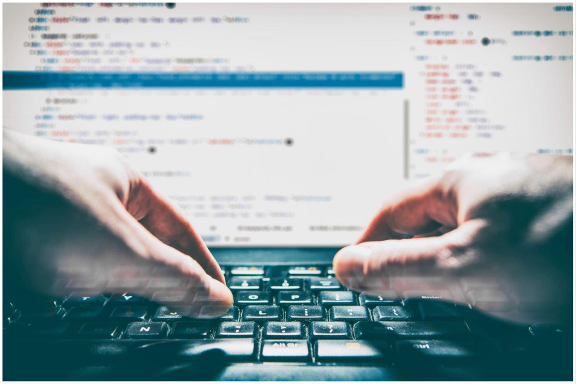
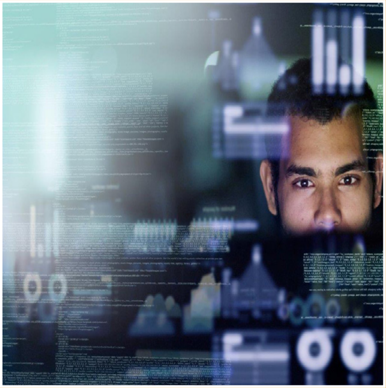
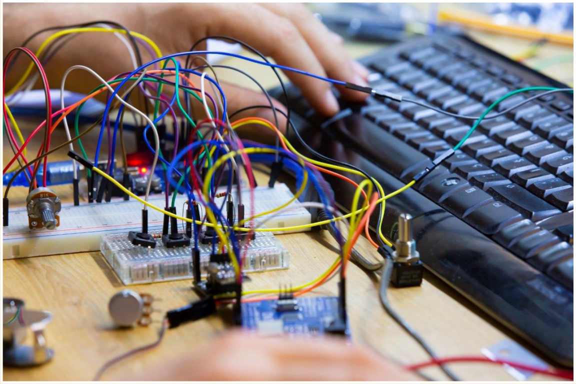
CMP521A



COMMUNICATION INFORMATION TECHNOLOGY

Introduction to Computer Science





Curriculum Guide

Prince Edward Island
CANADA

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INTRODUCTION

Course Description

CMP521 - Introductory Computer Science is designed to provide students exposure to four big ideas of computer science: programming skill development, data analysis, prototyping and computer literacy. The intended focus of study is the introduction of principles, methodologies and skills that will provide a foundation toward the successful understanding of how computer science can enable students to better understand they world they live. Through the application of a wide range of disciplines, students will strive to complete meaningful work that builds resiliency, confidence and competency within the discipline of computer science. It is through trial and troubleshooting that students are expected to build a spirit of curiosity, exploration, self-confidence, and solution seeking.

Notes on Revision

- Removed Table of Specification.
- Updated Unit Structure and Weightings.
- Outcome codes changed to reflect unit name.

Essential Graduation Competencies

Curriculum is designed to articulate what students are expected to know and be able to do by the time they graduate from high school. The PEI Department of Education and Lifelong Learning 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.

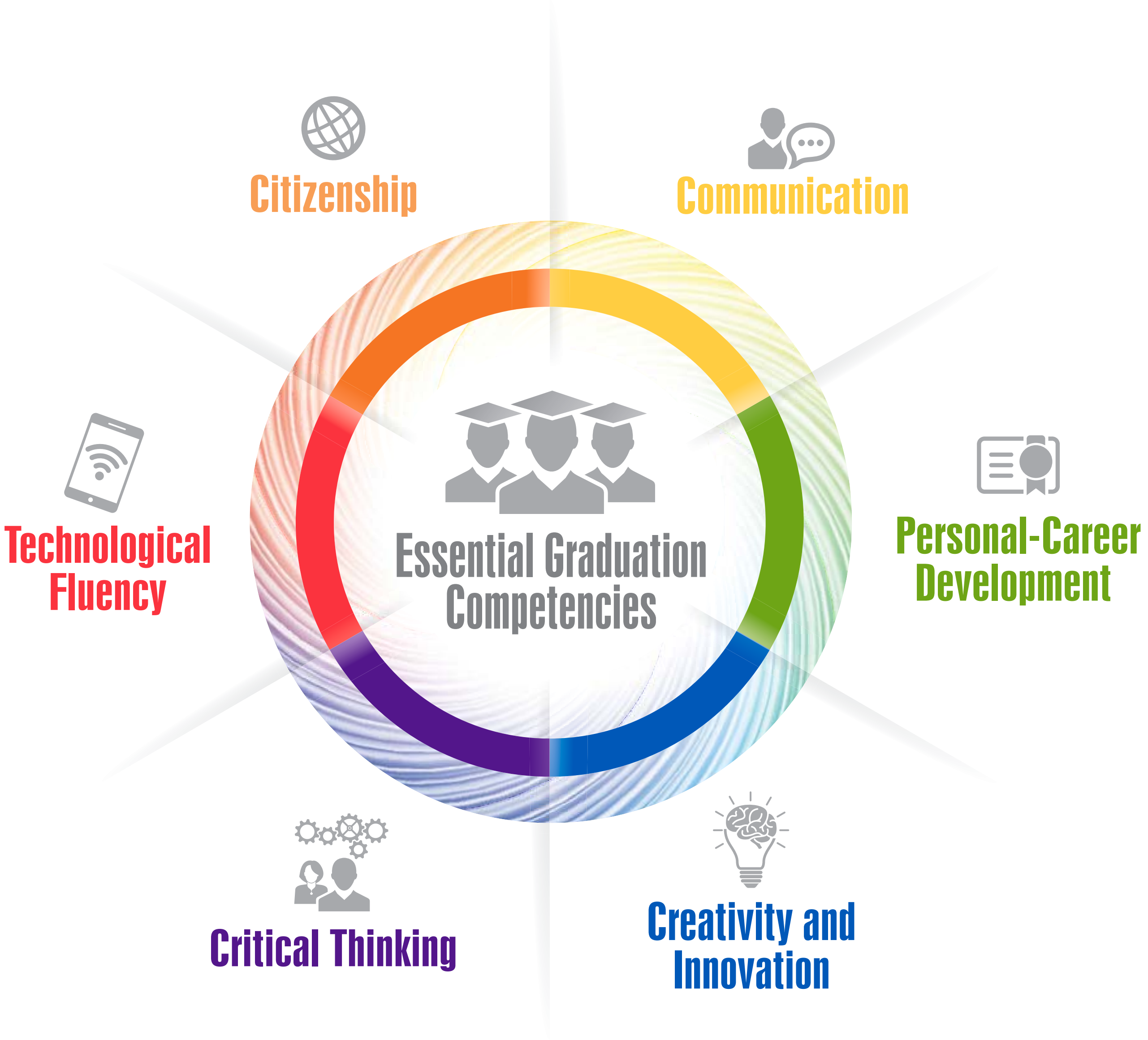


Figure 1. Essential Graduation Competencies

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 interconnectedness 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.

Broad Overview of Program Area

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.

Pathways and Oppourtinites in CIT

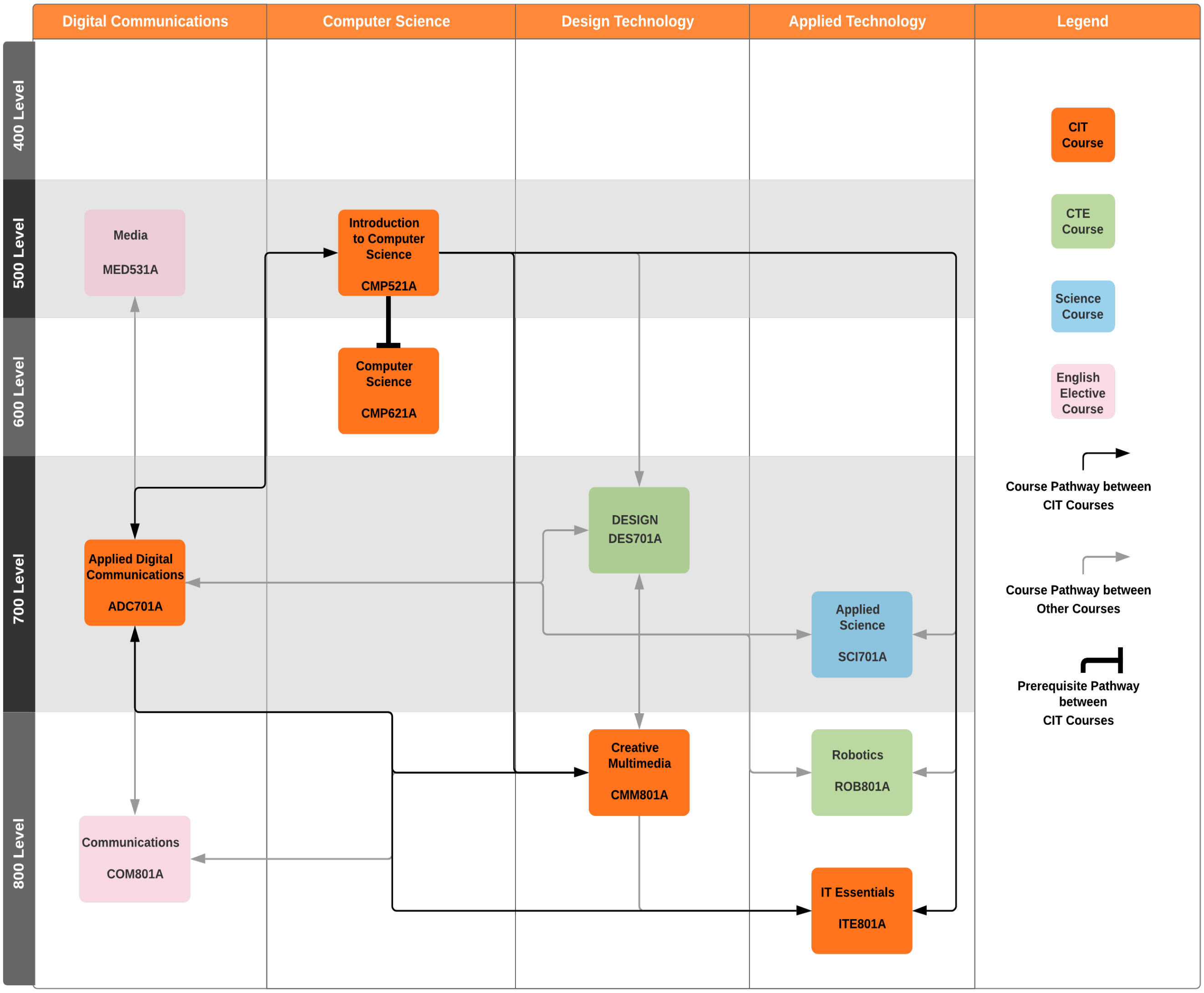


Figure 2. CIT Pathways

General Curriculum Outcomes

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

Table 1. Technology Education General Curriculum Outcomes

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

Unit Structure

The table below outlines the unit structure for Communication and Information Technology courses. The specific curriculm outcomes for individual courses are organized into these units and provide a lens through which each curriculum outcome may be viewed and understood. Although the outcomes are organized into specific units, they are not intended to be experienced in isolation, but should be considered in ways that allow them to be integrated across units.

Table 2. CIT Unit Structure

Units	Description
Technological Fluency	Through the lens of Technology Fluency, learners use information and communication technologies to consume, curate, evaluate, create, and share digital content to express themselves in an appropriate and professional way. Learners leverage the use of digital tools in a digital practice that is ethical, responsible and reflective in their academic, social and personal life.
Skills Development	Through the lens of skill development, learners acquire, practice, and improve their skills related to the principles, procedures, and conventions of digital technologies through the creation of projects, presentations and publications.
Applied Design	Through the lens of applied design, learners explore their curiosity and creativity by creating digital artifacts through a design process that is cognitive, strategic, and practical. Learners create artifacts through experiential, hands-on experiences that promote innovative thinking, problem solving, and collaboration.
Technological Systems	Through the lens of technology systems, learners acquire the knowledge and ability to use computers and technologies efficiently by developing a range of skills allowing learners to explore areas of personal interest, post secondary opportunities, and apply these skills in routine activities.

Specific Curriculum Outcomes

Specific curriculum outcomes (SCOs) identify what students 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 student performance and are the basis for the assessment of student 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 support, define, and demonstrate 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 student for that particular outcome. It is important to note that AIs are not a prescriptive checklist to be taught in a sequential manner, are not a prioritized list of instructional activities, and are not a set of prescribed assessment items. Achievement indicators provide clarity and understanding to ensure instructional design is aligned to the SCO.

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 the purpose of 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 students 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 students, 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 3. 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.

Knowledge Dimension

The knowledge dimension classifies four types of knowledge, ranging from concrete to abstract, that learners may be expected to acquire or construct.

These types of knowledge include factual, conceptual, procedural, and metacognitive. The noun(s) or noun phrase(s) included in a specific curriculum outcome represent the type of knowledge for the knowledge dimension.

Table 4. Knowledge Process Dimension

Category	Description
Factual	The basic elements students must know to be acquainted with a discipline or solve problems in it (e.g., knowledge of terminology; knowledge of specific details and elements).
Conceptual	The interrelationship among the basic elements within a larger structure that enables them to function together (e.g., knowledge of classifications and categories, knowledge of theories, models, and structures).
Procedural	How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods (e.g., knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, knowledge of criteria for determining when to use appropriate procedures).
Metacognitive	Knowledge of cognition in general as well as awareness and knowledge of one's own cognition (e.g., strategic knowledge, knowledge about cognitive tasks, including appropriate contextual and conditional knowledge, self-knowledge).

Taxonomy Tables

Combining the cognitive process dimension and knowledge dimension into one taxonomy table helps teachers to visualize the overall expectations. As teachers reflect deeply and collaborate to identify the types of cognition and knowledge required by each outcome, they will be better able to plan what student achievement will look, sound, and feel like in the learning environment, leading to student achievement of the outcomes at the targeted level.

The taxonomy tables in the PEI curriculum guides are constructed as two-dimensional tables where the knowledge dimension forms the vertical axis and the cognitive process dimension forms the horizontal axis. This results is a 24-cell matrix on which any specific curriculum outcome can be classified in terms of both dimensions.

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.

verb: APPLY

cognitive process: APPLYING

SD1—apply coding principles, procedures, and conventions to produce code using two or more programming languages.

nouns: coding principals, procedures, and conventions

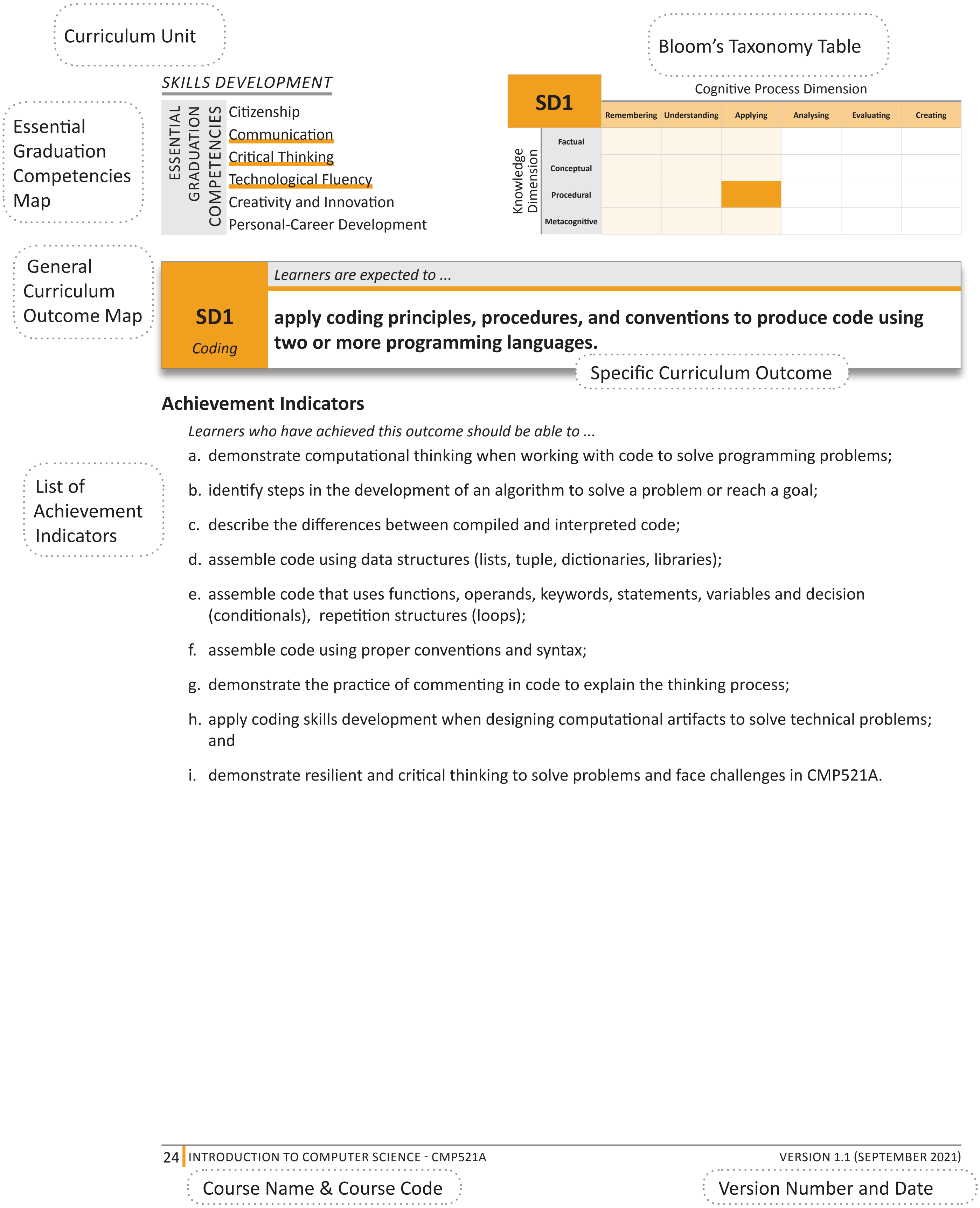
knowledge: PROCEDURAL

Curriculum Guide Layout

The curriculum guide layout is designed to highlight the critical elements of the curriculum guide.

Table 5. Curriculum Guide Layout

Feature	Description
Unit Name	Appears in the upper left hand corner.
Taxonomy Table	Appears in the upper right hand corner and is specific to the given outcome.
SCO Block	Appears in the coloured box; may contain a scope and sequence chart.
AI List	Appears in the body of the page immediately following the SCO.
EGC Map	Appears at the bottom of the page.



SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- Critical Thinking
- Technological Fluency
- Creativity and Innovation
- Personal-Career Development

SD1

Cognitive Process Dimension

Knowledge Dimension	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Factual						
Conceptual						
Procedural			■			
Metacognitive						

SD1

Coding

Learners are expected to ...

apply coding principles, procedures, and conventions to produce code using two or more programming languages.

Achievement Indicators

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

a. demonstrate computational thinking when working with code to solve programming problems;

b. identify steps in the development of an algorithm to solve a problem or reach a goal;

c. describe the differences between compiled and interpreted code;

d. assemble code using data structures (lists, tuple, dictionaries, libraries);

e. assemble code that uses functions, operands, keywords, statements, variables and decision (conditionals), repetition structures (loops);

f. assemble code using proper conventions and syntax;

g. demonstrate the practice of commenting in code to explain the thinking process;

h. apply coding skills development when designing computational artifacts to solve technical problems; and

i. demonstrate resilient and critical thinking to solve problems and face challenges in CMP521A.

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Figure 3. Sample Curriculum Guide Page

Teaching Strategies

Teaching is both a science and an art. There is a wealth of instructional strategies and methodologies described in the literature related to Computer Information Technology (CIT) that teachers have at their disposal when creating a learning environment that best suits the needs of their students.

Below is a CIT Teaching Strategies Wheel that is designed to identify a range of strategies that are effective when preparing lessons, assignments, and experiences for the CIT classroom. The list is not intended to be exhaustive and CIT teachers are encouraged to continually read and engage in current research, pedagogy, and practice related to their field.

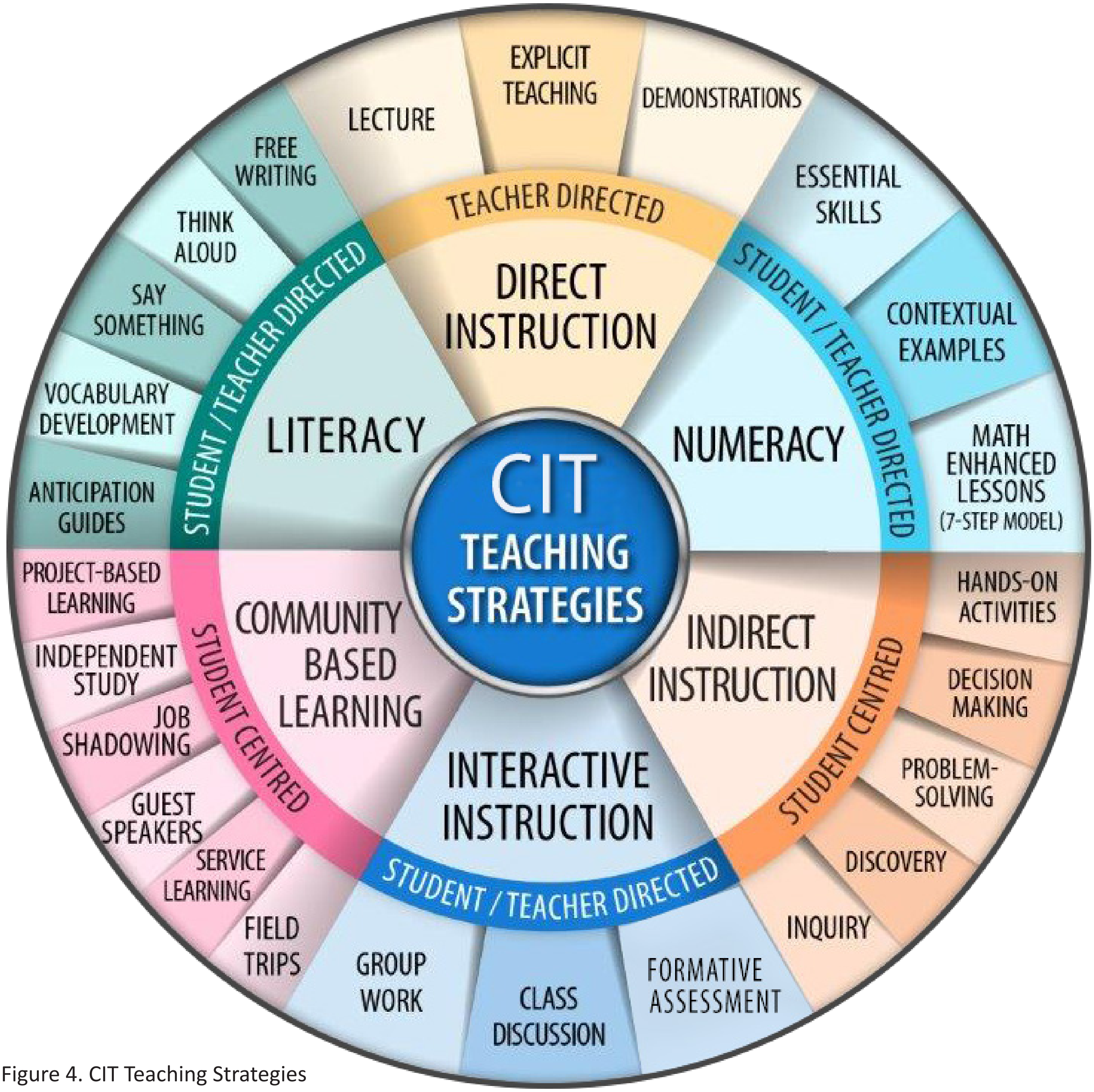


Figure 4. CIT Teaching Strategies

Direct Instruction

Direct instruction is highly teacher-directed and is among the most commonly used strategy. Direct instruction is effective for providing information, developing step-by-step skills, introducing other teaching methods, or actively involving students in knowledge construction. Examples include lecture, didactic questioning, explicit teaching, practice and drill, and demonstrations.

Indirect Instruction

Indirect Instruction is primarily student-centred and complements direct instruction. Indirect instructin draws on the inquiry process, induction, problem solving, decision making, and discovery. Examples include reflective discussion, concept formation, concept attainment, problem solving, and guided inquiry.

Interactive Instruction

Interactive instruction relies heavily on discussion and sharing among learners and allows for a range of groupings and interactive methods. Examples include full class discussions, small group discussions, group projects, and peer support when working on assignments.

Numeracy

Numeracy instruction is an integral part of all learning. By Incorporating numeracy into the CIT context, students are able to make connections to their math classes and continue to develop their transferable math skills.

Community Based Learning

Community-based learning is an instructional teaching and learning strategy that integrates meaningful community engagement with instruction and reflection enriching the learning experience with a greater emphasis on reciprocal learning and reflection (Marshall University, 2020).

Literacy

Integrating literacy into the CIT classroom is essential for students to develop strong connections between the practical skills and technical knowledge required. The following strategies are a sample of reading and writing strategies support effective CIT instruction.

Pre-Reading Strategies

Pre-reading strategies are used prior to assigning a reading and are designed to activate the students' prior knowledge on a subject, promote inquiry and discussion, provide clarity, and give the students reason to engage in the text. Examples include the following.

Free Writing - provides students with a short amount of time to record what they already know or believe about the topic. Free writes should never be collected or evaluated. The only rule of the free write is that students write for the entire time allotted even if they run out of things to say.

Anticipation Guides - consist of four or five statements about a topic that students are asked to either agree or disagree with prior to reading. The statements should be carefully crafted to raise the students' interest in the subject (so that all students do not respond in the same way), and be supported by the assigned reading. After reading, students should revisit and discuss their responses.

During-Reading Strategies

During-Reading strategies are designed to promote active reading of the material. They provide students' with specific tasks to complete or things to discover while reading the document. During-reading strategies can be used in small groups or as individual tasks.

Think Aloud - Think Aloud is a very effective strategy to use when reading aloud to students. During the Think Aloud it is important to model and reflect on how you yourself make meaning when reading challenging CIT related text, and how you relate the topic back to prior topics covered.

Say Something - Before assigning the Say Something, take time to model the strategy with a student or colleague and review the rules that will make for a successful Say Something (it is a good idea to post these rules so everyone can see them and be reminded of them during the activity):

- With your partner, decide who will say something first;
- When you say something, make a prediction, ask a question, clarify something you had misunderstood, and or make a connection;
- If you cannot do one or more of the above things, then you need to reread.

Re-reading - "Re-reading is probably the number one strategy independent readers use when something stumps them in a text. It's probably the last strategy dependent readers use." (Kylene Beers). Before asking students to reread a section of text you must first set the activity up for success:

- Prove to students that rereading is valuable to their learning. You can model this while doing a Think Aloud where you model your thinking as you interpret the text.
- Provide the students with specific tasks to complete while they reread a section.
- Review the text as a group after everyone has reread it.

BIG 3! Learning Goals, Success Criteria, and Descriptive Feedback

The "Big 3" describes strategies that teachers can use with students that are proven to increase student achievement. These are: setting and communicating learning goals, creating lists of things that students need to do to be successful (success criteria), and providing timely and descriptive feedback to students based on those criteria.

Workshop Model

The opening is an opportunity to share the day's learning targets and set the stage for the day.

During the mini-lesson the teacher provides direct instruction for the whole class.

During the work time, students get to dig in and practice the learning. This is the most important part of the workshop and therefore must be the longest part of the period. Students should use the bulk of the class to work, practice, or apply what has been taught during the mini-lesson.

Students may be working at different tasks during work time and teachers may be working with individual students. This supports student independence while also scaffolding to support growth in skills.

Gradual Release Model

Teachers must determine when students can work independently and when they require assistance. In the gradual release of responsibility model, students move from a high level of teacher support to independent practice. The teacher models a concept or strategy and makes explicit the thinking he/she engages in when choosing, and applying the strategy in a specific context. The teacher gradually releases the responsibility through a phase of shared and guided practice which leads the student to independence. If necessary, the teacher increases the level of support when students need further assistance.

Teachers may begin the process at any point in the cycle. For example, teachers may provide a diagnostic assessment (independent stage) to establish what students know prior to teaching in order to determine which practices need to be modelled and which ones the students are able to perform independently.

Marzano's High-Yield Instructional Strategies

Below is a set of High-Yield Strategies that are key to CIT. The list is not intended to be exhaustive.

- Identifying similarities and differences.
- Summarizing and note taking.
- Reinforcing effort and providing recognition.
- Homework and practice.
- Non linguistic representations.
- Cooperative learning.
- Setting objectives and providing feedback.
- Generate and testing hypothesis.

Curricular Planning Using Understanding by Design

Understanding by Design (UbD) is often referred to as "backward design". UbD is a curricular planning model developed by American educators Grant Wiggins and Jay McTighe. The main premise is that learning, and hence understanding, must be demonstrated through transference—the ability to apply what has been learned to a new situation or problem. In order to assess the level of learning, it is necessary to plan instruction as a "backward" experience of three stages: beginning with the end-in-mind or the desired results, evidence-of-learning or assessment, and finally the learning plan or the activities that will engage students and scaffold toward the end result or performance task.

The basics of UbD is to

- help transform SCOs into meaningful learning elements and assessments;
- encourage teachers to become coaches and facilitators of meaningful learning rather than purveyors of superficial content;
- reveal learning when students make sense of and are able to transfer learning to new and authentic situations;
- require ongoing review of instructional design to ensure effective practice and continuous improvement for achievement;
- promote a way of thinking about curricular planning in a broader sense not a rigid program or prescriptive plan;
- ensure deeper student understanding by making meaning from "big ideas"; and
- overcome tendency to commit the twin sins; textbook coverage and activity-oriented teaching (activity without a clear purpose).

Table 6. Understanding by Design

Stage 1—Desired Results	Stage 2–Evidence	Stage 3—Learning Plan
The knowledge, skills, and attitudes that are articulated in specific curriculum outcomes (SCOs) are identified.	Performance tasks and criteria are determined. Performance tasks should be authentic tasks that are designed to simulate or replicate real-world performances and establish a realistic context with a genuine purpose, audience, and constraints. Performance criteria will provide the evidence of learning that is needed to assess performance or product. • Criteria can be weighted and include: • Content: aptness, adequacy, or accuracy of knowledge and skills used. • Process: the means, processes, attitude, or approaches taken in the performance or in the preparation for performance. • Quality: attention to detail, polish, and craftsmanship • Impact: Did the performance work? What was its effect, its result, its outcome, irrespective of effort, attitude, and approach?	In the final stage the sequence of learning activities that will scaffold students toward the performance task and understanding are planned.

Assessment and Evaluation

Assessment and evaluation are integral components of the teaching and learning process.

Effectively planned assessment and evaluation promotes learning, builds confidence, and develops students' understanding of themselves as learners. It also improves and guides future instruction and learning.

Effective and authentic assessment involves

- designing performance tasks that align with specific curriculum outcomes;
- including students in determining how their learning will be demonstrated; and
- planning for the three phases of assessment (for, as, and of learning).

Assessments need to be reflective of the cognitive processes and level(s) of knowledge and skill indicated by the outcome. An authentic assessment will collect data at the level for which it is designed.

Whether conducting assessment for learning or assessment of learning, a teacher must have sufficient proof of a students' learning. By using a process known as triangulation, teachers can obtain data of student learning from three different sources (e.g., observations, conversations and products) thereby ensuring sufficient data is collected for evaluation. Observations and conservations are more informal forms of evidence which may be, for example, recorded as anecdotal notes. Products include tests, projects, or other tasks that enable students to demonstrate what they know and can do at the end of the learning process. By collecting data from multiple sources, teachers are able to verify the data they collect against each other thus allowing them to gain an accurate portrayal of student progress.

Effective evaluation involves considering the totality of the assessment data and interpreting it to make informed judgments about student learning.

Assessment Strategies

Assessment is the act of gathering information on an ongoing basis in order to understand students' individual learning and needs. It is the journey of their learning.

Effective assessment improves the quality of learning and teaching. It helps students to become self-reflective and to feel in control of their own learning and enables teachers to reflect on and adjust their instructional practices. When students are given opportunities to demonstrate what they know and what they can do with that knowledge, optimal performance can be realized.

Assessment has three interrelated purposes:

- Assessment for learning to guide and inform instruction.
- Assessment as learning to involve students in self-assessment and setting goals for their own learning.
- Assessment of learning to determine student progress relative to curriculum outcomes.

Even though each of the three purposes of assessment requires a different role and planning for teachers, the information gathered through any one purpose is beneficial and contributes to an overall picture of an individual student's achievement.

All assessment practices should respect the needs of diverse learners and should respect and appreciate learners' cultural diversity. Teachers should provide students with a variety of ways to demonstrate on an ongoing basis what they know and are able to do with many different types of assessment over time. Valuable information about students can be gained through intentional conversations, observations, processes, performance, and products. A balance among these sources ensures reliable and valid assessment of student learning.

Effective assessment strategies

- are appropriate for the purposes of instruction, the needs and experiences of the students, and learning strategies used;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- reflect where the students are in terms of learning and help to determine the levels and types of support or instruction that will follow;
- allow for relevant, descriptive, and supportive feedback that gives students clear directions for improvement, and engages students in metacognitive self-assessment and goal setting that can increase their success as learners;
- are explicit and communicated to students and parents so students know expectations and criteria to be used to determine the level of achievement;
- must be valid in that they measure what they intend to measure and reliable in that they consistently achieve the same results when used again, or similar results with a similar group of students;
- involve students in the co-construction, interpretation, and reporting of assessments by incorporating their interests, multiple intelligences, and their learning styles;
- accommodate for the diverse learning needs of students; and
- are comprehensive and enable all students to have diverse and multiple opportunities to demonstrate their learning consistently, independently, and in a range of contexts in everyday instruction.

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.

This information allows students to make informed choices about the most effective ways to demonstrate what they know and are able to do. It is important that students participate actively in assessment by co-creating criteria which can be used to make judgments about their own learning. Assessment must provide opportunities for students to reflect on their progress, evaluate their learning, and set goals for future learning. Students may benefit from examining various scoring criteria, rubrics, and student exemplars.

Student involvement in the assessment process can be achieved by

- incorporating students’ interests into assessment tasks (e.g., allowing students to select texts to read/view that relate to their interests);
- providing opportunities for students to self-assess their learning;
- co-creating assessment criteria with the student, working to describe how a specific skill or product is judged to be successful; and
- using student exemplars to illustrate a range of skill development (i.e., practise using the assessment criteria to guide their own work).

Evaluation

Evaluation is the culminating act of interpreting the balanced information gathered through relevant and authentic assessments for the purpose of making judgments.

Inherent in the idea of evaluating is "value". Evaluation is based on the cumulative assessments of the SCOs. The SCOs should be clearly understood by learners before instruction, assessment, and evaluation takes place. Evaluation is informed by a quality, authentic formative and summative assessment process.

During evaluation, the teacher

- interprets all assessment information and makes judgments about student progress;
- reports on student progress; and
- makes informed decisions about student learning programs based on the judgments or evaluations.

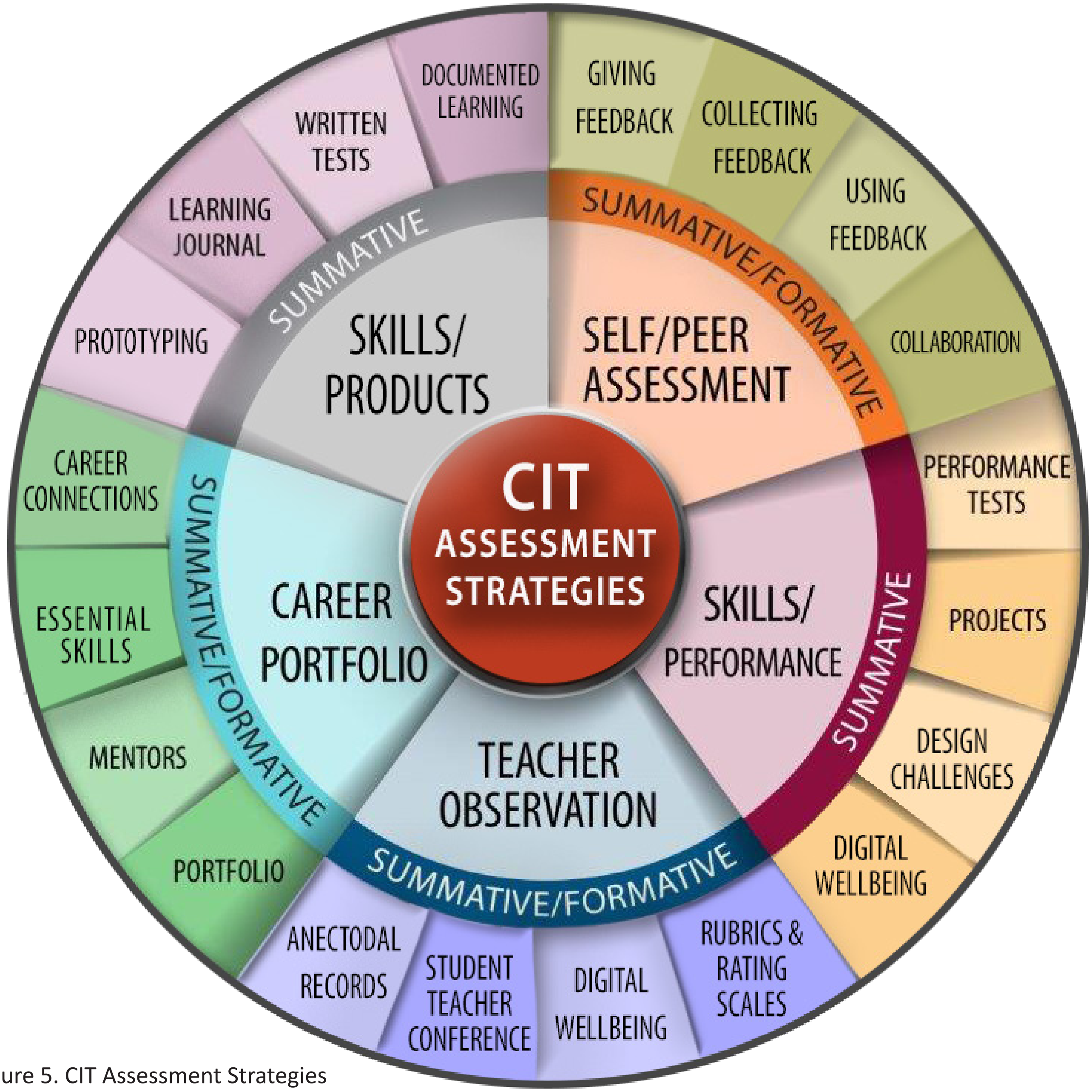


Figure 5. CIT Assessment Strategies

Outcome Summary

The outcomes of CMP521A are categorized into four 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 starting on page 24.

Table 7. Summary of Specific Curriculum Outcomes for CMP521A

Unit	Weighting	Code	Learners are expected to ...
Skills Development	**50-60%**	SD1	apply coding principles, procedures, and conventions to produce code using two or more programming languages.
		SD2	demonstrate the skills and knowledge required to modify code.
		SD3	control electronic circuits using basic electronic knowledge and coding skills.
		SD4	demonstrate processes used in the collection and processing of data.
		SD5	demonstrate processes used in the interpretation and representation of data.
Applied Design	**25-30%**	AD1	create prototypes that demonstrate their technical skill and proficiency.
		AD2	apply a design process to ideate, prototype and test solutions to technical challenges.
Technological Systems	**5-10%**	TS1	explore the relationship between hardware and software using physical computing devices.
Technological Fluency	**5-10%**	TF1	discover personal interests and opportunities related to computer science.
		TF2	research impacts of computing on various aspects of society both locally and globally.

Application of Bloom’s Taxonomy

Table 8 below shows where CMP521A outcomes sit within Bloom’s Taxonomy. This should serve as a guide to the breadth and depth to which outcomes are addressed. Refer to “Bloom’s Taxonomy” on page 12 for descriptions of the Cognitive Process and Knowledge Dimensions. Please note that the Skills Development (SD) outcomes build essential skills and knowledge for learners to use within other outcomes. This should be considered when developing an assessment and evaluation plan.

Table 8. Bloom’s Taxonomy Table for CMP521A

		Cognitive Process Dimension					
		Remembering	**Understanding**	**Applying**	**Analysing**	**Evaluating**	**Creating**
Knowledge Dimension	**Factual**						
	Conceptual			SD2, SD4, TF2	SD3, TS1		
	Procedural			SD1, SD5, AD2			AD1
	Metacognitive						TF1

Verb Chart

Table 9 below will provide guidance as to the intended cognitive process that is associated with each verb in the context of the guide. It is important to note that some verbs could easily appear in different cognitive process levels, but have been placed as indicated because of the nature of the task(s).

The verb, ***explain***, for example, could be found under the Understanding level in some curricula, but what students are asked to do within Computer Science puts this verb at an Analysing level.

For a detailed description of each category see “Bloom’s Taxonomy” on page 12.

Table 9. Verb Chart for CMP521A

Remembering	Understanding	Applying	Analysing	Evaluating	Creating
	assemble	acquire	configure	develop	create
	describe	apply	control	discover	
	discuss	build	exchange	evaluate	
	identify	combine	explain	select	
	locate	contribute	explore		
	research	demonstrate	produce		
	understand	practice	troubleshoot		
		prepare	verify		
		use			

SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- Critical Thinking
- Technological Fluency
- Creativity and Innovation
- Personal-Career Development

SD1		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual	░	░	░			
	Conceptual	░	░	░			
	Procedural	░	░	█			
	Metacognitive	░	░	░			

Learners are expected to ...

SD1

Coding

apply coding principles, procedures, and conventions to produce code using two or more programming languages.

Achievement Indicators

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

a. demonstrate computational thinking when working with code to solve programming problems;

b. identify steps in the development of an algorithm to solve a problem or reach a goal;

c. describe the differences between compiled and interpreted code;

d. assemble code using data structures (lists, tuple, dictionaries, libraries);

e. assemble code that uses functions, operands, keywords, statements, variables and decision (conditionals), repetition structures (loops);

f. assemble code using proper conventions and syntax;

g. demonstrate the practice of commenting in code to explain the thinking process;

h. apply coding skills development when designing computational artifacts to solve technical problems; and

i. demonstrate resilient and critical thinking to solve problems and face challenges in CMP521A.

Context

The outcomes in this curriculum are intended to be integrated as much as possible, attention should be taken to refrain from teaching and learning them in isolation unless the development of skills, thinking and attitudes are needed prior to integration with other outcomes. These outcomes require learners to actively participate in all projects, tasks, and learning opportunities for the course.

To become proficient in any computational language it is essential that learners develop their understanding of the fundamental building blocks of Computer Science (CS) principles and procedures. Learners should be provided with “hands-on” opportunities to build a combination of skills and concept learning through the scaffolding of step by step procedures that allow students to “try them out”. It is necessary that learners develop confidence with learning coding principles, procedures, and conventions.

Exposure to coding in this “hands-on” way allows for further development of these concepts through the continual practice of similar concepts in a variety of different scenarios that are designed to encourage problem-solving skills by working with increasingly complex computational items.

Content

A knowledge of computer programming fundamentals will provide learners the means to develop the computational understanding required to undertake increasingly complex computational problems. Direct questioning and reflection opportunities in the development of code will provide learners the chance to demonstrate and explain their thinking process.

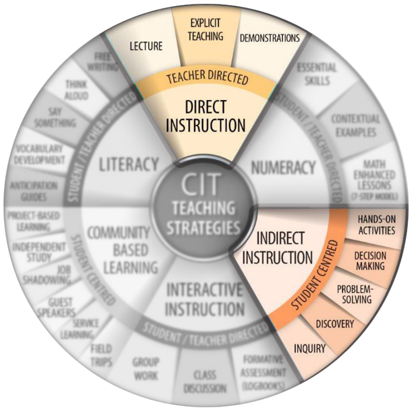
In the development of learning activities, teachers should be mindful to scaffold learning activities and guide the learners thinking. Constant practice is required for learners to actively reflect on their programming experience and they should be encouraged to undertake each activity as a way of learning by thinking and doing instead of only programming in a trial and error mode. It is by encouraging learners to push themselves from merely imitating code to combining new programming knowledge in the creation of code that will allow them to engage with the ideas or tasks they are trying to create or express.

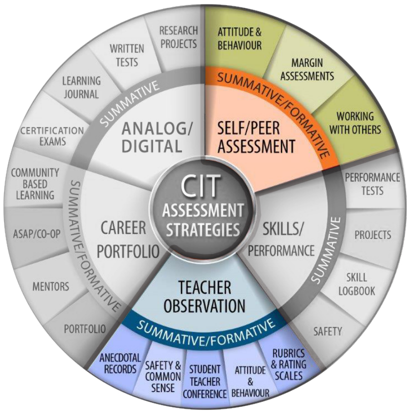
Success in mastering a programming language is built on making and fixing coding mistakes. Providing programming examples that contain flaws is a way to challenge learners construction of new knowledge and provide them opportunities to practice troubleshooting skills through debugging. This process of examining the code for issues can provide a cognitive understanding to the role debugging plays in the solving of computational problems and in the development of computational thinking skills.

Considerations for Effective Instruction and Assessment

Learners should be formatively assessed on these outcomes continually and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to these outcomes.

Remember, the best way to learn to code is by coding!





SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- [✓ Critical Thinking]
- [✓ Technological Fluency]
- Creativity and Innovation
- Personal-Career Development

SD2		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual						
	Conceptual			■			
	Procedural						
	Metacognitive						

SD2

Coding

Learners are expected to ...

demonstrate the skills and knowledge required to modify code.

Achievement Indicators

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

a. describe how abstraction is used in developing code;

b. demonstrate abstraction as a method to solve computational problems;

c. practice troubleshooting procedures used to deconstruct existing code;

d. describe intended and unintended implications of modifying computational artifacts;

e. assemble code by adding to or changing existing functionality;

f. combine existing code to create a new computational artifact; and

g. contribute to coding artifacts through collaborative development using resources created by others.

ELABORATIONS

Context

There is value in the process of modifying existing code to create something new. In fact, much of the code that is used today is a direct result of remixing and customizing others work. Coding decisions by learners need to be constantly evaluated and analyzed against their current knowledge to decide if what exists should be modified or added to in order to meet the desired objective. To accommodate this, every opportunity should be given for learners to demonstrate their accumulation of new knowledge with programming by contributing to existing coding artifacts. Designing learning activities that allow learners to contribute knowledge to other's coding artifacts can enable them to gain a sense of satisfaction and can help them achieve a sense of empowerment.

Learning activities need to emphasize how principles, procedures, and conventions are used in a variety of circumstances. Through the reusing and remixing of existing coding artifacts, connections to previous learning content can be made helping to promote engagement and creativity in learning. Without directed connections to prior knowledge, students may struggle to make bridges between the skills being learned and the ability to apply them to what they are attempting to achieve.

Content

One of the foundations for success in computer science is the development of algorithmic thinking in code construction. Algorithmic thinking assists learners in formulating problem-solving skill when undertaking computational problems. Activities designed to develop learners computational thinking skills using this process challenges their ability to recall and apply previous activities in the pursuit to create something new and more complex. There can be a benefit in this pursuit to have learners solve computational problems in collaboration with others.

Definitions

An *algorithm* is a plan, a set of step-by-step instructions to solve a problem.

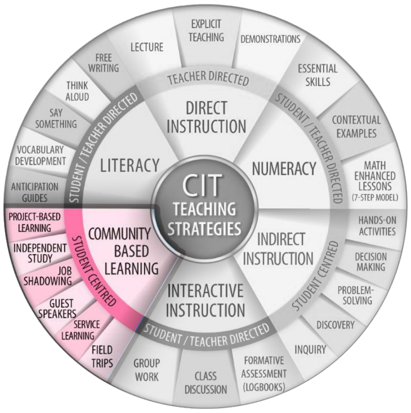
Abstraction is the process of taking away or removing characteristics from something in order to reduce it to a set of essential characteristics.

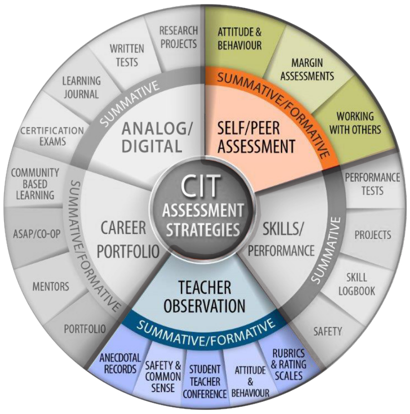
Modularization is an approach that tackles of complex problem by subdividing it into separate subprograms that each have a specific function or subroutine and working on them individually.

Considerations for Effective Instruction and Assessment

The goal of learning activities should be to nurture learner interests. With this approach, learners experience with computational activities should be interesting and meaningful to them as a way to trigger and extend their engagement. This approach will work to foster an environment of self-learning and experimentation that is the core of developing problem-solving abilities.

Formatively assessing learners on their work and thinking process while continually giving timely feedback helps to deepen their knowledge and develop their skills related to these outcomes.





SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- Critical Thinking
- Technological Fluency
- Creativity and Innovation
- Personal-Career Development

SD3		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual						
	Conceptual				■		
	Procedural						
	Metacognitive						

SD3

Arduino

Learners are expected to ...

control electronic circuits using basic electronic knowledge and coding skills.

Achievement Indicators

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

a. identify a variety of electronic components found on physical computing devices (Ram, processor, power supply, resistors, integrated circuit, inputs, outputs, sensors);

b. describe the function and operation of an electronic circuit (What is electricity?, voltage?, current?, resistance?, and Ohm’s Law? What is a circuit? integrated circuits (ICs)?);

c. assemble circuits using electronic components in a logical and efficient sequence;

d. explain how coding commands are carried out on physical computing device. (Analog vs. Digital, Ram);

e. produce code to control electronic circuits and peripheral components; and

f. troubleshoot issues or errors on physical computing devices related to circuitry and coding;

Context

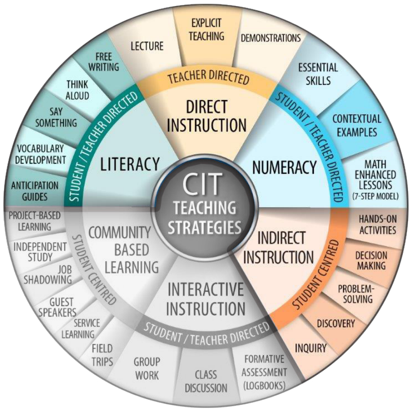
Increasingly learners' interaction with technology is extending into every facet of their lives. Learners' engagement with "smart" technology in the world around them should not be seen as a mystery. Understanding the relationship, rules, laws, and constraints between coding and physical devices that interact with coding can present learners with opportunities to cognitively understand technology's impact on their lives and how they can contribute to its development.

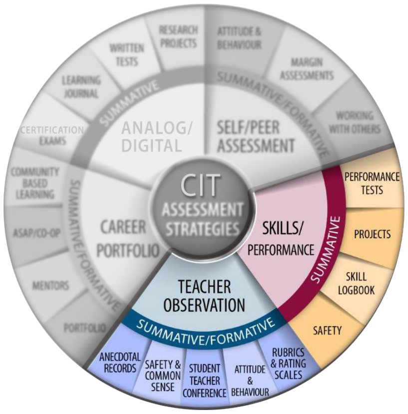
Learners should work at developing knowledge of how, where and why circuits are created, how they work, how they can be controlled using code and where that coding information is stored in physical devices in order to carry out a program.

Content

Combining computational thinking knowledge and applied skills with external devices like microcontrollers, provides a holistic awareness of the ways coding and physical computing devices interact together. This offers a tangible space for learners to connect their knowledge, receive physical feedback to computational thinking and practice coding. This state of understanding, combined with projects, tasks and learning opportunities supports learners as they explore topics in areas of interest to them. This can be in the form of guided exploration or extended to allow the learner to explore areas of interest to them. This allows for the scaffolding of previous knowledge to solve increasingly complex computational tasks.

Considerations for Effective Instruction and Assessment





SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

Citizenship
Communication
Critical Thinking
Technological Fluency
Creativity and Innovation
Personal-Career Development

SD4

Cognitive Process Dimension

Knowledge Dimension	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Factual						
Conceptual						
Procedural			■			
Metacognitive						

SD4

Analysing Data

Learners are expected to ...

demonstrate processes used in the collection and processing of data.

Achievement Indicators

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

a. describe a variety of methods for collecting data;

b. describe a variety of methods for processing data for computational use;

c. acquire data from existing data sets created/captured from other sources;

d. acquire data using multiple methods of data collection;

e. apply appropriate formatting rules and processes when organizing and retrieving data sets.

Context

In the world today more and more information is accessible through digital means like the web or from products and platforms that are prevalent in the digital world. The information collected comes from multitude of sources like surveys, sensors, or data mining and include various types of data like personal data, transactional data, web data and sensory data.

Data is simply another word for information. Data, in essence, is a collection of facts (numbers, words, measurements, observations, etc) translated into a form that computers can process. In itself, data provides little value, it needs to be processed and interpreted by someone or something before it can be used to answer relevant questions, evaluate outcomes and make predictions about future probabilities and trends. Computer technology along with programming languages provide a way for learners to capture information and manipulate it into meaning.

Content

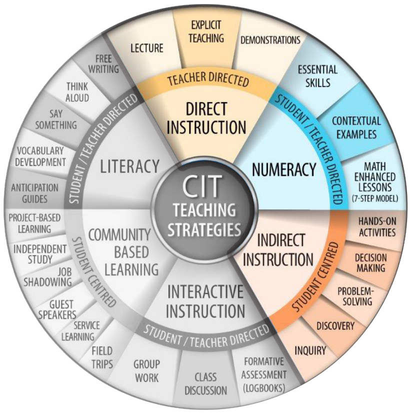
The primary goal of any data collection process is to capture specific, structured data that easily translates for analysis and interpretation.

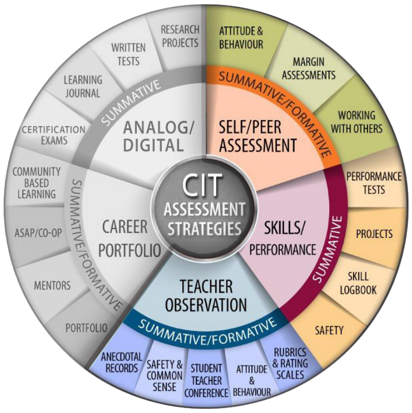
Humans vs Machines

Human-readable (also known as unstructured data) refers to information that only humans can interpret, such as an image or the meaning of a block of text. If it requires a person to interpret it, that information is human-readable.

Machine-readable (refers to information that computer programs can process). A program is a set of instructions for manipulating data. When we take data and apply a set of commands to that program, we get software. In order for a program to perform instructions on data, that data must have some kind of uniform structure. Ideally, the process of collecting data should strive to be automated and transparent.

Considerations for Effective Instruction and Assessment





SKILLS DEVELOPMENT

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- [✓ Critical Thinking]
- [✓ Technological Fluency]
- Creativity and Innovation
- Personal-Career Development

SD5		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual						
	Conceptual						
	Procedural			■			
	Metacognitive						

SD5 *Analysing Data*	*Learners are expected to ...*
	demonstrate processes used in the interpretation and representation of data.

Achievement Indicators

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

a. use data from a variety of collection methods;

b. use data sets to determine patterns (if any) from a variety of different data representations;

c. contribute to collaborative discussions with peers to gain insight and knowledge related to interpreting and representing data;

d. understand processes used to interpret, represent, store and transmit data;

e. locate possible abstractions within a data set; and

f. use appropriate visualizations, notations, and precise language when representing digitally processed data.

ELABORATIONS

Context

Data analysis is a process undertaken when obtaining raw data and converting it into usable information. This information can be used to inform decision making, answer questions, test hypotheses or to interpret patterns.

The process of gathering data can come from computer sensors, open data sets or user generated collections.

Content

Modelling and Simulation: Computational modeling and simulation help to represent and understand complex processes and phenomena. Computational models and simulations are used to analyze and identify patterns, to answer compelling questions of real phenomena and hypothetical scenarios.

Learners use critical thinking skills to locate, capture, evaluate and analyze data information sources, their own computational artifacts, and the computational artifacts others have produced.

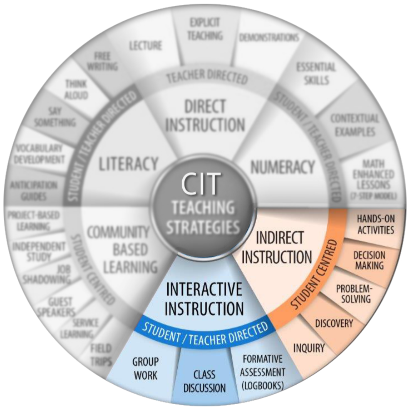
Data analysis: is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, while being used in different business, science, and social science domains.

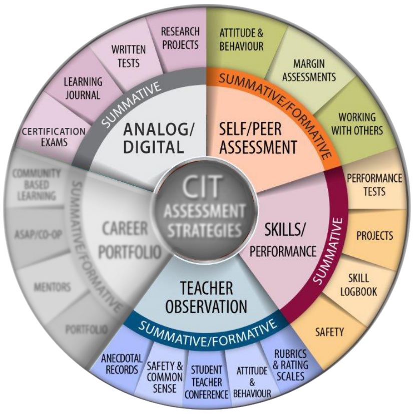
Definitions

Data analysis: Analysing raw data in order to make conclusions about the information

Modelling and Simulation: Computers combined with models used to valuate the results of some physical phenomenon.

Considerations for Effective Instruction and Assessment





APPLIED DESIGN

ESSENTIAL GRADUATION COMPETENCIES

Citizenship
Communication
Critical Thinking
Technological Fluency
Creativity and Innovation
Personal-Career Development

AD1		Cognitive Process Dimension					
		Remembering	**Understanding**	**Applying**	**Analysing**	**Evaluating**	**Creating**
Knowledge Dimension	**Factual**						
	Conceptual						
	Procedural						■
	Metacognitive						

AD1 *Prototyping*	*Learners are expected to ...* **create prototypes that demonstrate their technical skill and proficiency.**

Achievement Indicators

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

a. explain the purpose and function of prototyping;

b. apply a design process when developing computational artifacts;

c. create an computational artifact with a practical, personal, or societal intent;

d. select appropriate techniques to develop computational artifacts;

e. exchange knowledge and feedback within a community of learning; and

f. evaluate prototype development incorporating critical and constructive feedback;

ELABORATIONS

Context

During the creation of prototypes, cooperation with others can serve learners in accomplishing great results. Through collaboration and discussion at all stages of the prototype development, the shared ideas and approaches allow for development that would not necessarily be possible in isolation. Much like working in the real world of computer science, there are often teams assigned to develop or debug prototypes with each person bringing their own strengths and insights to the prototyping process.

Opportunities to prototype computational solutions for or with others should be explored and encouraged. In attempting to create something new, learners will need to apply their knowledge and make decisions about what approach should be used to proceed. Opportunities for success criteria co-creation of learning problems being investigated or the question being explored can help learners make prior knowledge connections or provide pathways in knowledge gaps.

Group work in this area can engage learners while exploring solutions to interest-driven topics.

Learners need to be provided with flawed code and processes as a way to practice their new skills of debugging. Issues in the development of coding ideas are going to arise. Repeated practice of debugging will help develop their skills, allowing learners opportunities to make mistakes in the pursuit of solving computational problems. Learners should be encouraged to build prototype solutions step-by-step, test them at each step, developing them further as new knowledge is gained and technical problems are solved.

Debugging opportunities for groups of learners should be provided so peers can learn from one another as a way to explore different approaches to problems.

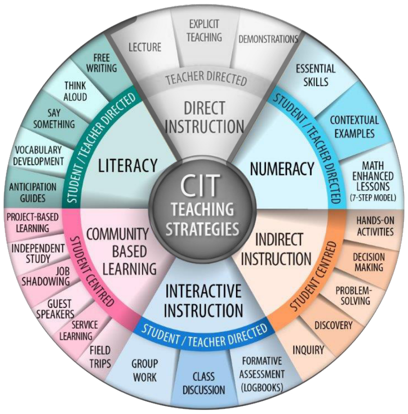
Content

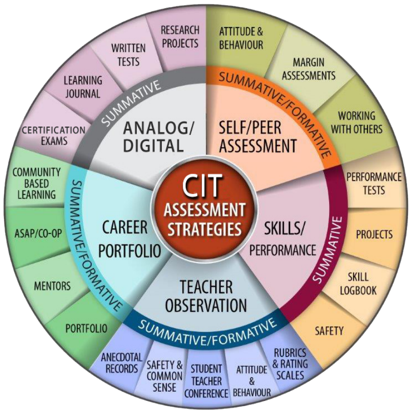
In the construction of learning activities, care should be given to not only interrelate them, but they should build on one another. Learners should be given opportunities to develop strategies for predicting and tackling problems through ‘‘trial and error”, transferring knowledge from previous activities, or drawing support from knowledgeable others’. As learners struggle to have their ideas take form, they can learn as much or more by developing the skills, attitudes, and processes required to overcome challenges. These experiences are just as valuable to the learning experience as the successful outcome of a developed prototype solution.

Definition

A prototype is an early sample, model, or release of a product built to test a concept or process, or to act as a thing to be replicated or learned from. It provides opportunities for learners to continuously develop solutions or diagnose issues based on what they have previously learned or new information gained in the prototyping process.

Considerations for Effective Instruction and Assessment





APPLIED DESIGN

ESSENTIAL GRADUATION COMPETENCIES

Citizenship
[✓ Communication]
[✓ Critical Thinking]
[✓ Technological Fluency]
[✓ Creativity and Innovation]
Personal-Career Development

AD2		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual						
	Conceptual						
	Procedural			■			
	Metacognitive						

AD2

Prototyping

Learners are expected to ...

apply a design process to ideate, prototype and test solutions to technical challenges.

Achievement Indicators

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

a. research existing design processes;

b. research existing artifacts and resources created by others to address similar challenges;

c. describe connections between computing concepts;

d. use ideating models and simulations to formulate and refine solutions;

e. use pseudocode and flowcharts to represent ideas in the development of algorithms;

f. build and test prototypes;

g. practice working both independently and collaboratively throughout the design process; and

h. demonstrate resilient and critical thinking to solve problems and face challenges in CMP521A.

Context

The design process is an important component in the development of computational knowledge. Learners' attempting to create something new will need them to reflect and evaluate their existing knowledge to decide on next steps. There exists an ongoing balance of combining existing knowledge with new ideas in the pursuit of achieving programming outcomes. This development can manifest itself in a variety of ways from the novel to complex.

Undertaking a design strategy approach prompts learners to first build foundational programming competency and computational thinking skills and apply them to a design concept through development.

Encouraging learners to think about designing and prototyping solutions for real-world application should motivate learners to reflect on their relationship with the digital world.

Content

Approaching activities using a design strategy is meant to encourage the reuse and remixing of previously developed or existing code, blending it with the addition of any newly acquired coding skills. Learning how to combine coding in this way, along with computational thinking skills, provides a scaffold for learners to undertake increasingly complex tasks.

In the development of their ideas, learners should be encouraged to think about a full range of design requirements or success criteria for the creation of prototypes.

This process of design thinking provides opportunities for learners to develop problem-solving skills through problem formulation, decomposition, generalization, abstraction, and finding feasible computational solutions while also being engaged in testing and debugging activities as they work toward a solution. Ongoing opportunities for this repeated cycle of ideating will be needed.

Questions to consider

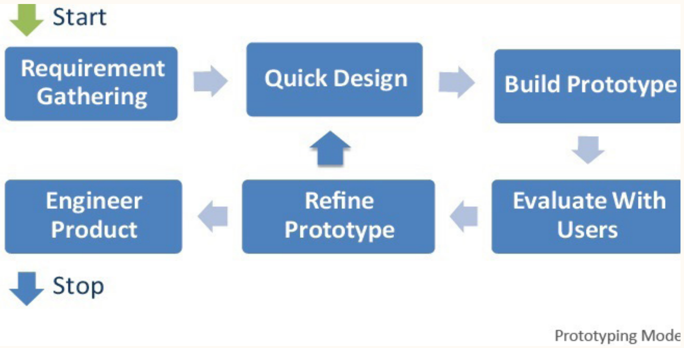
What is the design objective

What applications/tools are required

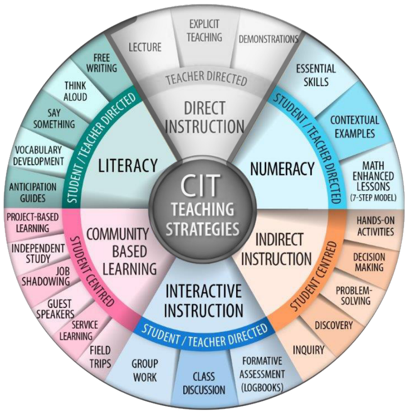
What are potential obstacles

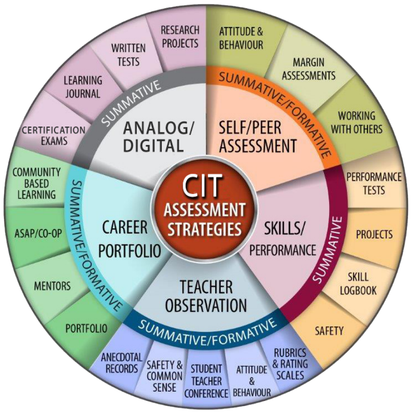
What design approach should be undertaken (flowchart, diagram, written design specifications, pseudocode)

How will development be tracked (recording, reflection)



Considerations for Effective Instruction and Assessment





TECHNOLOGICAL SYSTEMS

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- Critical Thinking
- Technological Fluency
- Creativity and Innovation
- Personal-Career Development

TS1		Cognitive Process Dimension					
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Knowledge Dimension	Factual						
	Conceptual				🟧		
	Procedural						
	Metacognitive						

TS1

Microcontrolers

Learners are expected to ...

explore the relationship between hardware and software using physical computing devices.

Achievement Indicators

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

a. assemble components in a logical and efficient sequence;

b. produce computational artifacts using physical devices and coding that aim to answer a specific question or problem

c. prepare code to be used with a physical device;

d. verify and transfer code to a physical device;

e. configure components of a physical device as required; and

f. troubleshoot physical devices and code as required.

Context

In an attempt to make connections and understanding between coding and its use to contribute to the digital world, physical computing devices can provide tangible feedback on learner's ideas. Learners should have a basic understanding of how the computer handles programming commands, how these commands are interpreted, stored and carried out in relation to hardware components. Understanding these interdependent relationships helps to demystify what actions are taking place behind the scenes. Clarity of these topics supports learners attempts to troubleshoot computational artifacts as they modify existing code and create new things using programming commands and microcontrollers.

Content

Receiving feedback from the input process of physical computing devices (i.e. Arduino microcontroller) provides a sense of empowerment and engagement for learners, helping to connect computer science to the world around them. As learners continue the development of their skills they will begin to create and express their ideas in a meaningful way.

A microcontroller basically contains one or more following components:

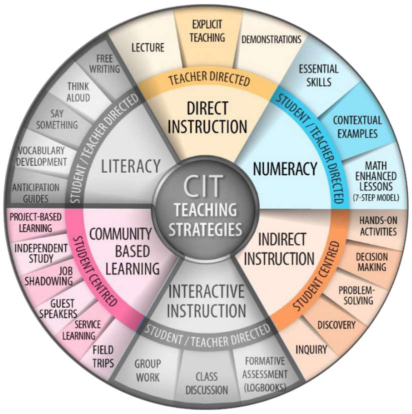
- Central processing unit(CPU)
- Random Access Memory)(RAM)
- Read Only Memory(ROM)
- Input/output ports
- Timers and Counters
- Interrupt Controls
- Analog to digital converters
- Digital analog converters
- Serial interfacing ports
- Oscillatory circuits

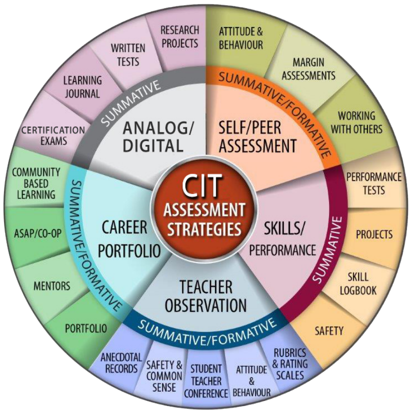
Definition

Microprocessor: Is the brain of all computing systems (such as your PC, smartphone, home assistant, blood sugar measuring device…etc). It's the unit responsible for all necessary calculations which allow a system to work and produce the expected output. A Microprocessor can't work alone because it needs to receive data from other units, and this is why you'll need other parts such as registers, memory units and Input/Output ports (at least).

Microcontroller: It's an EMBEDDED SYSTEM, and this means it embeds several unit in one single chip: Microprocessor + Memory units (RAM, ROM, FLASH) + Input/Ouput Ports + other peripherals (such as Analog-to-Digital Converter or Analog-Comparator or Timers..etc). Microcontrollers are special because they allow developers to build a functioning system in short time, a Microcontroller is a single chip that cannot work alone: It needs power and a proper interface to load and flash programs and display the processed data out.

Considerations for Effective Instruction and Assessment





TECHNOLOGICAL FLUENCY

ESSENTIAL GRADUATION COMPETENCIES

- Citizenship
- Communication
- Critical Thinking
- Technological Fluency
- Creativity and Innovation
- Personal-Career Development

TF1

Cognitive Process Dimension

Knowledge Dimension	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Factual						
Conceptual						
Procedural						
Metacognitive					■	

Learners are expected to ...

TF1

Careers

discover personal interests and opportunities related to computer science.

Achievement Indicators

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

a. identify personal learning opportunities in information technology;

b. identify post-secondary learning opportunities and programs related to computer science;

c. identify career opportunities in information technology;

d. explore a computing innovation with specificity;

e. discover connections between the broad range of careers and opportunities related to computer science and personal projects within the 521A course; and

f. develop personal goals (career, interest, and/or wellness goals) related to project work with the 521A course.

Context

The importance of supporting the learner’s interest as it relates to computer science needs to be emphasized by encouraging curiosity and exploration. Interest-driven activities enhance learners engagement and serve to make connections with other options within the field of computer science not previously considered. Areas to consider: How will computer science alter the world of finance, science, engineering, recreation, travel?

Not all learners will decide to pursue fields of computer science and Information technology, but exploring an interest-driven approach allows for the potential of fusing this new knowledge into future fields of study.

Content

Interest-driven creations can help demystify the digital world of the learner and demonstrate to them that they can be content creators. All activities should be considered in the following ways:

First: the learning activities should be kept up-to-date and regarded as modern by learners.

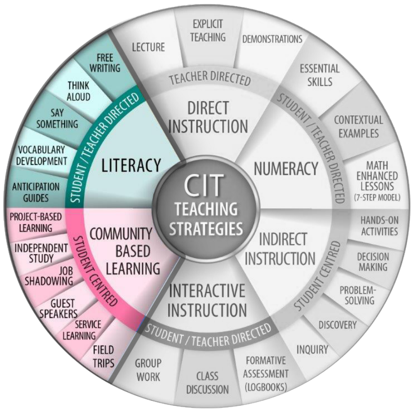
Second: the content of the activities has to be relevant to learners’ daily lives. Problem solving requires an authentic problem in which learners become more engaged in the learning activities

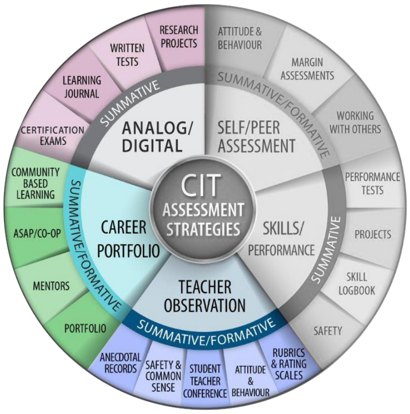
Third: there is a need to value the learners’ opinions on what is considered as meaningful and interesting, and incorporate them into the activities design.

Lastly: the learning environment should be relaxing and inclusive for all learners and the teacher, considering the diverse composition and interests of the classroom. There are going to be hurdles and mistakes, dissonance should be encouraged and supported as learners take risks and try out new strategies.

Without this approach, it may be difficult for learners to become motivated to explore their interests at a deeper level. Teachers should aim to change the perception that computer science itself is generally seen as a technical and specialized activity which only suits a small community.

Considerations for Effective Instruction and Assessment





TECHNOLOGICAL FLUENCY

ESSENTIAL GRADUATION COMPETENCIES

Citizenship
Communication
Critical Thinking
Technological Fluency
Creativity and Innovation
Personal-Career Development

TF2

Cognitive Process Dimension

Knowledge Dimension	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Factual						
Conceptual				■		
Procedural						
Metacognitive						

TF2

Research

Learners are expected to ...

research impacts of computing on various aspects of society both locally and globally.

Achievement Indicators

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

a. identify themes, opportunities, and advances in the field of computer science;

b. discuss how computing innovations affect communication, interaction, and cognition;

c. discuss the benefits and harmful effects of computing; and

d. identify connections between computing and economic, social, and cultural contexts.

Context

Learners become more knowledgeable about the digital world they live in through their ability to contribute to it in meaningful ways. They should be challenged to investigate what effect technology has on the world. Learners should explore, either individually or with peers, the complexities of a digital world on topics that affect them locally and globally.

Allowing learners to learn from each other provides a means by which the group can investigate topics they may not have thought of on their own. A safe place to negotiate differences, understand each other's experiences, and establish shared meaning is essential.

The ever-changing field of computer science challenges meaning making from its ongoing advances. The topics explored through this outcome should provide opportunities for learners to wrestle with the conditions that new advances in computer science will have in learners personal, academic and professional lives.

Content

It is in seeking to find meaning to technology-related problems that learners should be challenged to think through complex moral dilemmas, employ higher-order reasoning skills, and apply course principles as they construct knowledge through investigation.

These areas of exploration that could be considered:

- under representation of females in the field of computer science
- cyber security vs individual privacy
- artificial intelligence
- benefits/drawbacks relating to climate change
- big data and machine learning
- computer science ability to create more/less independent lifestyles

Considerations for Effective Instruction and Assessment