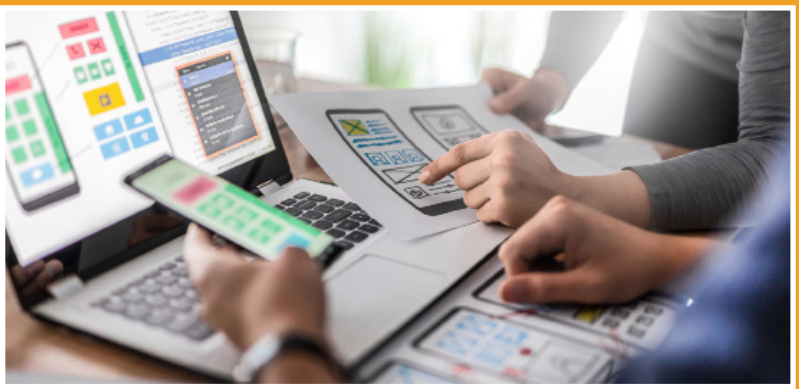
CMP621A



COMMUNICATION & INFORMATION TECHNOLOGY

Computer Science 621A

Curriculum Guide

Prince Edward Island
CANADA

ACKNOWLEDGMENTS

The Prince Edward Island Department of Education and Early Years (DEEY) gratefully acknowledges the contributions of the following individuals in the development of the Computer Studies CMP621A curriculum guide.

Mark Lamey	Bluefield Senior High School
Andrew Pauls	Charlottetown Rural Senior High School
Andrew MacDougald	Colonel Gray Senior High School
Sandy Gallant	Morell Regional High School
Paige Wright	Montague Regional High School
Ken MacMillan	Three Oaks Senior High School
John Stephens	Department of Education and Lifelong Learning
Devin Clayton	Department of Education and Lifelong Learning

Further acknowledgment to all Computer Information Technology teachers across Prince Edward Island for their experience and knowledge. The conversations and feedback received throughout the process was critical to the completion of this document.

Prince Edward Island
Department of Education and Lifelong Learning
250 Water Street, Suite 101
Summerside, Prince Edward Island, Canada, C1N 1B6
Tel: (902) 438-4130. Fax: (902) 438-4062
www.princeedwardisland.ca

Implementation: February, 2023

TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

Vision of Program

Communication and Information Technology (CIT) is more than computers and computing systems. Learners who have a working understanding of information communication technology principles and practices and who can think computationally will be better prepared to take advantage of opportunities in the modern digital world. Leveraging computational thinking and practical understanding of computer-based technology will help build learner confidence and competency. This allows learners to explore a wide range of disciplines and complete meaningful work. CIT challenges students to explore, find, and apply solutions to solve problems in all other fields of study.

Goals of Communication and Information Technology

The goals for Communication and Information Technology are to:

- develop skill and competence through the study of CIT enabling the learner to actively participate, not merely consume, in the modern digital world;
- support an environment of exploration and experimentation, normalizing failure as learning opportunities in the pursuit of understanding the world around us in computational terms;
- make connections between CIT and other fields of study that require technological literacies, enabling the agility required for learners to actively engage
  in the development and implementation of their own career plans. (e.g., postsecondary education, entrepreneurship, or within other working opportunities);
- develop the tools learners need to develop their sense of digital wellbeing and apply technological habits in order to achieve their own personal digital wellbeing goals; and
- reflect critically on thinking processes enabling learners to explore a broad range of transferable problem-solving skills and techniques.
- explore curiosity and creativity by creating artifacts that promote innovative thinking, problem solving, and collaboration.

Purpose of Curriculum Guide

The overall purpose of this curriculum guide is to advance computer science education through teaching and learning, and, at the same time, recognize and validate effective practices that already exist in many classrooms.

More specifically, this curriculum guide

- provides detailed curriculum outcomes to which educators and others can refer to when making decisions concerning learning experiences, instructional techniques, and assessment strategies for computer science;
- informs both educators and members of the general public about the philosophy and scope of computer science education for the senior high school level in Prince Edward Island; and
- promotes the effective teaching and learning of computer science.

Essential Graduation Competencies

Curriculum is designed to articulate what learners are expected to know and be able to do by the time they graduate from high school. The PEI Department of Education and Early Years designs curriculum that is based on the Atlantic Canada Framework for Essential Graduation Competencies released by the Council of Atlantic Ministers of Education and Training (CAMET 2015).

Competencies articulate the interrelated sets of attitudes, skills, and knowledge—beyond foundational literacy and numeracy—that prepare learners to successfully participate in lifelong learning and life/work transitions. They are cross-curricular in nature and provide opportunities for interdisciplinary learning. Six competencies have been identified: citizenship, communication, personal-career development, creativity and innovation, critical thinking, and technological fluency (Figure 1). Achievement of the essential graduation competencies (EGCs) will be addressed through the assessment and evaluation of curriculum outcomes developed for individual courses and programs.

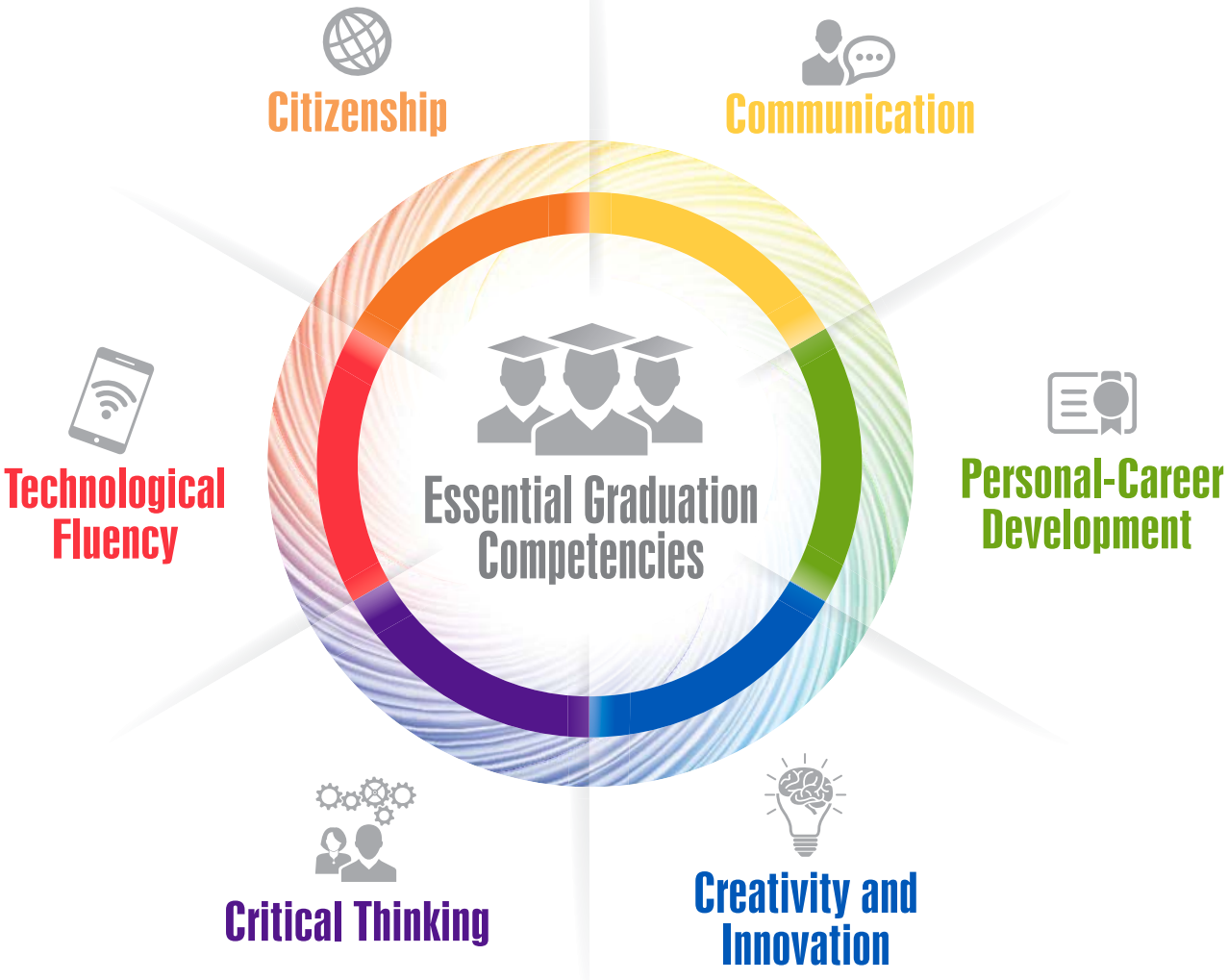


Figure 1. Essential Graduation Competencies

Critical Thinking

Learners are expected to analyse and evaluate evidence, arguments, and ideas using various types of reasoning and systems thinking to inquire, make decisions, and solve problems. They reflect critically on thinking processes.

Learners are expected to

- use critical thinking skills to inquire, make decisions, and solve problems;
- recognize that critical thinking is purposeful;
- demonstrate curiosity, inquisitiveness, creativity, flexibility, persistence, open- and fair-mindedness, tolerance for ambiguity, and suspension of judgment;
- ask powerful questions which support inquiry, decision-making, and problem solving;
- acquire, interpret, and synthesize relevant and reliable information from a variety of sources;
- analyse and evaluate evidence, arguments, and ideas;
- use various types of evidence, reasoning, and strategies to draw conclusions, make decisions, and solve problems;
- reflect critically on thinking processes used and acknowledge assumptions;
- effectively communicate ideas, conclusions, decisions, and solutions; and
- value the ideas and contributions of others who hold diverse points of view.

Technological Fluency

Learners are expected to use and apply technology to collaborate, communicate, create, innovate, learn, and solve problems. They use technology in a legal, safe, and ethically responsible manner.

Learners are expected to

- recognize that technology encompasses a range of learning tools and contexts;
- use and interact with technology to create new knowledge;
- apply digital technology to gather, filter, organize, evaluate, use, adapt, create, and share information;
- select and use technology to impact and advance one another; and
- adopt, adapt, and apply technology efficiently, effectively, and productively.

Citizenship

Learners are expected to contribute to the quality and sustainability of their environment, communities, and society. They analyse cultural, economic, environmental, and social issues; make decisions and judgments; and solve problems and act as stewards in a local, national, and global context.

Learners are expected to

- recognize the principles and actions of citizens in just, pluralistic, and democratic societies;
- demonstrate the disposition and skills necessary for effective citizenship;
- consider possible consequences of decisions, judgment, and solutions to problems;
- participate in civic activities that support and promote social and cultural diversity and cohesion; promote and protect human rights and equity;
- appreciate the complexity and inter-connectedness of factors in analysing issues; and
- demonstrate understanding of sustainable development.

Communication

Learners are expected to express themselves and interpret effectively through a variety of media. They participate in critical dialogue, listen, read, view, and create for information, enrichment, and enjoyment.

Learners are expected to

- listen and interact purposefully and respectfully in formal and informal contexts;
- engage in constructive and critical dialogue;
- understand, interpret, and respond to thoughts, ideas, and emotions presented through multiple media forms;
- express ideas, information, learnings, perceptions, and feelings through multiple media forms, considering purpose and audience;
- assess the effectiveness of communication and critically reflect on intended purpose, audience, and choice of media; and
- analyse the impact of information and communication technology.

Personal-Career Development

Learners are expected to become self-aware and self-directed individuals who set and pursue goals.

They understand and appreciate how culture contributes to work and personal life roles. They make thoughtful decisions regarding health and wellness, and career pathways.

Learners are expected to

- connect learning to personal and career development;
- demonstrate behaviours that contribute to the well-being of self and others;
- build healthy personal and work relationships;
- establish skills and habits to pursue physical, spiritual, mental, and emotional well-being;
- develop strategies to manage career balance and wellness;
- create and implement a personal, education, career, and financial plan to support transitions and achievement of personal, education, and career goals; and
- demonstrate preparedness to learn and work individually, cooperatively, and collaboratively in diverse, evolving environments.

Creativity and Innovation

Learners are expected to demonstrate openness to new experiences; to engage in creative processes; to make unexpected connections; and to generate new and dynamic ideas, techniques, and products. They value aesthetic expression and appreciate the creative and innovative work of others.

Learners are expected to

- gather information through all senses to imagine, create, and innovate;
- develop and apply creative abilities to communicate ideas, perceptions, and feelings;
- take responsible risk, accept critical feedback, reflect, and learn from trial and error;
- think divergently, and embrace complexity and ambiguity;
- recognize that creative processes are vital to innovation;
- use creation techniques to generate innovations;
- collaborate to create and innovate;
- critically reflect on creative and innovative works and processes; and
- value the contribution of creativity and innovation.

General Curriculum Outcomes (GCOs)

General curriculum outcome statements articulate what learners are expected to know and be able to do upon completion of study in the Communication and Information Technology courses.

Table 1. CIT General Curriculum Outcomes

Strand	Description
GCO 1	Technological Problem Solving Learners will be expected to design, develop, evaluate,and articulate technological solutions.
GCO 2	Technological Systems Learners will be expected to operate and manage technological systems.
GCO 3	History and Evolution of Technology Learners will be expected to demonstrate an understanding of the history and evolution of technology,and of its social and cultural implications.
GCO 4	Technology and Careers Learners will be expected to demonstrate an understanding of current and evolving careers and of the influence of technology on the nature of work.
GCO 5	Technological Responsibility Learners will be expected to demonstrate an understanding of the consequences of their technological choices.

Specific Curriculum Outcomes (SCOs)

Specific curriculum outcomes (SCOs) identify what learners are expected to know and be able to do for a particular course. They provide a focus for instruction in terms of measurable or observable learner performance and are the basis for the assessment of learner achievement across the province. PEI specific curriculum outcomes are developed with consideration of Bloom's Taxonomy of Learning and the Essential Graduation Competencies.

SCOs will begin with the phrase—Learners are expected to… .

Achievement Indicators (AIs)

Each specific curriculum outcome is described by a set of achievement indicators that aid in defining and demonstrating the depth and breadth of the corresponding SCO.

Taken together as a set, AIs support the SCO in defining specific levels of knowledge acquired, skills applied, or attitudes demonstrated by a learner for that particular outcome. Achievement indicators provide clarity for understanding and ensure instructional design is aligned to the SCO.

When planning for instruction, teachers must be mindful of the complete set of achievement indicators in order to fully understand the breadth and depth of the outcome. Teachers may alter, or add to, the existing indicators to be responsive to the interests, lives, and prior knowledge of learners. It is important to note that changes to the given indicators must be reflective of, and consistent with, the intended breadth and depth of the outcome.

The set of achievement indicators for a given outcome begins with the phrase—Learners who have achieved this outcome should be able to… .

Elaborations

An elaboration provides a fuller description of the SCO and the instructional intent behind it. It provides a narrative for the SCO, gives background information where possible, and offers a broader context to help teachers gain a deeper understanding of the scope of the SCO. This may also include suggestions and/or reference supporting resources that may be helpful for instruction and assessment of the SCO.

Bloom's Taxonomy

Bloom's Taxonomy was published in 1956 as a framework for classifying expectations for student learning as indicated by educational outcomes. David Krathwohl's 2002 revision of this taxonomy expands on the original work by defining the relationship between the cognitive process dimension—how we expect learners to come to know and think about the outcome—and the knowledge dimension—the category of knowledge expressed by the outcome.

A full understanding of the relationship between the cognitive process and knowledge dimensions of Bloom's Taxonomy will serve learners, teachers, and administrators by:

- providing a framework for developing the specific curriculum outcomes (SCOs) for a particular course;
- identifying the type of knowledge and cognitive process of the outcome;
- providing a means for the alignment of specific curriculum outcomes with instructional activities and assessments; and
- providing a common language about the curriculum outcomes within all subjects to facilitate communication

Cognitive Process Dimension

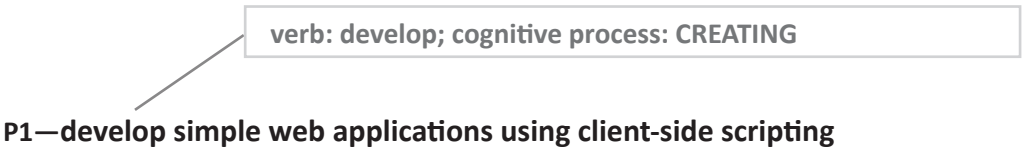
The cognitive process dimension classifies six types of cognition that learners may be expected to demonstrate or use as they work towards proficiency of any given specific curriculum outcome. The verb(s) that begins a specific curriculum outcome identifies the cognitive process dimension.

Table 2. Bloom's Taxonomy—Cognitive Process Dimension

Category	Description
Remembering	Retrieve, recall, and/or recognize specific information or knowledge from memory.
Understanding	Construct meaning from different sources and types of information, and explain ideas and concepts.
Applying	Implement or apply information to complete a task, carry out a procedure through executing or implementing knowledge.
Analysing	Break information into component parts and determine how the parts relate or interrelate to one another or to an overall structure or purpose.
Evaluating	Justify a decision or course of action, problem solve, or select materials and/or methods based on criteria and standards through checking and critiquing.
Creating	Form a coherent functional whole by skillfully combining elements together and generating new knowledge to guide the execution of the work.

SCO Structure

Examining the structure of a specific curriculum outcome is necessary to fully understand its intent prior to planning instruction and assessment. The verb(s) in the outcome relates to the expected level and type of thinking (cognitive process). A noun or noun phrase communicates the type of knowledge (i.e., factual, conceptual, procedural, or metacognitive) that is the focus of the outcome.



Curriculum Guide Layout

The curriculum guide layout is designed to highlight the critical elements/features of the provincial curriculum required for a given course.

Table 3. Details of Curriculum Guide Layout

Feature	Description
Unit Name	Appears in the upper left hand corner.
SCO Block	Appears in the coloured box; contains the cognitive process level
AI List	Appears in the body of the page immediately following the SCO.
EGC Map	Appears at the bottom of the page.

Name of Curriculum Unit

PROGRAMMING

Specific curriculum outcome (SCO)

P3	*Learners are expected to ...*
	develop simple web applications using client-side scripting

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Cognitive process level for this particular SCO

Achievement Indicators

Learners who have achieved this outcome should be able to ...

Set of achievement indicators (AIs)indicating "breadth and depth" of SCO

a. demonstrate an understanding of fundamental programming concepts, including data types, variables, control structures (conditionals and loops), and functions;
b. apply separation of concerns in programming, in which code for structure, styling, and behaviour is arranged in clearly separated files or modules;
c. apply debugging strategies to identify logical or syntactic coding errors;
d. apply documentation to code to enhance understanding, maintainability, and collaboration;
e. refactor existing code to improve efficiency, readability, or maintainability;
f. manipulate web page content and style using the Document Object Model (DOM);
g. develop simple web applications that respond to user actions; and
h. develop readable, efficient, and maintainable code.

Essential Graduation Competencies Map

	Citizenship		Critical Thinking		Personal-Career Development	Essential Graduation Competencies
✓	Communication	✓	Technological Fluency	✓	Creativity and Innovation	

Assessment and Evaluation

Assessment and evaluation are integral components of the teaching and learning process. They are continuous activities that are planned for and derived from specific curriculum outcomes (SCOs) and should be consistent with instruction. Effectively planned assessment and evaluation improves and guides future instruction. It also promotes learning, builds confidence, and develops learners' understanding of themselves as learners.

Students should know what they are expected to learn as designated by SCOs and the criteria that will be used to determine the quality of their achievement.

Assessment must provide opportunities for students to reflect on their progress, evaluate their learning, and set goals for future learning.

Assessment is the process of gathering evidence about student learning. Assessments need to be reflective of the cognitive process and type of knowledge indicated by the SCO ("Bloom's Taxonomy" on page 10). The achievement indicators inform teachers of the depth and breadth of skills, knowledge, and understandings expected for each SCO.

Assessment has three interrelated purposes:

- assessment for learning to guide and inform instruction (formative);
- assessment as learning to involve learners in self-assessment and setting goals for their own learning (formative); and
- assessment of learning to determine learner progress relative to curriculum outcomes (summative).

Triangulation is a process by which a teacher uses evidence about student learning from three different sources. These sources include conversations, observations, and products. Collecting data from a balance of these sources ensures reliable and valid assessment of student learning.

Evaluation involves analysing and reflecting upon various forms of evidence of student learning and making judgments or decisions regarding student learning based upon that evidence.

Effective assessment strategies

- must be valid in that they measure what is intended to be measured and are reliable in that they consistently achieve the same results when used again, or similar results with a similar group of learners;
- are appropriate for the purpose of instruction and learning strategies used;
- are explicit and communicate to learners and parents the expectations and criteria used to determine the level of achievement;
- are comprehensive and enable all learners to have diverse and multiple opportunities to demonstrate their learning consistently, independently, and in a range of contexts in everyday instruction;
- accommodate the diverse learning needs and experiences of the learners;
- allow for relevant, descriptive, and supportive feedback that gives learners clear directions for improvement, and engages learners in metacognitive self-assessment and goal setting that can increase their success as learners; and
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility of learning.

Social and Emotional Learning (SEL)

Social and Emotional Learning is the process through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions (Weissberg & Cascarino, 2013).

The benefits of social and emotional learning (SEL) are well-researched. Evidence demonstrates that an education integrated with SEL yields positive outcomes for learners, adults, and school communities. These findings include increased social and emotional skills, academic performance, mental wellness, healthy behaviours, school climate and safety, and positive lifetime outcomes (Durlak et al., 2011).

Learners will experience a sense of belonging and emotional safety when teachers develop a supportive atmosphere where learners feel valued and are encouraged to express their ideas and emotions. While SEL isn't a designated subject like history or math, it must be woven into a school's curriculum and community (Durlak et al., 2011; Wiglesworth et al., 2016). The following five skills provide examples of how social-emotional learning competencies can be incorporated into the curriculum:

Self-Awareness entails the understanding of one's own emotions, personal identity, goals and values. Integrating self-awareness involves planning activities and practices that help learners understand and connect with their thoughts, emotions, and strengths and how they influence behaviour;

Self-Management entails skills and attitudes that help learners to regulate emotions and behaviours. Integrating self-management involves developing learners' organizational skills, resilience, and goal-setting abilities through structured activities, personalized learning plans, and providing consistent feedback;

Social Awareness entails recognizing the perspective of those with the same or different backgrounds and empathizing and feeling compassion. Integrating social awareness involves incorporating diverse perspectives, cultural contexts, and collaboration while encouraging learners to understand and appreciate the broader societal implications of the content they are learning;

Relationship Skills entail the tools to establish and maintain healthy relationships and effectively navigate settings with different social norms and demands. Integrating relationship skills involves fostering collaborative projects, encouraging effective communication and teamwork, and enabling learners to develop positive interpersonal connections that enhance their learning experience; and

Responsible Decision-making entails the knowledge, skills and attitudes to make caring and constructive choices about personal behaviour and social interactions across diverse settings. Integrating responsible decision-making within lessons involves incorporating real-world scenarios, ethical considerations, and critical information analysis to make thoughtful choices.

Supporting English as an Additional Language (EAL) Learners

Multilingual learners add valuable experiences to the classroom. The linguistic knowledge and experiences of English as an additional language (EAL) learners can extend the understanding of the linguistic diversity of all learners. When the language, prior knowledge, and culture of EAL learners are valued, respected, and incorporated into learning, the learning environment is enhanced.

Supportive learning includes classroom practices that affirm cultural values and leverage learners' home language and prior knowledge. Making connections to content and language structures in their home language and English is encouraged when possible. It is also essential that EAL learners make connections between their learning in English and learning in other curricular areas and use learning contexts in other subjects to practice, reinforce, and extend their language skills. Addressing the demands of the subject area and discussing how different forms, styles, and registers of English are used for various purposes will benefit learners. Providing learners learning English as an additional language with ample opportunities to use English in communicative ways and designing classroom activities to aid language development through active language use will support their learning.

It's essential to address barriers to equitable instruction and assessment for EAL learners. By providing various ways for them to access content, demonstrate learning, and develop language skills, we can ensure their full participation and contribution to the classroom community. This approach not only benefits EAL learners but also enhances the overall learning environment.

Although Computer Science Education is still relatively new, compared to other subjects, there is a rapidly evolving body of research-based information, as well as tried-and-tested best practices developed by teachers.

The following information highlights just some of these approaches to teaching computing.

Code Tracing

Code tracing is a well-established approach to helping learners develop program comprehension. When tracing code, learners read and analyse chunks of code or short programs ***before*** running it, and record expected behaviour / program flow etc. Code tracing can be used as a standalone activity or as part of a broader approach, and is a great way to check learners understanding.

The PRIMM Approach

PRIMM is a scaffoded approach to structured programming lessons that encourages learners to read code before they write it (Sentance et al, 2019)

PRIMM stands for ***Predict - Run - Investigate - Modify - Make***, representing the different stages of a lesson or series of lessons. PRIMM promotes discussion between learners, and the use of starter programs to encourage the reading of code before writing it.

To use PRIMM educators work through the following 5 stages:

Predict: Learners discuss a starter program and predict what it might do.

Run: Learners run the starter code to test their predictions.

Investigate: Learners work on activities designed to explore the code. This could include tracing, debugging and annotating.

Modify: Learners edit the program to change functionality through increasingly challenging exercises. The transfer of ownership moves from code being 'not theirs', to 'partially theirs'.

Make: Learners create new programs using the same structures that solve new problems.

Parson's Problems

Parson's problems are tasks in which learners are given all the blocks or lines of code needed to solve a problem. However the lines of code are jumbled so that they are no longer in the correct order. The goal of the activity is for learners to rearrange the code into a specific order to complete a task. Tasks can vary in difficulty to accommodate learners' prior understanding. Tasks can be presented in many ways and make great offline or paper activities that can be completed individually, in pairs, or in small groups. Parson's problems can be used to support formative assessment and discussions following the activity plays an important role in learners development.

The main benefit of Parson's problems is that learners can focus on the structure and logic of code without worrying too much about the syntax of individual elements. This process reduces cognitive load and supports learners with practicing sequencing and problem-solving with code. It is recommended that there be a unique answer or correct order for each question (Denny et al, 2008).

Project-Based Learning

Project-based learning (PBL) is an approach to teaching computing in which the learning activities are organised around the design, creation, and evaluation of a digital artefact. Working as individuals or in small groups, learners deepen and consolidate their knowledge through hands-on, tangible experiences that allow them to reflect on their learning (Papert, 1980). Project-based learning provides opportunities for learners to solve real-world problems by designing and creating a project over a specific time.

A project-based learning approach helps learners to apply their programming knowledge to real-world scenarios and build a toolkit of solutions

Agency

There's a fundamental difference for learners between being asked whether they know the answer to a problem, and being asked to find a solution to one. The first assumes knowledge (and thereby frames a lack of knowledge as failure) and has a narrow focus, the second gives learners the room to be wrong or to not know yet, and to develop real understanding and practical skills in a self-directed way.

Engagement

Learners with more agency are much more likely to be engaged in their learning. One of the huge benefits of PBL, is the scope it provides to set relevant, real-world problems to learners. Being able to relate learning to their own lives motivates learners, and by seeing how they can apply new skills and knowledge to situations in their lives, learners understand the purpose of the work they are doing.

Universal Skills

PBL is not about providing ready answers to a specific problem, rather, it is about developing a mental toolkit for understanding any problem so that they can create solutions from the ground up. By developing this skill set, learners develop lifelong skills that are essential to their future - taking initiative, working responsibly, decomposing and solving problems, collaborating in teams and communicating ideas clearly.

Unplugged Computing

Unplugged computing (Bell et al., 2009) involves teaching concepts of Computer Science deliberately away from a computer. With unplugged computing, physical objects are used to illustrate abstract concepts. The strength of this approach lies in the way abstract concepts are made physical, making them easier for learners to understand, manipulate, and question. By providing a physical representation of a concept, learners can ask questions at the level of the analogy rather than fully having to verbalize concepts at a technical level. As with all approaches based on analogy, it is vital that the links to the concepts demonstrated are clearly made.

CMP621A

COMMUNICATION & INFORMATION TECHNOLOGY

Computer Science 621A

Curriculum Guide

Prince Edward Island
CANADA

Course Description

Computer Studies 621A is designed to provide learners with opportunities to engage in the following five focus areas: Technology and Society, Programming, Design, Computing and Networks, and Data. Through the lens of website design and development, learners will apply computational thinking skills to analyse problems and develop solutions. They will be challenged to think critically about the impact of technology, enabling them to become informed consumers and creators of technology, and to engage in real-world issues.

Computer Science education is more than just coding - it's about helping learners to become responsible consumers and creators of digital technologies.

Although programming and building digital projects are critical components of computer science education, learners must also develop a wider set of skills and competencies. As avid users of technology, all learners will benefit from learning foundational skills and competencies in computer science, regardless of whether they pursue advanced studies or a career in computer science or related STEM fields. The following table describes the five focus areas, and aligns with the Pan-Canadian K-12 Computer Science Education Framework – Learning For The Digital World.

Table 4. Focus Areas aligned with the Pan Canadian K-12 CS Education Framework

Technology and Society	As both users and creators of digital technologies, all learners will benefit from learning how to assess the effects that digital technologies have had on the world around them, allowing them to become responsible digital citizens capable of harnessing the power of technology to solve problems and respond safely and ethically.
Programming	All learners will benefit from learning programming skills so that they can create their own digital projects. By understanding how to give a computer a set of instructions that allows it to complete a specific task, learners will better understand how computers work. This will help learners to become more critical consumers of digital technologies and to develop computational thinking which can be applied to various fields.
Design	By learning how to design programs, incorporate the perspective of potential users, and create universally accessible products, learners will ultimately create better digital projects that work for a wider range of people.
Computing and Networks	As computers and the Internet become ubiquitous, all learners will benefit from learning how these devices work, how they can be connected with other devices and networks, and the benefits and risks associated with our increasingly connected world.
Data	As access to data grows, all learners will benefit from understanding how to effectively harness its powers to make sense of the world around them, as well as to better understand how their actions and activities generate data which can be used by others.

Outcome Summary

The outcomes of CMP621A are categorized into five units. These units and specific outcomes are designed to provide learners a holistic introduction to the skills and competencies needed for success. Each outcome, with its related achievement indicators and elaborations, can be found on the following pages.

.

Table 5. Summary of Specific Curriculum Outcomes for CMP621A

Unit	Code	Learners are expected to ...
Technology and Society	TS1	analyse ethical, legal, and societal implications of emerging technologies
	TS2	evaluate the effects of illegal and unethical digital activities on society
Programming	P1	analyse problems using computational thinking
	P2	develop responsive web pages using markup and style sheet languages
	P3	develop simple web applications using client-side scripting
	P4	demonstrate an understanding of object-oriented programming
Design	D1	develop web page designs using an iterative design process
	D2	create web page designs incorporating principles of user interface (UI) design, and user experience (UX) design
	D3	analyse user needs to design inclusive and accessible web pages
Computing and Networks	CN1	analyse the history and evolution of encryption, and its role in securing modern computer networks and communication
	CN2	analyse the impact of cyber security breaches on individuals, organizations, and society
Data	DT1	demonstrate an understanding of how data can be collected, stored, and manipulated
	DT2	evaluate social, ethical, and legal implications of data use in a digital society
	DT3	apply strategies to collect and manage data responsibly

Assessment Framework

The assessment framework describes the relative weighting of each unit and is constructed by transforming the depth and breadth of each specific curriculum outcome into an overall instructional time for each domain. The primary purpose of the assessment framework is one of validity - to align curriculum outcomes, instruction, and assessment. As such, the framework should be used to ensure that summative learner assessments are representative of the instructional time and complexity of the specific curriculum outcomes for each domain, to inform the specified course reporting structure, and be consulted as a high-level guide for course planning, pacing, and syllabus development.

Table 6. Assessment Framework for CMP621A

Unit/Domain	Remember	Understand	Apply	Analyse	Evaluate	Create	Unit/Domain Weight
Technology and Society				TS1			15%
					TS2		
Programming				P1			50%
						P2	
						P3	
			P4				
Design						D1	20%
						D2	
				D3			
Computing and Networks				CN1			5%
				CN2			
Data			DT1				10%
					DT2		
			DT3				

TS1	*Learners are expected to ...*
	analyse ethical, legal, and societal implications of emerging technologies

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. investigate examples of ethical dilemmas in computing;

b. describe legal implications of emerging technologies;

c. determine the social effects of computing on various groups considering multiple perspectives;

d. compare the societal benefits and risks of emerging digital technologies;

e. discuss the implications of algorithmic bias in machine learning;

f. analyse environmental impacts of technology; and

g. analyse ways in which technology can both support or undermine equity and inclusion.

✓ Citizenship	✓ Critical Thinking	Personal-Career Development	Essential Graduation Competencies
✓ Communication	Technological Fluency	Creativity and Innovation	

ELABORATIONS

This outcome challenges learners to think critically about how emerging technologies impact individuals, communities, and society. Technologies such as artificial intelligence, biometric surveillance, autonomous systems, and data-driven platforms are reshaping how we work, communicate, and live. With these shifts come new challenges - privacy concerns, algorithmic bias, misinformation, digital labour rights, and the growing digital divide. Learners should understand that the process of developing technology is not just a technical task, but that it also requires social and ethical responsibility

Algorithmic Transparency is the principle that we should understand how computers are making decisions about us. Only by understanding the data processes that impact our lives will we be able to make informed decisions, understand ethical concerns, correct and contest decisions made by algorithms, and to critically engage in real-world issues.

Case studies support analysis of emerging technologies (e.g., facial recognition in policing, AI in healthcare, self-driving vehicles, social media algorithms), and learners should analyse both benefits and unintended consequences of these innovations.

Learners should examine ethical dilemmas (such as data privacy, algorithmic bias, job displacement, surveillance, inequality, deepening the digital divide, and the weaponization of technology), how developers and users of technology make decisions that affect others, and consent, transparency, and accountability in digital design and usage.

Learners should consider legal implications of emerging technologies and analyse laws related to digital rights, copyright, intellectual property, cyber security, and data privacy. They should learn how these laws protect individuals and shape technology use.

Learners will analyse how technology often has both positive and negative impacts, and also examine how technology can impact some groups disproportionately.

Learners should be provided with opportunities to ask questions, form opinions, justify their positions on ethical dilemmas, and weigh what is technically possible with what is morally right. They should analyse multiple perspectives, including those of marginalized communities who may be disproportionately affected by certain technologies.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What are some unintended negative impacts of technology?

How can you tell if a technology is being used ethically or not?

What are some responsibilities of developers and users of technology?

Can computers make fair or unbiased decisions? Why or why not?

Should laws limit what emerging technologies can do? Who decides, and how?

How can emerging technologies affect different groups in society differently?

How can we ensure that technology is socially responsible?

TS2	*Learners are expected to ...*
	evaluate the effects of illegal and unethical digital activities on society

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. describe various forms of illegal and unethical digital activities;

b. explain how illegal or unethical digital activities affect individuals, communities, businesses, and governments;

c. examine how different societal groups may be disproportionately affected by illegal or unethical online behaviour; and

d. evaluate the effectiveness of current laws and industry practices in preventing and responding to unethical digital behaviour.

✓ Citizenship	✓ Critical Thinking	Personal-Career Development	Essential Graduation Competencies
✓ Communication	Technological Fluency	Creativity and Innovation	

ELABORATIONS

This outcome focuses on helping learners understand, and evaluate, the impact of illegal and unethical digital activities in today's interconnected world. As learners increasingly take on dual roles as both consumers and creators of technology, it is essential that they learn to recognize harmful digital behaviours, understand their consequences, and take steps to avoid them. Through this outcome, learners will explore how illegal and unethical activities can impact, individuals, businesses, and organizations.

Learners should examine case studies, and engage in inquiry and reflection on a wide range of issues, including data breaches, identity theft, online harassment, intellectual property theft, misinformation, and hacking. These investigations will help learners understand how these actions may affect individuals' privacy, safety, and trust, and how they can undermine institutions, businesses, and democratic processes.

Learners should explore topics such as:

Cyber Crime and Security Breaches
Learners should investigate different types of cyber crime, such as unauthorized access to data, data theft, ransom ware, and denial-of-service attacks. Learners should explore how these activities disrupt services, cause financial damage, and erode public trust in digital systems.

Privacy Violations and Data Misuse
Learners should examine unethical data practices, including surveillance, unauthorized tracking, and sharing user data without consent. They will consider how such practices can affect people's autonomy, sense of security, and rights to privacy.

Digital Harassment and Hate Speech
Learners will explore how unethical behaviours such as cyber bullying, doxxing, and targeted harassment can disproportionately impact marginalized groups and contribute to harm both on line and off line.

Intellectual Property Theft
Learners should evaluate how illegal downloading, plagiarism, and software piracy affect creators, developers, and the economy. They should discuss the importance of respecting licensing and copyright laws.

Misinformation and Disinformation
Learners should analyse how the spread of false or manipulated information can affect public opinion, health, elections, and democratic systems. They will consider the role of bots, algorithms, and artificial intelligence in amplifying this problem.

This outcome invites learners to critically evaluate the consequences of illegal and unethical digital activities, and to articulate how responsible, ethical practices in the digital space contribute to a safer and more just society.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What makes a digital activity illegal or unethical, and who decides?

How do activities such as hacking, identity theft and piracy affect individuals, businesses, and governments?

How should society respond to cyber bullying, doxxing (cyber bullying that uses sensitive information for harassment, exposure, financial harm, or exploitation), and online harassment?

What role do laws and policies play in shaping online behaviour? Are they keeping up with technology?

P1	*Learners are expected to ...*
	analyse problems using computational thinking

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. decompose complex problems into smaller, manageable components;

b. recognize patterns and similarities within problems or datasets to streamline problem-solving approaches;

c. use abstraction to identify and isolate relevant information while ignoring irrelevant details; and

d. analyse problems algorithmically to determine logical steps in solutions.

						Essential Graduation Competencies
	Citizenship	✓	Critical Thinking		Personal-Career Development	
✓	Communication	✓	Technological Fluency		Creativity and Innovation	

Computational Thinking (CT)

Computer science pedagogy is often based around the ideas of Piaget's *constructivism* (in which learners develop their knowledge through exploration), and Papert's ideas of *constructionism* (in which learners develop knowledge through creating artifacts). However, learners also need guidance on how to gain useful knowledge efficiently, and how to organize it in a clear way. They need to be able to break a problem down, remove unnecessary detail, find patterns, and think algorithmically before they can begin to write programs that solve complex problems.

Before a problem can be tackled, the problem itself and the ways in which it can be solved need to be fully understood. Thinking computationally allows learners to take a complex problem, understand what the problem is and develop possible solutions. These can then be presented in a way that a computer, a human, or both, can understand.

Computational Thinking is not programming. Nor is it thinking like a computer, as computers do not, and cannot, think. Rather, it is about thinking like a computer scientist, and problem solving using concepts and strategies related to computer science.

Simply put, programming tells a computer what to do and how to do it. Computational thinking enables learners to work out exactly what to tell the computer to do.

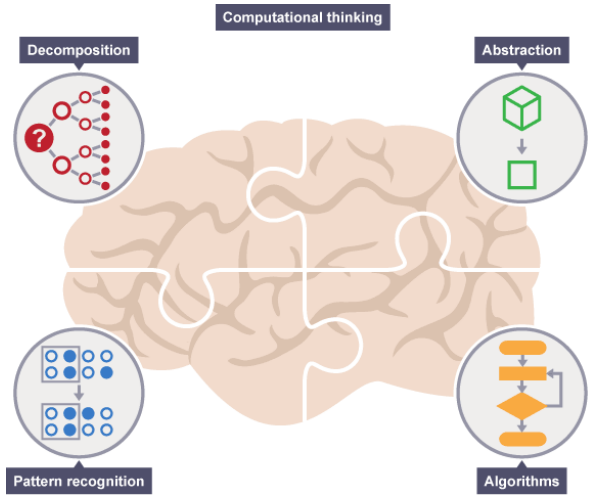
The 4 cornerstones to computational thinking are:

Decomposition
Breaking down a complex problem or system into smaller, more manageable parts. Computational Thinking often requires not only the skill to decompose a problem, but also to then compose the solution from individual parts.

Abstraction
Focusing on the important information only, ignoring (hiding) irrelevant details.

Pattern Recognition
Looking for similarities among and within problems and data.

Algorithms
Developing a step-by-step solution to the problem, or the rules to follow to solve the problem



Computational thinking is the thought processes involved in formulating a plan and expressing solutions in such a way that a computer - human or machine - can effectively carry out. Computational thinking describes the mental activity in formulating a problem to admit a computational solution. The solution can be carried out by a human or machine. This latter point is important. First, humans compute. Second, people can learn computational thinking without a machine. Also, computational thinking is not just about problem solving, but also about problem formulation (Wing, 2014).

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

How would you decompose the task of creating an app?

How is pattern recognition used with large language models (LLM's) in machine learning?

How does abstraction enable us to manage complexity and simplify technology in our everyday lives?

Can you write an algorithm or sequence of instructions to describe an everyday activity or process?

P2	*Learners are expected to ...*
	develop responsive web pages using markup and style sheet languages

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. describe how responsive design improves accessibility and user experience across devices;

b. apply web coding standards and best practices;

c. refactor existing code to improve efficiency, readability, or maintainability;

d. apply documentation to enhance understanding, maintainability, and collaboration;

e. develop readable, efficient, and maintainable code;

f. apply relative units and media queries to adapt layout and content across screen sizes; and

g. develop responsive web pages that work well on a variety of screen sizes.

							Essential Graduation Competencies
	Citizenship		Critical Thinking		Personal-Career Development		
✓	Communication	✓	Technological Fluency	✓	Creativity and Innovation		

Responsive Web Design (RWD)
Responsive web design is a crucial approach to web design and development that ensures websites and their content adapt effectively to various devices, screen sizes, and orientations. This adaptability is essential due to the ever increasing array of devices, including phones, tablets, laptops, and desktops, that are used to access online content.

Relative and Fractional Units
In responsive design, web designers use *relative units* such as %, em, rem, and fractional units (fr) in style sheets to determine sizes. Unlike fixed units such as pixels (px), these relative units scale in size based on other elements, such as screen-width or font size. This enables web page layouts to automatically adapt to different screen sizes and enables content to resize and re-flow naturally.

In responsive web design, "em" stands for "em square", a typographic term that originally referred to the width of the capital letter "M" in a given font. However in responsive web design 1em = the current element's font size.

So if an element has a font size of 16px, then 1em = 16px
2em = 32px
0.5em = 8px, and so on

Responsive web pages are typically based on flexible grids using layout methods such as Flexbox and CSS grid.

Learners should be provided with opportunities to create and test responsive web page layouts to see how they display on different screen sizes.

Benefits of Responsive Web Design (RWD)

Improved User Experience: Provides an optimal viewing and interaction experience across all devices, leading to higher user satisfaction.

Wider Reach: Ensures accessibility for users on diverse devices, expanding the potential audience.

Cost-Effectiveness: Eliminates the need for separate websites for different devices, reducing costs.

SEO Benefits: Google and other search engines favor responsive websites, potentially leading to better search rankings.

S*implified Content Management*: Content needs to be managed only once, as it adapts automatically to different layouts.

In essence, Responsive Web Design is about creating a single, cohesive website that intelligently responds to the user's environment, providing a consistent and user-friendly experience regardless of the device being used.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What devices can be used to access online content?
How are screen sizes measured?
What are some screen sizes of common devices?
Why is it important to design for a variety of devices?

P3	*Learners are expected to ...*
	develop simple web applications using client-side scripting

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. demonstrate an understanding of fundamental programming concepts, including data types, variables, control structures (conditionals and loops), and functions;

b. apply separation of concerns in programming, in which code for structure, styling, and behaviour is arranged in clearly separated files or modules;

c. apply debugging strategies to identify logical or syntactic coding errors;

d. apply documentation to code to enhance understanding, maintainability, and collaboration;

e. refactor existing code to improve efficiency, readability, or maintainability;

f. manipulate web page content and style using the Document Object Model (DOM);

g. develop simple web applications that respond to user actions; and

h. develop readable, efficient, and maintainable code.

							Essential Graduation Competencies
	Citizenship		Critical Thinking		Personal-Career Development		
✓	Communication	✓	Technological Fluency	✓	Creativity and Innovation		

ELABORATIONS

Web applications (or web apps) are websites that are designed with interactive features. They enable users to actually do something, and not just read content. Unlike traditional desktop applications, users don't need to install web applications as they are hosted online and can be accessed from anywhere through a web browser.

Web applications are often described as client-scripted (front-end) or server-scripted (back-end) applications. Client-scripted, or front-end applications can be coded mostly with JavaScript (plus some HTML/CSS), they update dynamically and run entirely in the user's browser (the client). This means things like interactivity, data manipulation, and even simple storage all happen in the browser. Functionality of these applications can be greatly extended by using API (Application Program Interface) calls to access data or services from another program. Some common API's include LocalStorage, Canvas, Geolocation, WeatherAPI, and Leaflet + Open Street Map.

Server-scripted or back-end applications in contrast, are typically more complex, requiring knowledge of additional languages and frameworks. These applications run on remote web servers, are much more secure, and typically incorporate accessing databases.

Feature	**Client-Side (Front-End))Application**	**Server-Side (Back-End) Application**
Runs On	User's browser	Remote web server
Main Language	JavaScript (plus HTML/CSS)	Node.js, Python, PHP, Java, Ruby, etc.
Processing Location	In the browser (after page load)	On the server (before page is sent to browser)
Speed	Fast interactions (no reloads)	Slower — depends on server response
Interactivity	Handles dynamic UI	Handles data logic, business rules
Security	Less secure (code visible to user)	More secure (logic stays hidden)
Data Access	Limited (localStorage, API calls)	Full access to databases, authentication, etc.
Examples	To-do app, calculator, image editor	Login system, online store, chat backend
Used For	UI/UX, real-time interaction	Data management, secure logic, APIs

In this outcome, learners should focus on client-side scripting using JavaScript. Note - cloud database providers can make developing simple CRUD applications (where users can Create, Read, Update, and Delete data), much more accessible to learners wishing to explore these functions.

Learners should be provided with opportunities to think critically and to address challenges that they either identify with personally, or that affect local or global communities.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What makes web apps engaging, useful, or even addictive?

When are the pros and cons of client-side scripting vs server-side scripting when developing a web application?

How can building a web app help us understand real-world systems and improve them?

P4	*Learners are expected to ...*
	demonstrate an understanding of object-oriented programming

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. identify advantages of an object-oriented approach to programming;

b. demonstrate an understanding of object-oriented programming concepts, including classes, objects, encapsulation, abstraction, inheritance, and polymorphism;

c. describe the relationship between classes and objects;

d. write basic class definitions with attributes and methods;

e. apply the principle of encapsulation to protect data; and

f. implement class hierarchies using inheritance.

						Essential Graduation Competencies
	Citizenship		Critical Thinking	Personal-Career Development		
✓	Communication	✓	Technological Fluency	Creativity and Innovation		

Most learners programming experience up to this point will have focused on procedural (or sequential) programming. This paradigm organizes code as a linear sequence of instructions or procedures that are executed step-by-step in order to achieve a desired outcome.

This outcome focuses on deepening learners' understanding of programming by introducing them to object-oriented programming (OOP). This programming paradigm models programs using real-world entities such as objects and classes, and builds on prior foundational programming concepts. Through this outcome, learners will develop an understanding of how object-oriented programming can help manage complexity in larger programs and foster collaboration through clear code organization.

Key concepts:

Classes and Objects
Learners should understand that classes define blueprints for objects, and that objects are specific instances of those classes. They will identify how objects bundle together both data (attributes) and behaviour (methods), allowing programs to mirror real-world systems in a structured and intuitive way.

Encapsulation and Abstraction
Learners will explore how encapsulation keeps internal object details hidden from the outside world, which makes code more secure and easier to maintain. Through abstraction, learners will see how only the essential features of an object are exposed, helping manage complexity.

Inheritance
Learners will investigate how a new class (subclass) can inherit attributes and methods from an existing class (superclass), reducing redundancy and promoting code reuse. This provides a way to build relationships between classes and supports the creation of generalized or specialized behaviours.

Polymorphism
Learners should be introduced to how different objects can respond to the same method in different ways, promoting flexibility in program design. This might be explored through method overriding or using interfaces/ abstract classes where applicable in the programming language used.

Understanding object-oriented programming strengthens computational thinking skills by encouraging learners to apply decomposition, pattern recognition, and abstraction. By the end of this outcome, learners should be able to write simple programs using object-oriented principles, and explain the benefits of object-oriented programming.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

How does organizing code into classes and objects improve clarity, reuse, and collaboration?

What are the trade-offs between using OOP and other programming paradigms like procedural or functional programming?

D1	*Learners are expected to ...*
	develop web page designs using an iterative design process

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. describe the steps of an iterative design process used in digital product development;

b. identify user needs and define design requirements for a digital product;

c. develop an initial prototype or version of a digital product based on user needs and design goals;

d. conduct usability testing to gather feedback;

e. refine the digital product using feedback and self-evaluation; and

f. iterate multiple times to enhance design, functionality, user experience, and accessibility.

						Essential Graduation Competencies
	Citizenship		Critical Thinking		Personal-Career Development	
✓	Communication		Technological Fluency	✓	Creativity and Innovation	

ELABORATIONS

This outcome focuses on developing an understanding of the design process as it applies to the planning and creation of web pages and web applications. Learners will learn how thoughtful, purposeful design, shaped by continual testing and revision, leads to designs that are more functional, inclusive, and responsive to user needs.

Learners should be introduced to design as a non-linear, cyclical, feedback-driven activity, emphasizing creativity, reflection, and problem-solving. This outcome encourages learners to think critically about how web pages are shaped by different users, devices, and contexts.

Exploring the Design Cycle
Learners should be familiar with the stages of the design process, including planning, sketching, prototyping, implementing, testing, evaluating, and refining. They should realize that design is rarely perfect on the first attempt, and that feedback and testing are crucial stages of the design process, and are key to improving web page design, function and user experience.

Incorporating User-Centered Design Principles
Learners should consider the needs, preferences, and constraints of real or hypothetical users in their design decisions. This may involve creating user personas, conducting informal user research, or engaging in peer feedback to gain insights into how others interact with digital content. Emphasis should be placed on ensuring designs are intuitive, inclusive, and accessible to a variety of users.

Creating Prototypes
As part of the design process, learners should create quick visual layouts that outline designs, using either physical sketching or digital tools. These prototypes enable learners to quickly visualize and refine navigation flow and content organization before any coding begins.

Testing and Refining Designs Based on Feedback
Learners should engage in peer and/or user testing of their web page designs, identifying usability issues and gathering feedback for improvement. They will learn how to revise their work in response to constructive feedback, and reflect on how those changes improved their product. This reinforces the idea that the design process is a cyclical, iterative process of testing and refinement.

Connecting to Broader Design Thinking Skills
This outcome provides opportunities to discuss how design thinking, the ability to define problems, ideate, prototype, and test, can be applied beyond web design. These skills are highly transferable and reflect real-world workflows used in UX/UI design, software development, product design, and digital media creation.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What makes a design process “iterative,” and why is that important in creating digital products?

How do you know when a digital product is “good enough” to stop refining?

How does user feedback shape the direction and improvement of a digital product?

What can go wrong if we skip or rush steps in the design cycle?

How can failure or unexpected results lead to a better solution?

D2	*Learners are expected to ...*
	create web page designs incorporating principles of user interface (UI) design, and user experience (UX) design

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. analyse the differences between user interface(UI) and user experience(UX) design;

b. demonstrate an understanding of key principles of UI design such as hierarchy, progressive disclosure (abstraction), proximity, alignment, repetition, contrast, and accessibility;

c. demonstrate an understanding of key principles of UX design such as user-centricity, consistency, hierarchy, context, user control, accessibility and usability; and

d. develop web page designs that consider principles of UI and UX design.

	Citizenship		Critical Thinking		Personal-Career Development	Essential Graduation Competencies
✓	Communication		Technological Fluency	✓	Creativity and Innovation	

In our modern, technology driven world, design is everywhere, constantly shaping our digital interactions. Every device, every website, app, and digital platform is the results of meticulous design work. In the realm of digital product design, the terms web design, user interface(UI) design, and user experience(UX) design are often confused and used interchangeably. In reality, they are distinct and essential components of design that together make the digital experiences we use every day possible.

Web Design
Web design is the overarching process of creating a complete website. This includes ensuring that websites that are both visually appealing and functional. Web designers serve as digital architects, shaping the online presence of businesses, organizations, and individuals. They ensure websites are aesthetically pleasing and user-friendly by carefully arranging visual elements, enhancing navigation, and creating a positive user-experience.

UI Design
UI design, short for User Interface design, is a specialized domain within the broader field of web design. It focuses on the visual elements of design that users engage with when they visit a website or use an application. UI designers apply color theory and knowledge of typography to designs, as well as principles such as visual hierarchy, contrast, and consistency.

UX Design
UX design or User Experience design, is another distinct and critical discipline within the field of web design. The core philosophy of UX design revolves around putting the user at the center of the design process. UX designers meticulously analyse user behaviour, preferences, and needs. Unlike UI design, which focuses on aesthetics, UX design focuses on functionality, usability, and overall emotional impact. In essence, UX designers are the architects of user satisfaction, aiming to make digital experiences as intuitive, enjoyable, and effective as possible.

Learners should be provided with opportunities to become familiar with, and to consider all components of web page design when creating their own products.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What makes a digital interface feel simple, clear, and useful to someone using it for the first time?
How do visual design choices affect the way people use and understand a website or app?
What's the difference between designing how something looks and designing how it works? Why do both matter?
How do you design for users whose needs, abilities, or devices might be different from your own?
What can you learn about good designs by examining poor ones?

D3	*Learners are expected to ...*
	analyse user needs to design inclusive and accessible web pages

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. identify a range of diverse user needs that impact digital accessibility;

b. research accessibility guidelines and inclusive design principles; and

c. analyse findings from user research to identify priorities for inclusive design.

✓ Citizenship	✓ Critical Thinking	Personal-Career Development	Essential Graduation Competencies
✓ Communication	Technological Fluency	Creativity and Innovation	

ELABORATIONS

When websites and web tools are properly designed and coded, people with disabilities can use them. However, currently many sites and tools are developed with accessibility barriers that make them difficult or impossible for some people to use. The World Wide Web Consortium (W3C) develops international standards for the web including Web Content Accessibility Guidelines (WCAG). These accessibility standards are described by principles and guidelines.

Web accessibility means that websites, tools, and technologies are designed and developed so that people with disabilities can use them. More specifically, people can:

- perceive, understand, navigate, and interact with the Web
- contribute to the Web

Web accessibility encompasses all disabilities that affect access to the Web, including:

- auditory
- cognitive
- neurological
- physical
- speech
- visual

Web accessibility also benefits people without disabilities, for example:

- people using mobile phones, smart watches, and other devices with small screens, different input modes, etc.
- older people with changing abilities due to aging
- people with “temporary disabilities” such as a broken arm or lost glasses
- people with “situational limitations” such as in bright sunlight or in environments where they cannot hear
- people using a slow Internet connection, or who have limited or expensive bandwidth

Making the web accessible benefits individuals, businesses, and society. Learners should be provided with opportunities to become familiar with Web Content Accessibility Guidelines (WCAG), and to consider ways in which they can ensure their designs are accessible to people with disabilities.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

Who gets left out when we don’t think about accessibility in digital design?

How do different users experience the same digital product in different ways?

How can accessible design improve the experience for everyone -not just people with disabilities?

What barriers do people face when using technology -and how can good design remove them?

Why is accessibility a responsibility—not just a feature?

CN1	*Learners are expected to ...*
	analyse the history and evolution of encryption, and its role in securing modern computer networks and communication

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. explain the significance of cryptography in major historical events;

b. describe how encryption methods have evolved over time;

c. apply programming concepts to encrypt communication;

d. analyse the role of encryption in securing modern computer networks and internet communications; and

e. analyse the ethical, legal, and social implications of encryption in modern society.

							Essential Graduation Competencies
	Citizenship	✓	Critical Thinking		Personal-Career Development		
✓	Communication	✓	Technological Fluency		Creativity and Innovation		

ELABORATIONS

This outcome focuses on developing an understanding of encryption as a foundational concept in computing and cyber security. It introduces learners to how humans have long relied on coded communication throughout history to protect sensitive information, and how those early strategies have evolved into the complex mathematical and computational encryption systems used to secure networks and digital communication today.

By exploring the historical development of encryption and its critical role in the protection of information, learners will gain a broader appreciation of how cyber security practices have been shaped by the need for privacy, trust, and data integrity across time and cultures. The outcome also highlights the ongoing tension between privacy and surveillance, and between security and accessibility, helping learners understand the real-world implications of encryption technologies in a connected society.

Evolution of Encryption
Learners should investigate early encryption techniques, such as the Caesar, Vigenere, and Vernam ciphers, and the Enigma machine, in order to develop an understand of the basic principles of encoded communication. These historical examples will help build foundational knowledge about how messages can be scrambled and decoded. They should be encouraged to explore how historical needs (e.g., military secrecy, diplomatic communication) drove the development of increasingly sophisticated encryption methods, setting the stage for the mathematical and computational techniques used in modern cryptography.

Modern Cryptography
Learners will be introduced to core concepts such as symmetric encryption (e.g., AES), asymmetric encryption (e.g., RSA), public and private key pairs, hashing, and digital signatures. They will explore how these methods are used to ensure confidentiality, integrity, and authenticity in modern digital communication, such as in email, secure websites (HTTPS), messaging apps, and digital payments.

Encryption in Network Security
Learners will analyse how encryption protects data during transmission across networks, such as through:

- Secure Sockets Layer (SSL) and Transport Layer Security (TLS);
- VPNs (Virtual Private Networks); and
- End-to-end encryption in messaging apps.

This understanding will help learners connect encryption to everyday technologies and realize how integral it is to maintaining trust and privacy in modern digital life.

Social and Ethical Dimensions of Encryption
As learners examine how encryption enables digital security, they should also consider the social, ethical, and legal implications of its use. This includes discussions around data privacy, surveillance, individual rights, and national security. These conversations will prompt learners to think critically about who controls data, who has access to it, and what safeguards exist to protect it, or to undermine it.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What can the history of encryption teach us about power and control?

What risks do we face when encryption is weak - or when it's missing entirely?

Who decides how secure our data should be - and who should have access to it?

How might encryption evolve next—and what challenges will that create?

CN2	*Learners are expected to ...*
	analyse the impact of cyber security breaches on individuals, organizations, and society

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. identify common cyber security threats and vulnerabilities;

b. examine how cyber security breaches affect both individuals and organizations;

c. analyse how breaches can lead to social, legal, and ethical issues; and

d. analyse examples of cyber security breaches and their consequences.

✓ Citizenship	✓ Critical Thinking	Personal-Career Development	Essential Graduation Competencies
Communication	Technological Fluency	Creativity and Innovation	

This outcome focuses on developing learners' understanding of how cyber security breaches affect people, systems, and society as a whole. Learners should investigate how unauthorized access to data, systems, or networks can lead to financial loss, reputational damage, operational disruption, and even public safety concerns. This outcome highlights the consequences of cyber threats in a world that increasingly depends on digital technologies for everyday life, business, and governance.

Learners should recognize that while technological connectivity brings efficiency and innovation, it also introduces vulnerabilities that must be anticipated, understood, and managed. By examining high-profile breaches and real-world case studies, learners should begin to develop an awareness of both the risks and responses to cyber security incidents.

Cyber security Breaches
Learners will begin by exploring what constitutes a cyber security breach. This includes unauthorized data access, ransomware attacks, data leaks, phishing, and denial-of-service (DoS) attacks. They will examine how breaches occur, who the potential attackers might be (cyber criminals, hacktivists), and what motivates them. Through this exploration, learners will understand that breaches vary in scale and intent but share the common feature of exploiting weaknesses in technology or human behaviour.

Impact
Learners will analyse how cyber security breaches can affect individuals by compromising their privacy, exposing their financial or medical records, and eroding their trust in digital systems. This includes examining issues such as identity theft, financial fraud, emotional stress from doxxing or harassment, or loss of access to personal data (through ransomware). Learners should also explore best practices for individuals to protect their digital identities, such as using strong passwords, two-factor authentication, and recognizing phishing attempts.

Learners should explore how cyber security breaches affect businesses, institutions, and public organizations. This includes data loss and intellectual property theft, financial loss and legal liabilities, service interruptions (hospital or city infrastructure shutdowns), and damage to reputation and consumer trust. Case studies may include breaches at major corporations, educational institutions, government agencies, and healthcare systems. Learners should analyse how organizations respond to such events, from public relations efforts to system audits and improved security protocols.

Learners should also reflect on the broader implications of cyber security breaches on society and global stability. Topics may include interference in democratic processes (election tampering), attacks on critical infrastructure (power grids, water systems), public health disruptions (ransomware attacks on hospitals)

The outcome encourages critical thinking about the balance between innovation and security, the ethical use of data, and the role of individuals as both potential targets and defenders in the cyber security landscape. This outcome also promotes career awareness in information technology, law, policy, and digital media, where understanding cyber security is essential.

Guiding questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What happens when trust in digital systems breaks down?
How should organizations be held accountable after a breach?
What can a cyber security breach reveal about the systems we rely on?
How can you protect yourself from becoming a target?

DT1	*Learners are expected to ...*
	demonstrate an understanding of how data can be collected, stored, and manipulated

Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. distinguish between analog and digital data;

b. describe common digital data types;

c. explain how data types are represented and stored in digital systems; and

d. apply programming techniques to collect, store, and manipulate data.

						Essential Graduation Competencies
	Citizenship		Critical Thinking	Personal-Career Development		
✓	Communication	✓	Technological Fluency	Creativity and Innovation		

This outcome focuses on building learners' capacity to understand, work with, and think critically about data as a foundational element of computing systems. This outcome emphasizes the need for learners to grasp how data is created, collected from digital interactions, organized for storage, and transformed for meaningful use. It encourages learners to explore data not just as a technical concept, but as a tool for inquiry, decision-making, and ethical reflection in a data-driven world.

By understanding the life cycle of data, from collection and storage to manipulation and analysis, learners are able to work responsibly with real-world data in practical ways. They should also be encouraged to consider how their own digital activities produce data, how that data can be stored and shared, and how it can be used by others for purposes both beneficial and concerning.

Web applications are expected to be dynamic and interactive, providing users with a seamless and responsive experience. Storing data in the browser is a fundamental aspect of building such applications. With the advent of modern web technologies, web developers now have access to various ways of storing data in the browser. Each storage option has its advantages and disadvantages, and can make a significant difference in the performance and user experience of an application. Web storage can be categorized broadly into client-side (browser-based) and server-side storage.

Client-Side Storage

Session Storage: Session storage is not persistent as data is only available for the duration of the user's session, meaning that the data will be lost when the user closes their browser. Options include simple variable storage, or SessionStorage which is part of the WebStorage API

Local Storage: Local storage is persistent, meaning that the data will remain available even if the user closes their browser. Local storage is however still only available on an individual device but can be a good choice for storing data for simple web apps or prototypes. LocalStorage is part of the WebStorage API.

IndexedDB: The indexedDB API is a powerful client-side database for storing structured data directly in browsers. The *IndexedDB* API however is complex to use, and can be greatly simplified by using *LocalBase* - an easy-to-use JavaScript library that greatly simplifies IndexedDB interactions.

Server-Side Storage

For larger, more complex, and sensitive data that needs to be shared across multiple users or accessed from different devices, data is typically stored in server-side databases. Common types include:

Relational Databases (e.g., MySQL)

NoSQL Databases (e.g., MongoDB)

For prototyping, cloud options such as Google Firestore can be quicker and easier to use than traditional options.

Essential questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

Where does data go after it's collected? Who controls it?

How do you turn raw data into something meaningful?

What does "clean" data look like? Why is cleaning it important?

What are the risks of relying too much on data?

How can data tell different stories depending on how it's used?

DT2	*Learners are expected to ...*					
	evaluate social, ethical, and legal implications of data use in a digital society					
	Remembering	Understanding	Applying	Analysing	Evaluating	Creating

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. describe how organizations collect and use personal data;

b. explain the concept of informed consent in data collection;

c. discuss data ownership and the right to be forgotten;

d. analyse how data-driven algorithms may perpetuate bias or discrimination;

e. understand how personal data generated through online activities can be collected and used by others;

f. understand and be able to advocate for their data rights and the rights of others;

g. evaluate privacy laws and data protection regulations; and

h. evaluate the quality, reliability, and potential bias of collected data.

✓ Citizenship	✓ Critical Thinking	Personal-Career Development	Essential Graduation Competencies
Communication	Technological Fluency	Creativity and Innovation	

ELABORATIONS

This outcome provides an opportunity to connect computer science with real-world issues, and empowers learners to think critically about the technologies they use every day. Learners will develop a critical understanding of how data is collected, shared, stored, and used in today's digital world, and will consider how individuals, organizations, and governments all have responsibilities when it comes to handling data. This outcome reinforces the idea that data use can have serious implications, and that evaluating its use requires both technical understanding and social awareness.

This outcome supports learners in becoming informed digital citizens who can make thoughtful decisions, protect their personal data, and consider how data practices affect others.

Understanding the Nature and Scope of Data Use
Learners will examine how data is created and collected — through online activity, smart devices, apps, sensors, social media, and more. They will explore how this data can be used to personalize services, support decision-making, influence behaviour, or automate systems. Through case studies and real-world examples, learners can begin to assess both the benefits and potential harms of data-driven technologies.

Analysing Social Impacts
Learners should consider how data use affects individuals and communities, and should explore topics such as surveillance, algorithmic bias, digital profiling, and data-driven inequality. For example, learners might investigate how predictive policing, facial recognition, or social media algorithms impact marginalized groups differently, and how access to data can shape power dynamics in society.

Investigating Ethical Considerations
Learners should evaluate what constitutes responsible and ethical data use. They will reflect on questions such as *Who owns data?, Who benefits from it?, and Who is harmed by its misuse?* Ethical issues such as consent, transparency, data commodification, and digital manipulation should be explored to help learners develop informed opinions.

Legal Acts and Regulations
Data protection regulations, such as Canada's Personal Information Protection and Electronic Documents Act (PIPEDA), and the European Union's General Data Protection Regulation (GDPR), establish rules for how organizations collect, use, and disclose personal information. Learners should analyse laws that govern data such as privacy laws, data protection regulations, and emerging legislation around artificial intelligence.

Developing Critical Awareness
Learners should recognize when their data is being collected, understand how it may be used, and how to take steps to protect it. They should consider privacy settings, terms of service agreements, and data-sharing practices to make more informed choices. Discussions could also include the role of education, advocacy, and civic engagement in shaping ethical data practices and responsible innovation.

Essential questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

Who owns your data? Should they?
What makes data use ethical or unethical?
Why do some groups benefit more from data collection than others?
How can laws keep up with fast-changing technologies that use data?
What responsibilities do companies have when using personal data?
How can systems be designed that respect data rights?

DT3	*Learners are expected to ...*					
	apply strategies to collect and manage data responsibly					
	Remembering	**Understanding**	**Applying**	**Analysing**	**Evaluating**	**Creating**

Achievement Indicators

Learners who have achieved this outcome should be able to ...

a. identify appropriate data to collect;

b. explain the importance of minimizing data collection;

c. implement methods to collect data securely and transparently;

d. use data structures to store data;

e. describe and apply strategies to protect data;

f. apply a data management strategy that includes strategies for collection, storage, access, and disposal of data; and

g. reflect on how user data collected in a project could be misused.

✓ Citizenship		Critical Thinking	Personal-Career Development	**Essential Graduation Competencies**
✓ Communication	✓	Technological Fluency	Creativity and Innovation	

ELABORATIONS

Through this outcome, learners will develop an understanding of how data is gathered, stored, and accessed. Learners should examine the full data-lifecycle, from collection to deletion, and the responsibilities that come with managing data in a digital society. By understanding how data practices affect individuals, communities, and organizations, learners become better equipped to make informed decisions as both consumers and creators of digital technologies.

Data Collection Methods
Learners should examine how data is collected from a wide range of sources, including websites, mobile apps, social media platforms, surveys, and everyday digital interactions. They should understand some of the reasons data is collected, for example, for improving products, supporting research, enabling automation, or targeting advertising, and they should also understand some of the unintended consequences, such over-collection, surveillance, or misuse. Learners should understand both automated and manual collection methods and consider the scale and sensitivity of different types of data (e.g., personal, biometric, behavioural, or location data).

Responsible Data Collection and Management
Learners should understand what it means to collect and manage data responsibly, and should explore topics such as data minimization (collecting only what's necessary), transparency and consent, anonymization, encryption, security, and controlled access. Real-world breaches and mishandling incidents should be discussed to highlight the risks of poor data management practices.

Legal Acts and Regulations
Learners should be aware of legal frameworks such as Canada's Personal Information Protection and Electronic Documents Act (PIPEDA) and international standards like the General Data Protection Regulation (GDPR). They should discuss how these laws protect users' rights to access, correct, or delete their personal information.

This outcome provides learners with opportunities to make connections between development decisions and the broader impact of technology. It encourages them to consider how developers share responsibility not only for writing functional code, but for shaping digital spaces that respect privacy and support ethical data use. Learners should understand that ethical web development involves balancing business needs with user rights, and that thoughtful design can help prevent harm while still supporting innovation.

By the end of this outcome, learners should be able to make informed choices about data collection and management, and explain best practices for protecting user data. Learners should apply these ideas when designing or developing web applications.

Essential questions can support deep thinking, real-world connections and reflection. They work well for whole-class discussions, reflection prompts, or project check-ins.

What does it mean to collect data responsibly?
How can you design a system that respects users' rights while still being useful?
Why is it risky to collect more data than you actually need?
Who benefits and who might be harmed when data is collected?
How can you tell if a website manages data securely and ethically?

REFERENCES & RESOURCES

Bell, T., Alexander, J., Freeman, I., & Grimley, M. (2009). *Computer Science Unplugged: School Students Doing Real Computing Without Computers. New Zealand Journal of Applied Computing and Information Technology, 13*(1), 20–29.

Council of Atlantic Ministers of Education and Training. (2015). Atlantic Canada Framework for Essential Graduation Competencies. Retrieved November 3, 2023, from https://www.ednet.ns.ca/files/curriculum/atlantic_canada_essential_grad_competencies.pdf

Denny, P. (2008). Evaluating A New Exam Question: Parsons Problems. In *Proceedings of the Fourth International Workshop on Computing Education Research (ICER 2008)* (pp. 113–124). Sydney, Australia: ACM. https://doi.org/10.1145/1404520.1404532

Durlak, J.A., Weissberg, R.P., Dymnicki, A., Taylor, R.D., & Schellinger, K.B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. Child Development, 82, 405-432.

Israel, M., Lash, T. A., & Jeong, G. (2017). Utilizing the Universal Design for Learning framework in K-12 computer science education. *Project TACTIC: Teaching All Computational Thinking through Inclusion and Collaboration.*

Krathwal D.R. (2002). A Revision of Bloom's Taxonomy, An Overview*. Theory into Practice*. *41(4),* 212-218.

Parsons, D., & Haden, P. (2006). Parsons Programming Puzzles: A Fun And Effective Learning Tool For First Programming Courses. In *Proceedings of the Eighth Australasian Conference on Computing Education (ACE 2006)* (CRPIT Vol. 52, pp. 157–163). Hobart, Australia: Australian Computer Society>

Papert, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas*. Basic Books Inc.

Sentence, S., Waite, J., Kallia, M. (2019). Teaching Computer Programming with PRIMM: a sociocultural perspective Computer Science Education. 29(2-3), 136-176.

Srinivasan, M. (2019) SEL Everyday: Integrating Social and Emotional Learning with Instruction in Secondary Classrooms. W.W. Norton & Company.

"Standards for the 21st Century Learner to launch during AASL National Conference." American Library Association. 2007. http://www.ala.org/ala/pressreleases2007/october2007/standards07.htm (Accessed 03 Nov, 2021) Collaborative for Academic, Social, and Emotional Learning (CASEL). (n.d.). Home - CASEL.

Weissberg, R.P. & Cascarino, J. (2013). Academic learning + social-emotional learning = national priority. Phi Delta Kappan, 95 (2), 8-13.

Wiglesworth, M., Lendrum, A., Oldfield, J., Scott, A., ten Bokkel, I., Tate, K., & Emery, C. (2016). The impact of trial stage, developer involvement and international transferability on universal social and emotional learning programme outcomes: A meta-analysis. Cambridge Journal of Education, 46, 347-376.

Wing, J (2014, January). Computational Thinking Benefits Society. *Social Issues In Computing*. http://socialissues.cs.toronto.edu/2014/01/computational-thinking