each student optimal opportunity to demonstrate what he/she knows and can do.

Assessing Student Learning in the Technology Education Classroom

Because of the nature of technology, assessing and evaluating student learning in technology education has specific considerations:

- Assessment strategies, integral to design activities, are seamless components of the learning experience.
- Technology education outcomes are the basis for assessment.
- Collaborative strategies, essential to all technological activities undertaken by students, provide a model that makes the student a partner in assessment.
- Students engaged in technological activities are required to assess their own learning and interpret that assessment as a component of the activity.
- Experiential authenticity, expressed by the use of real-world problems, systems, and resources, is critical to growth in technological capability.

Growth in capability is exhibited in a variety of ways. These include tacit and other forms of technological knowledge, technical proficiency, development of technological solutions, assessment and management of technological systems, collaborative and team management skills, and students' evaluation of their own technological solutions and processes. Assessment tools have to be effective across all these forms of evidence. In addition to the standard assessment tools and techniques employed in all subject areas, the following merit special consideration for technology education.

The Design Brief

The design brief, negotiated between student and teacher, sets the conditions under which the student engages in a design activity.

The brief parallels the industrial and commercial practice of design briefs and contracts, with one notable difference-design professionals are assessed mainly on the solution to the problem, while students are assessed mainly on growth in design capability.

The Design Portfolio

The student's design portfolio is essentially a diary of the progress of the design activity. It contains all relevant information, especially trial and error information. It is used to illustrate the thinking and planning processes that students engage in while developing a technological solution to a problem. Assessment of process is often indirect, in that the evidence comes from a variety of sources. The value of the portfolio comes from how well it represents the process.

A design portfolio, containing the facts of what transpired and documenting students' decision-making processes, is a significant tool in assessing growth in design capability. Employing the major phases of the design process as headings, it documents

- processes and components that were successful, and those that were not
- topics of discussion if decisions had to be made
- decisions
- the rationale for decisions
- the student's evaluation of the process and the solution

Other evidence of student progress provided by the portfolio includes use of technical language and terminology, use of technical drawings, and the organization and technical presentation of the material.

The Solution

Students' technological solutions are assessed and evaluated by both students and teachers with respect to the design brief.

Solutions typically result in a product or service that can be examined, assessed, and evaluated as an independent entity. The context for assessment and evaluation is the design brief. It provides the problem statement and the conditions under which the problem will be resolved. A valid assessment of the solution requires a determination of how the designers addressed not just the problem but also the constraints and conditions.

Student assessments provide evidence of how students considered the criteria, how the criteria affected their decision making, and what, if anything, they did about it. These are important issues for assessing growth in design capability.

The Report

The report is an opportunity for students and student design teams to demonstrate how they solved the problem, why they made particular choices, and how the solution could be improved, extended, and/or adapted to different circumstances.

Typically the report takes the form of an individual or design team presentation. Presenting to the client (as represented by the teacher and the class) at various stages of the process is an important part of design. Assessment of the report should consider, among other things,

- organization
- completeness
- appropriate use of technical language
- evidence that students have a developmentally appropriate grasp of the issues arising from the problem and the solution
- evidence of growth in collaborative and team skills

External Assessment

Administration of externally prepared assessments is on a large scale in comparison to classroom assessments, and often involves hundreds, sometimes thousands of students, allowing for use of results at the provincial, district and/or school levels. Depending on the comprehensiveness of the assessment, information can be used for all of the same purposes as classroom-based assessment, but it can also serve additional administrative and accountability purposes, such as for admissions, placement, student certification, educational diagnosis, and program evaluation. External assessments offer common standards for assessment and for administration, scoring, and reporting that allow for comparison of results over time.

As part of the regional agenda, development of external assessments in specific curricular areas is being undertaken. Generally, external assessment includes assessments prepared by departments of education, national and international assessment groups, publishers, and research groups. Each provincial department of education makes decisions on whether or not to administer external assessments.

Program and System Evaluation

The results from both external and internal assessments of student achievement can be used to varying degrees for program and system evaluation.

External assessment results, however, are more comparable across various groups and are therefore more commonly the basis for these types of evaluations.

In essence, the main difference between student evaluation and program and system evaluation is in how the results are used. In program evaluation, marks or scores for individual students are not the primary focus of the assessment-it is the effectiveness of the program that is evaluated, and the results are used to show the extent to which the many outcomes of the program are achieved.

When results are used for system evaluation, the focus is on how the various levels and groups within the system, such as classrooms, schools, districts, and so on, are achieving the intended outcomes. In many ways, student and program evaluation are very much the same in that both emphasize obtaining student information concerning their conceptual understanding, their ability to use knowledge and reason to solve problems, and their ability to communicate effectively.

Glossary

Capability is an expression of understanding, ability, and desire through a deliberate action. Capability increases through doing.

Design is a specific form of technological problem solving, often associated with manufacturing industries, and professions such as architecture or engineering. While variations in procedure exist across the many implementations of design, there are important commonalities. Design has a specific function to provide a solution to the problem or opportunity, and success or failure is determined in that context. It must occur within the boundaries of pre-set constraints with respect to factors such as time, money, and other resources, and usually within specific rules and regulations.

Design Brief is a widely used mechanism that is structured to ensure the designer and the client both understand the problem that is to be solved, the scope of the work to be undertaken, any conditions or criteria that apply to the solution, and an indication of what constitutes a satisfactory solution. Note that the latter does not necessarily determine what the solution will be, or what it will look like. When used with students in a technology education program, the design brief provides guidelines to the student, and is frequently structured to ensure that the student works within specific constraints, including a range of tools and resources.

Design Portfolio is a tool used in technology education to help students understand the process of design, the evolution of their ideas, and the rationale for their decisions. It is also a tool used for assessment of student achievement, particularly with respect to growth in design capability. It usually takes the form of a diary of activities, actions, and decisions, and the reasons for them, and includes a collection of all (or samples) ideas, and materials developed as part of the evolution of the solution, commencing with the design brief and concluding with the evaluation of the solution.

Develop is using a variety of processes and materials to make or fabricate a working solution as part of a design activity.

Educational Technology is the use of multimedia technologies or audio-visual aids, including computers, as tools to enhance the teaching and learning process.

Evaluate is to determine quality, worth, condition, or suitability of technological resources, systems, or products.

Information Literacy is the ability to access, interpret, evaluate, organize, select, produce, and communicate information in and through a variety of media technologies and contexts.

Innovation is the use of non-traditional strategies. It is characterized by abrupt, radical, or complete changes in practice and/or outcomes. It results in something new.

Instructional Technology is the use of computers, multimedia, and other technological tools to enhance the teaching and learning process. Sometimes referred to as Educational Technology.

Invention is the deliberate creation of a product, system, or service that is new, novel, or does something in a manner not possible before.

Making or Fabricating is bringing into being by shaping, changing, or combining materials.

Managing a System is making determinations about the functioning of a system, and making modifications to its operation in order to improve its function or its efficiency.

Materials are substances, either naturally occurring or human-made, which are employed in the fabrication of a product.

Problem Solving is the process of understanding a problem, devising a plan, carrying out the plan, and evaluating the plan in order to solve a problem or meet a need or want.

Systems are entities that perform a function that none of the components of the system could perform independently.

Technological Capability is an expression of ability and understanding through considered and planned action that combines technical skill and technological knowledge to achieve a desired result.

Technological Literacy is the ability of a person to assess, manage, use, and make informed decisions about the consequences of a wide variety of technological systems and resources.

Technological Problem Solving refers to a wide variety of strategies and methods that are used to develop solutions to problems of human adaptation of the environment to meet needs and wants. Collectively, these strategies indicate a generic model that starts with identification of need or problem, moves to identification of solutions, then to the application of resources to develop the solution, and finally to implementation of the solution. Technological action and solutions always have consequences-good, bad, known, and unknown-that generally lead to new needs, wants, problems, and opportunities.

Technological Resources include people, information, knowledge, time, money, tools and machines, and materials. Technological resources are consumed in all human activities. Food, for example, is a technological resource, produced through a variety of technological means, essential for the human body and mind to function.

Technological Responsibility is understanding the consequence of technological activity, taking appropriate action, and taking responsibility for that action.

Technological Systems, which include products and environments, are physical, informational, and biotechnological.

Technology is how humans modify the world around them to meet their needs and wants, or to solve practical problems. Technology includes process, knowledge, and product. As a result of technological activity, resources are consumed to develop the human/made world.

Technology Education is a program of study consisting of activities, modules, and courses with the purpose of developing technological literacy, capability, and responsibility, particularly with respect to design and technological systems across a wide variety of situations and technologies.

Technology Laboratory/Classroom is the formal environment in school where the study of technology takes place. At the elementary level this will most likely be the regular classroom. At the secondary level this will most likely be a separate laboratory with areas for hands-on activities, as well as group instruction.

Troubleshooting is assessing non-functioning systems with the intent to repair or otherwise restore the system to full functionality. Troubleshooting requires understanding of the system and its components, and employs logical procedures.

Essential Graduation Learnings

Purpose

This document has been designed to illustrate the relationship between the Atlantic Canada essential graduation learnings and the regionally-developed public school curriculum in the four provinces.

Background

The Atlantic provinces departments of education and their partners have been collaborating on the development of curriculum since 1995. This collaboration has resulted in the production of high quality and timely materials, shared expertise and resources, strengthened professional contacts and networks, and consolidated purchasing power.

The common curriculum development process began with the identification and validation of statements of essential graduation learnings for all schools in Atlantic Canada.

The essential graduation learnings statements offer students clear goals and a powerful rationale for students' school work. Essential graduation learnings statements were developed from the mission statements of the four Atlantic provinces to provide a vision for the development of a relevant curriculum for students from school entry to grade 12. They help ensure that the provincial mission statements are met by design and intention.

Mission Statements

New Brunswick
… to have each student develop the attitudes needed to be a lifelong learner, to achieve personal fulfillment, and to contribute to a productive, just and democratic society.

Newfoundland and Labrador
… to enable and encourage every individual to acquire, through lifelong learning, the knowledge, skills and values necessary for personal growth and the development of society.

Nova Scotia
… to provide excellence in education and training for personal fulfillment and for a productive, prosperous society.

Prince Edward Island
… to provide for the development of children so that each may take a meaningful place in society.

Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students graduating 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 the knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries. They also prepare students to be ready to meet the current and emerging opportunities, responsibilities, and demands of life after graduation. Provinces may add essential graduation learnings statements as required. The essential graduation learnings are as follows:

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.

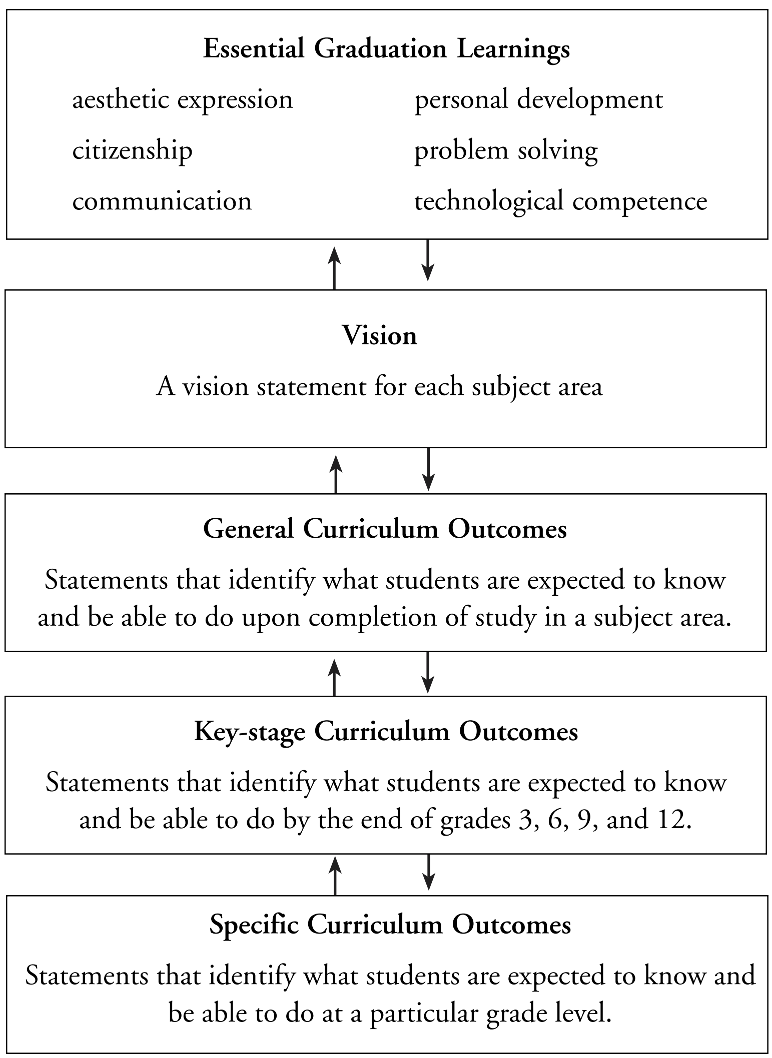
Technological Competence
Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

Curriculum Development Framework

For each curriculum area the process is the same, starting with the development of a foundation document. Foundation documents describe general and key-stage curriculum outcomes for a particular subject area. They also describe exemplary learning environments and act as the basis for grade-level specific curriculum development.

Foundation documents are now available for arts education, English language arts, French immersion, core French (orientation document), mathematics, science, social studies, and technology education. The outcomes on the following pages illustrate how key-stage curriculum outcomes, taken as examples from current foundation documents, relate to the essential graduation learnings. The outcomes of provincial subject areas also contribute to the achievement of the essential graduation learnings.

After general and key-stage curriculum outcomes are developed and validated, curriculum for each grade may be developed.



Essential Graduation Learnings and Curricululm Outcomes

Essential Graduation Learnings	Sample Outcomes (from Foundation Documents)
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.	For example, students will be expected to: use patterns to solve problems (grade 3 mathematics) describe how culture is preserved, modified, and transmitted (grade 6 social studies) demonstrate awareness of the power of spoken language to influence and manipulate, and to reveal ideas, values, and attitudes (grade 9 English language arts) interpret and represent a range of thoughts, images, and feelings using and responding to non-verbal gestures (grade 12 music)
Citizenship Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.	For example, students will be expected to: demonstrate an awareness of visual images and their daily effects on people (grade 3 visual arts) account for effects of cultural diversity on technological solutions (grade 9 technology education) evaluate social issues related to the applications and limitations of science and technology, and explain decisions in terms of advantages and disadvantages for sustainability, considering a variety of perspectives (grade 12 science) recognize and explain the interdependent nature of relationships among individuals, societies, and the environment (grade 6 social studies)
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.	For example, students will be expected to: describe, extend, and create a wide variety of patterns and relationships to model and solve problems involving real-world situations (grade 6 mathematics) communicate questions, ideas, intentions, plans, and results using lists, notes in point form, sentences, data tables, graphs, drawing, oral language, and other means (grade 9 science) create dances that express and communicate ideas of personal significance (grade 3 dance) articulate and justify a personal vision of a sustainable future (grade 12 social studies)

Essential Graduation Learnings	Sample Outcomes (from Foundation Documents)
Personal Development Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.	For example, students will be expected to: demonstrate increasing awareness of healthy and safe practices when engaging in technological activity (grade 6 technology education) access, select, and research, in systematic ways, specific information to meet personal and individual learning needs (grade 12 English language arts) show interest in and curiosity about objects and events within the immediate environment (grade 3 science) create a movement sequence that communicates a social theme (grade 9 dance)
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.	For example, students will be expected to: analyse and evaluate historical and contemporary developments in order to make informed, creative decisions about issues (grade 9 social studies) ask discriminating questions to acquire, interpret, analyse, and evaluate ideas and information (grade 12 English language arts) conduct design studies to identify a technological solution to a problem (grade 6 technology education) examine a range of possible solutions to problems encountered in their drama work, and reflect on their decisions (grade 9 drama)
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.	For example, students will be expected to: create written and media texts using a variety of forms (grade 3 English language arts) use maps, globes, pictures, models, and other technologies to represent and describe physical and human systems (grade 6 social studies) operate, monitor, and adjust a representative range of technological systems (grade 9 technology education) appreciate that the applications of science and technology can raise ethical dilemmas (grade 12 science)