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Career and Technical Education

Intermediate
Technology Education



Curriculum Guide

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Career and Technical Education

Curriculum Renewal

Renewal of curriculum begins with the common understanding that K-12 students must engage in learning that enables them to participate in a world of rapid and complex change. This dynamically evolving environment requires that students develop multiple literacies, increase depth of knowledge, and acquire a range of skills, attitudes, and abilities that foster creativity, innovation, and problem-solving skills.

Students must also develop a desire for personal and collective achievement, and a willingness to collaborate for the well-being of themselves and others. It is essential that educators and administrators have an in-depth understanding of curricular expectations as part of a broader learning continuum.

Importance of Career and Technical Education

Career and Technical Education (CTE) provides relevance to learning and values the technical skills required to complete meaningful work as equally important to the academic skills required. This blend of thinking and doing is fundamental for CTE students to fully comprehend and demonstrate competency within CTE programming. The false dichotomy between hands-on and heads-on education is no longer relevant to modern education systems or modern economic systems. The current labour market demands that people have the ability to acquire skills, build proficiency, seek out critical knowledge, and adapt to an ever-changing landscape. To this end, students must be lifelong learners who commit to cultivating their knowledge and skills through a combination of experience and education.

High quality Career and Technical Education programs prepare students for success by incorporating rigorous academic and technical skills, essential workplace competencies, and a commitment to career education. Thinking and doing are not at odds; rather each is critical for the development of the other and the success of the learner.

Career and Technical Education curricula are designed to foster the development of all learners as technologically literate and capable citizens who possess the technical skills, strategic knowledge, and agility required in the development of innovative and responsible solutions to relevant technical problems and the career awareness required to transition to further education and work after secondary school.

Goals for Career and Technical Education

Students will develop

- the technical skills, confidence, and employability skills needed to gain employment within their area of interest along with the critical thinking and problem solving skills required to sustain employment.
- the academic skills required to further their education and to embrace the ever-changing reality of technical work as active learners and innovators with an entrepreneurial spirit.
- the knowledge, skills, and attitudes that will enable the agility required to be actively engaged in the development and implementation of their own career plans.

“If, instead of keeping a child at his books, I keep him busy in a workshop, his hands labor to his mind’s advantage: while he regards himself only as a workman he is growing into a philosopher.”

Jean Jacques Rousseau
Emile; or, Concerning Education
p. 140. 1889

Intermediate Technology Education

Overview

The Intermediate Technology Education program is designed as a 75-hour program delivered over 3 years. The outcomes are broken into two levels to enable schools the flexibility required to deliver this program in a wide variety of school configurations and schedules.

By the end of grade 9, students are expected to have demonstrated competency with the Level II outcomes. The Level I and Level II outcomes are designed to scaffold required skills and knowledge directly (i.e., Level I A.1 scaffolds directly to Level II A.1). This enables all learners to progress towards mastery at their own pace and challenges instructors to differentiate instruction and facilitate learning experiences that encourage students' continued growth.

Intermediate Technology Education Unit Breakdown

Unit A: Safety (2 outcomes)

Unit B: Technical Skills (4 outcomes)

Unit C: Design Thinking (2 outcomes)

Course Descriptions

Level I

The Intermediate Technology Education Level I program is designed to introduce students to working and learning in a technology education environment. Students will experience working with a variety of tools and materials to develop solutions to technical problems. Students will be introduced to the concept of design as a creative process that allows people to plan, create, modify and/or build products, systems, or solutions to problems. Students will begin to use the engineering design process to solve simple tasks or problems. The focus of the course is on building technical skill, learning through failure, and redesigning past solutions to problems. Students are expected to be working safely and responsibly in a technical classroom, building technically proficient skills involving hand tools and materials, following safe work procedures when operating power tools, and engaging with the work with a spirit of curiosity, critical thinking, and innovation.

Level II

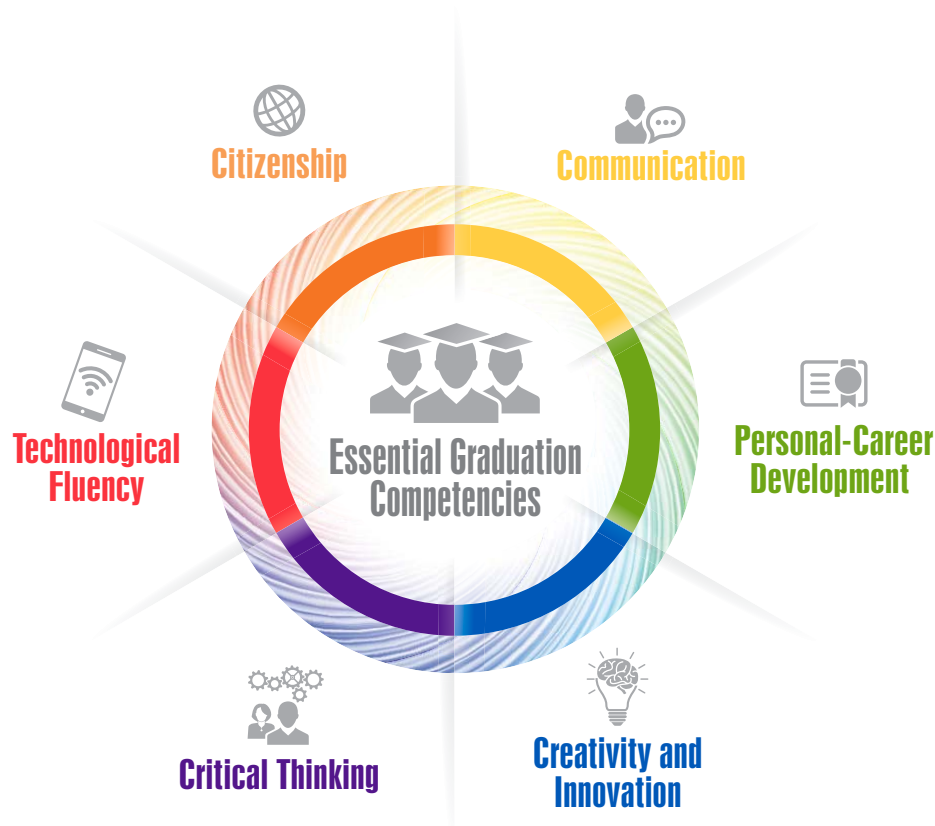
The Intermediate Technology Education Level II program is designed to challenge students to use the engineering design process to develop creative and innovative solutions to complex technical problems. Building on their prior knowledge, students will document and record their process—from clearly defining the problem(s) and identifying criteria and constraints through to building and evaluating design solutions. The focus of the course is on building technical skill, learning through failure, and designing technical solutions to problems. Students are expected to be working safely and responsibly in a technical classroom, building technically proficient skills involving the safe use of a variety tools and materials, and engaging with the work with a spirit of curiosity, critical thinking, and innovation.

Essential Graduation Competencies (EGCs)

EGC Overview

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, Early Learning, and Culture 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) in 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 by CAMET: citizenship, communication, personal-career development, creativity and innovation, critical thinking, and technology 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.



EGC Definitions

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.

Technology 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.

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.

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.

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.

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.

Curriculum Design

General Curriculum Outcomes (GCOs)

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

Technological Problem Solving

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

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

Technological Systems

Students will be expected to operate and manage technological systems.

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

History and Evolution of Technology

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

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

Technology and Careers

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

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

Technological Responsibility

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

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

Specific Curriculum Outcomes (SCOs)

Specific curriculum outcomes state the intended outcomes of instruction, and identify what students are expected to know and be able to do for a particular unit or course. SCOs provide the goals or targets of the prescribed education program. 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 essential graduation competencies

Specific curriculum outcomes will begin with the phrase, "Students are expected to ...".

Achievement Indicators (AIs)

Each specific curriculum outcome is described by a set of achievement indicators which help to support and define the depth and breadth of the corresponding SCO when taken as a set.

The set of achievement indicators provided for an SCO

- provides the intent (depth and breadth) of the outcome;
- tells the story, or creates a picture, of the outcome;
- defines the level and types of knowledge intended by the outcome;
- is not a mandatory checklist, prioritized list of instructional activities, or prescribed assessment items; and
- may include performance indicators.

The intent of AIs is for clarity and understanding, so that instructional design is aligned with the SCO. When teachers are planning for instruction, they must be aware of the set of indicators in order to fully understand the depth and breadth of the outcome. Teachers may substitute or add to the set of AIs as long as these additions maintain the integrity of the SCO. By constantly analysing and monitoring the needs of the students, teachers can determine which indicators are appropriate and relevant to prior knowledge, developmental stages, or the continuum of the scholastic year.

Lists of achievement indicators will begin with the phrase, "Students who have achieved this outcome should be able to ...".

Sample of Curriculum Page

CTE *Technology Education Level I*

UNIT A *General Safety*

SCO - Specific Curriculum Outcome

Students are expected to...

SCO A.1 apply general safety practices and policies.

Targeted Level for Assessment of SCO

Technical Skill Dimension					Safety Regulations	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension						
			Recall	Remembering			1.2, 1.9, 1.10, 1.11, 1.12,		
				Understanding		1.4, 1.5, 1.7, 1.8			
		A.1	Procedural	Applying		1.1	1.3, 1.6, 1.13		
				Analysing					
			Critical Thinking	Evaluating					
				Creating					

Achievement Indicators

Students who have achieved this outcome should be able to

Als - Set of Achievement Indicators for SCO

- A.1.1 use terminology associated with workplace hazards and safe work practices;
- A.1.2 follow regulations and standards pertaining to workplace hazards and safe work practices;
- A.1.3 apply the procedures used to maintain a safe work environment and to remediate potential dangers within the CTE facility;
- A.1.4 discuss fires safety including the classes of fires, fire triangle, and procedures and equipment related to fire safety;
- A.1.5 identify procedures and fire safety equipment related to the prevention, detection, and warning of fires;
- A.1.6 apply the 3 rights of workers to their work in Technology Education;
- A.1.7 identify safety hazards as either personal hazards, workplace hazards, and/or environmental hazards;
- A.1.8 describe safe work practices and equipment to address safety hazards (personal, workplace, environmental);
- A.1.9 locate fire exits;
- A.1.10 locate electrical shut-off switches;
- A.1.11 locate eyewash station;
- A.1.12 locate first aid stations;
- A.1.13 report potential dangers related to workplace hazards.



Elaborations

An elaboration provides a fuller description of the SCO and the instructional intent behind it. It sets the parameters of 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 supporting resources that may be helpful in teaching the related outcome. Teachers should vet material for any inappropriate sidebars, questionable information, or redirected links.

Formative Assessment Guide

The formative assessment guide provides teachers with a general description of what the students are able to do within the context of each unit at each level of technical skill development. Teachers can use this tool as a foundation when developing customized rubrics, checklists, or observation methods. Teachers can also use the language in the formative assessment guide when providing descriptive feedback to students on how well they are progressing towards the learning outcome.

Bloom's Taxonomy

In 1956, Bloom, et.al., published a framework for the purpose of classifying expectations for student learning as indicated by educational objectives (outcomes). This unidimensional framework of cognitive processes became known as Bloom's Taxonomy. David Krathwohl's 2002 revision of this taxonomy introduced a second dimension, the knowledge dimension, that classified the type of knowledge described by an outcome. To fully understand an SCO, it is important to understand how the learning is representative of both the cognitive process and knowledge dimensions.

Knowledge Process Dimension

The knowledge process dimension classifies four types of knowledge, ranging from concrete to abstract, learners may be expected to acquire or construct. The noun included in a specific curriculum outcome represents the knowledge process dimension.

Explanation of Knowledge Level	
Factual The basic elements students must know to be acquainted with a discipline or solve problems in it KNOWING THAT	<ul style="list-style-type: none">• knowledge of terminology (e.g., technical vocabulary, name of equipment)• knowledge of specific details and elements (e.g., general shop safety procedures, operating procedures)
Conceptual The interrelationship among the basic elements within a larger structure that enables them to function together KNOWING WHAT and WHY	<ul style="list-style-type: none">• knowledge of classifications and categories (e.g., types of tools, equipment, and materials)• knowledge of theories, models, and structures (e.g., engineering design process, selecting materials)
Procedural How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods KNOWING HOW	<ul style="list-style-type: none">• knowledge of subject-specific skills and algorithms (e.g., technical skills with tools, squaring stock)• knowledge of subject-specific techniques and methods (e.g., safe operating procedures on stationary equipment)• knowledge of criteria for determining when to use appropriate procedures (e.g., work plans, procedures, bills of materials)
Metacognitive Knowledge of cognition in general as well as awareness and knowledge of one's own cognition KNOWING HOW TO KNOW	<ul style="list-style-type: none">• strategic knowledge (i.e., knowledge of where to locate required information)• knowledge about cognitive tasks, including appropriate contextual and conditional knowledge (i.e., knowledge of the skills required to complete a task)• Self-knowledge (i.e., awareness of one's own knowledge and ability level).

Cognitive Process Dimension

The cognitive process dimension represents a continuum of increasing cognitive complexity, from lower order thinking skills to higher order thinking skills. The verb that begins a specific curriculum outcome represents the cognitive process dimension. The verbs listed under each cognitive process dimension represent the specific verbs used for SCOs or AIs within this course. There is also a subject-specific definition of each cognitive process dimension that relates directly to Intermediate Technology Education.

Explanation of Cognitive Process Dimension	
Remembering	Retrieve, recall, and/or recognize specific information or knowledge from memory
follow, locate	Students can define terminology and locate equipment, tools, and safety requirements related to the course. Students can also follow safety and operational procedures established within the technology facility.
Understanding	Construct meaning from different sources and types of information, and explain ideas and concepts
discuss, identify, describe, understand, research, determine, explain	Students can describe the function and operation of common tools, equipment, and procedures by reading, writing, and talking. Students can also choose the correct procedure, tool, or resource to support and further their understanding of the knowledge and skill required to meet the outcome.
Applying	Implement or apply information to complete a task, carry out a procedure through executing or implementing knowledge
apply, use, report, maintain, choose, complete, produce, distinguish, practise	Students can execute a given task or work towards a solution to a technical problem when the procedure is provided. This is where students deepen their understanding of concepts by engaging their hands and beginning to practise their skills. Students can also communicate both orally and in writing, and access information related to the technical tasks in which they are engaged.
Analysing	Break information into component parts and determine how the parts relate or interrelate to one another or to an overall structure or purpose
demonstrate, construct, assemble, examine	Students make the connection between the theory and the practice. This is where students begin to put together their understanding of the technological design processes, drawing/communication skills, and technical skills to complete design challenges and solve technical problems. Students will start to make connections between tasks and begin to transfer their knowledge to new situations.
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
perform, select, interpret, enhance, troubleshoot, evaluate, debate, reflect	Students can make decisions and select and adjust design and technical parameters independently to complete design challenges. This is when students begin to respond to challenges and perform tasks with a combination of both skill and precision.
Creating	Form a coherent functional whole by skillfully combining elements together and generating new knowledge to guide the execution of the work
design, fabricate, create, develop	Students can solve technical design challenges/projects safely, efficiently, and precisely. This is where students begin to take responsibility for their own knowledge and skill, and approach their work in an independent manner and with a proficiency of skill.

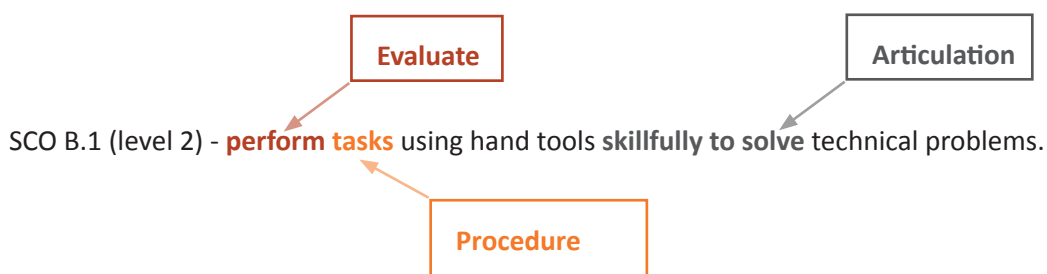
Technical Skill Dimension

The technical skill dimension, as defined by Dave's psychomotor taxonomy (1975), classifies five types of ways learners may be expected to demonstrate or carry out skilled tasks, procedures, or movements. This ranges from imitation, (where students mimic what they see modeled), through to naturalization, (where students perform tasks automatically and with high level of skill).

Explanation of Technical Skill Dimension	
Imitation	ability to copy or replicate the actions of others following observations
Manipulation	ability to repeat or reproduce actions to prescribed standard from memory or instructions
Precision	ability to perform actions with expertise and without interventions and the ability to demonstrate and explain actions to others
Articulation	ability to adapt existing psychomotor skills in a non-standard way, in different contexts, using alternative tools and instruments to satisfy need
Naturalization	ability to perform actions in an automatic, intuitive, or unconscious way appropriate to the context

Structure of an SCO

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



Taxonomy Tables

Combining the three dimensions, (cognitive process dimension, knowledge process dimension, and technical skill dimension), into one taxonomy table helps teachers to visualize the overall expectations of a course. As teachers reflect deeply and collaborate with each other to identify the types of 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. This clear visualization of the desired results (i.e., evidence of achievement of outcomes) assists teachers in planning learning experiences that will lead to student achievement of the outcome at the targeted level.

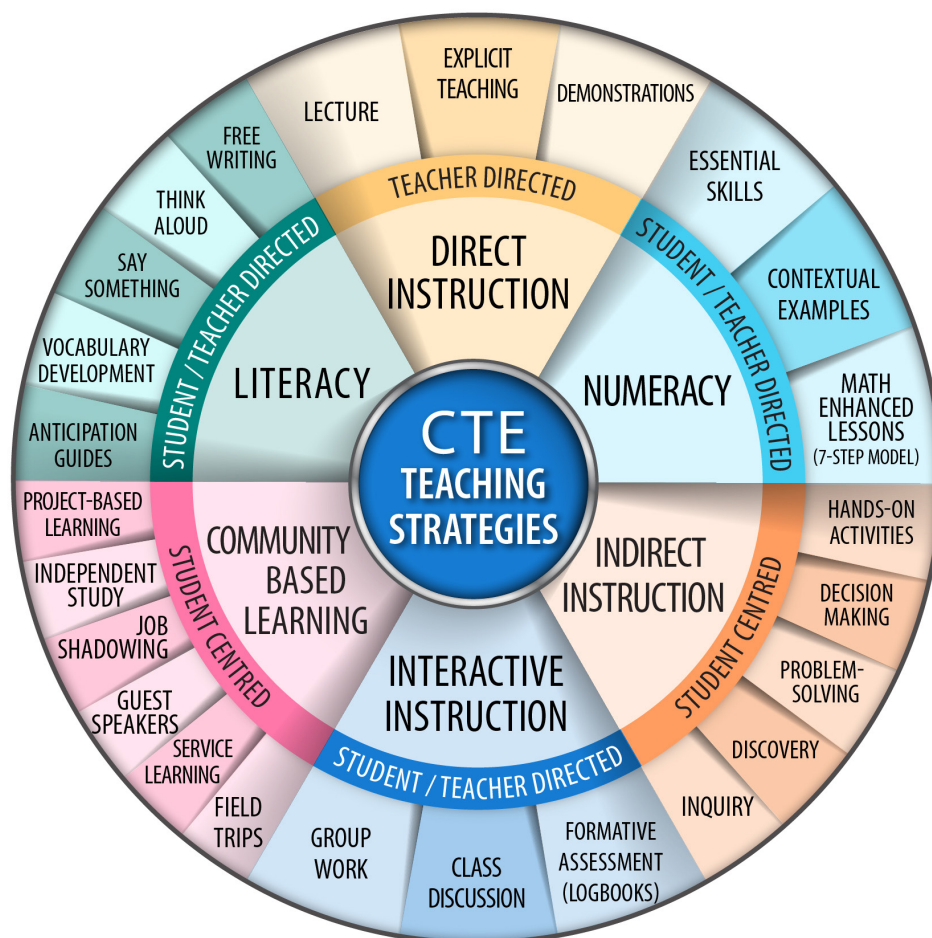
The taxonomy tables for each level appear on pages 24 and 25. Each outcome also has a taxonomy table that is specific to that outcome and the given achievement indicators. The table is located on the upper right-hand corner.

Curriculum Delivery

Instructional Strategies

Teaching is both a science and an art. There is a wealth of instructional strategies and methodologies described in the literature related to career and technical education that teachers have at their disposal when creating a learning environment that best suits the needs of their students.

Below is an instructional strategies wheel that is designed to identify a range of strategies that are effective when preparing lessons, assignments, and experiences for the career and technical education classroom. The list is not intended to be exhaustive, and CTE teachers are encouraged to continually read and engage in current research, pedagogy, and practice related to their field.



Literacy

Employing cross-curricular reading and writing strategies in the delivery of the curriculum will provide students with tools that will help them build knowledge and develop strategies to become more proficient in both their technical skills and their literacy skills. Integrating literacy into the CTE classroom is essential for students to develop strong connections between the practical skills and technical knowledge required.

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 a reason to engage in the text. Examples include the following:

- **FREE WRITING** - This strategy 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** - These 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 trade-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" (Beers 2003, p.105). 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.*

Post-Reading Strategies

Post-reading strategies are designed to provide students with opportunities to reflect on what they have read and make links to their learning.

- *LEARNING JOURNALS* - These journals provide a forum through which students can record and document their learning.
- *SUMMARIZING* - Summarizing is an effective strategy to use prior to having students complete an assigned task in the shop. This provides students with an opportunity to describe what they are going to do and how they plan to accomplish it. This may be done in written form or orally, depending on the given task.

Math In CTE

The National Council of Teachers of Mathematics states that wanting all students to learn math does not mean that all students can or should learn math in the same way.

The National Research Center for Career and Technical Education (NRCCTE) has developed the Math in CTE model that addresses and makes explicit the math concepts as they arise naturally from the CTE curriculum. Math is an essential component of CTE curriculum and is an essential tool required to perform the tasks of given occupations (NRCCTE, 2006).

One of the challenges in teaching contextual math in CTE is that students are unable to transfer the math skills and knowledge to a new situation, as it is too embedded in the original context (NRCCTE 2006). The Math in CTE model addresses this challenge by bringing the math skill out of context and into the abstract, so that students may develop the understanding behind what they are learning, and then the model continues to provide opportunities for students to apply the knowledge in context.

By making explicit the math that is incorporated into the CTE context, students are able to make connections to their math classes and develop their transferable math skills.

Math in CTE 7-Step Model

Below is the 7-step Math in CTE model that will enable CTE teachers to identify the math skills covered in their lessons, develop a math-enhanced lesson, and assess the students' math abilities.

Introduce technical lesson.

- Explain the technical lesson.
- Identify the math embedded in the lesson.

Assess students' math awareness.

- Use a formative assessment.
- Assess whether students use the correct mathematical terms when discussing the lesson topic.
- Use a variety of questioning /discussion techniques to determine students' math awareness.

Work through math problems related to the technical lesson.

- Connect the technical vocabulary to the math vocabulary and gradually integrate the two, being sure to not abandon either set.

Work through related contextual examples.

- Use examples with varying levels of difficulty.
- Continue to bridge the gap between the technical concept and the math skills.
- Check for understanding.

Work through traditional math examples.

- Provide students with an opportunity to practise using a worksheet of basic math problems as they would appear on a test.
- Move from basic to advanced examples.
- Check for understanding.

Have students demonstrate understanding.

- Provide students with the opportunity to relate the math concept back to CTE context.
- Conclude the math lesson back in the context of the technical lesson.

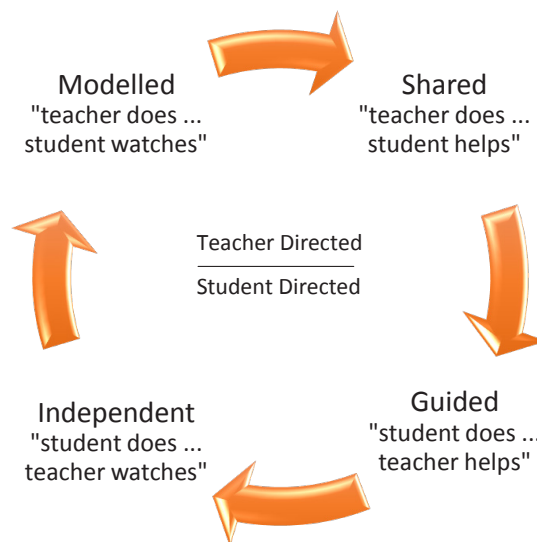
Assign a formal assessment.

- Include math problems in formal assessments of the technical lesson.

Gradual Release of Responsibility

Teachers must determine when students can work independently and when they require assistance. In the *gradual release of responsibility* approach, 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 that leads the student to independence. If necessary, the teacher increases the level of support when students need further assistance. Gradual release is a useful strategy to employ. The graphic below provides a visual representation of this process.

Teachers may wish to 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.



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, moving to the second stage of *evidence-of-learning* or assessment, and ending with the *learning plan* or the activities that will engage students and scaffold them toward the end result or *performance task*.

Basics of UbD

- helps transform specific curriculum outcomes (SCOs) into meaningful learning elements and assessments
- encourages teachers to become coaches and facilitators of meaningful learning rather than purveyors of superficial content
- reveals learning when students make sense of, and are able to transfer, learning to new and authentic situations
- requires ongoing review of instructional design to ensure effective practice and continuous improvement for achievement
- promotes a way of thinking about curricular planning in a broader sense, not a rigid program or prescriptive plan
- ensures deeper student understanding by making meaning from big ideas
- overcomes instructional errors associated with simplified textbook coverage and activity-oriented teaching (activity without a clear purpose)

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.	<p>Performance tasks and criteria are determined. <i>Performance tasks</i> 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. <i>Performance criteria</i> will provide the evidence of learning that is needed to assess the learning. Criteria can be weighted and include the following:</p> <ul style="list-style-type: none">• 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.

The Evaluative Process

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

Effectively planned evaluation promotes learning, builds confidence, and develops students' understanding of themselves as learners. Effectively planned assessment and evaluation 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).

Through the entire evaluative process, the teacher reflects on the appropriateness of the assessment techniques used to evaluate student achievement of the SCOs. Such reflection assists the teacher in making decisions concerning adjustments to subsequent instruction, assessment, and evaluation.

Assessments need to be reflective of the cognitive process(es) 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 student's learning. By using a process known as triangulation, teachers can obtain data of student learning from three different sources, (i.e., observations, conversations, and products), thereby ensuring sufficient data is collected in order to evaluate student learning. Observations and conversations are more informal forms of evidence that 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

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

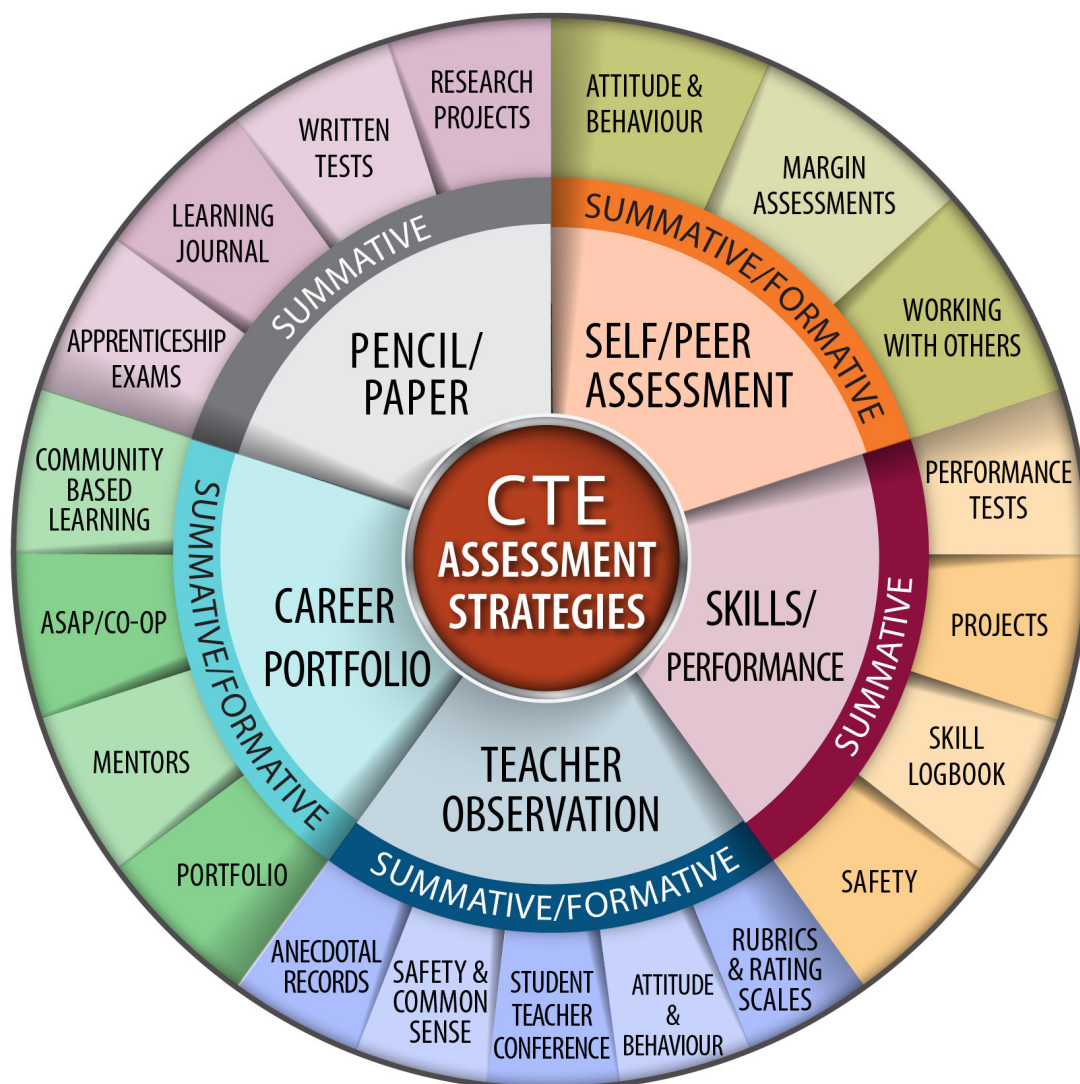
- are appropriate for the purposes of instruction, the needs and experiences of the students, and learning strategies used;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- reflect where the students are in terms of 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 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 and independently.

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 that 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 and read texts 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.

STEAM Pedagogy

The acronym STEAM represents Science, Technology, Engineering, Art, and Math. STEAM education is a pedagogical approach which provides students the opportunity to integrate learning associated with these five disciplines while solving meaningful problems.

The original acronym, STEM was introduced in the 1990s by the National Science Foundation. The 'A' was added to STEM in recognition that creative thinking normally associated with art is as necessary as analytical thinking when solving problems in science, engineering, and technology. The ability to think mathematically is also an integral aspect of these three fields.

Problem-solving is an iterative, multi-layered and multi-stepped process that requires flexible thinking patterns (Figure 12). The analytical thinking component involves selecting, gathering, sorting, comparing, and contrasting information. Analytical thinking is convergent thinking which helps to identify and narrow possible solutions. Creative thinking is required to solve broad, open-ended problems that do not have a readily apparent solution and are not single-outcome specific. Creative processes involves divergent thinking or out-of-the-box thinking. A creative thinker may consider solutions that are based on intuition and emotion rather than logic. Creative solutions can also arise from observation, inspiration, and serendipity. STEAM activities are designed to encourage the flexibility to move back and forth between these two cognitive processes. They also support the development of other habits of mind necessary for STEAM such as persistence and resilience.

Selected Habits of Mind and Skills Encouraged by STEAM

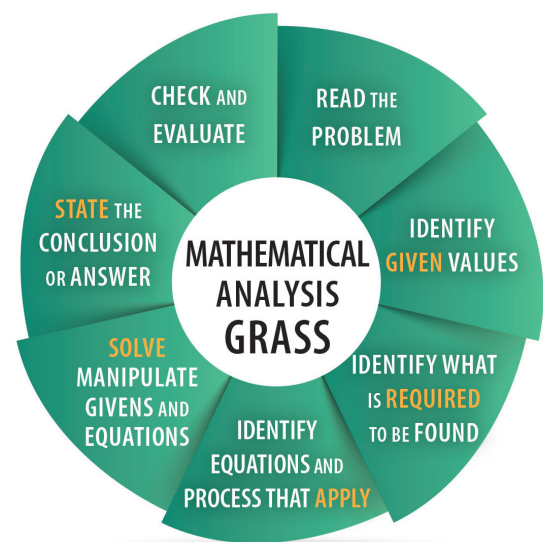
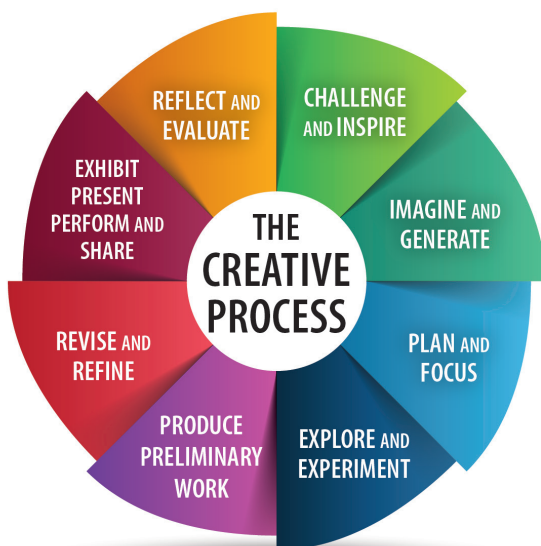
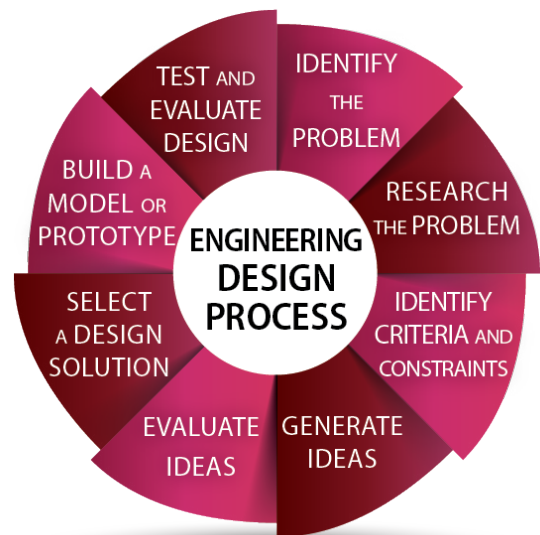
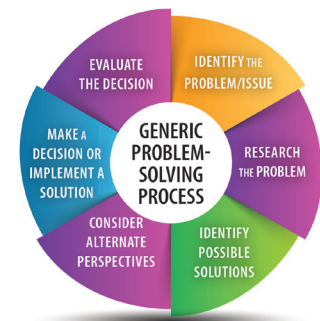
- creativity
- innovation
- persistence
- resilience
- flexibility
- collaboration
- communication
- critical thinking
- analytical thinking
- manipulative skills
- digital fluency

All five disciplines do not have to be targeted at the same time during a STEAM activity. To obtain the benefit of STEAM-based instruction, the problem presented should not have a readily apparent solution or be single outcome specific. The problem should be open-ended and designed in a way that the learner has more than one possible path to the solution. Productive struggle and reflection should be encouraged.

Problem Solving Component	S	T	E	A	M
	Science	Technology	Engineering	Art	Mathematics
Nature of Problem	Extending our understanding of the natural world	Developing ways to extend human capacity	Addressing a human need or concern	Expressing and interpreting human perception	Discovering mathematical relationships
Name of Process	Scientific Inquiry	Technology Design	Engineering Design	Creative Process	Mathematical Analysis
Initial Question	What causes...?	How can I ...?	How can I make...?	Imagine if...	What is the relationship...?
Solutions and Products	Communications of new knowledge	Digital products, digital processes	Structures, equipment, machines, processes	Aesthetic expression, products, processes	Numerical solutions, equations

Steam Processes

STEAM problem-solving processes (i.e., scientific inquiry, technology and engineering design, the creative process, and mathematical analysis) differ in the nature of the question and the solution or product. However, all are based on the generic problem-solving process. All are iterative processes that involve reflection, evaluation, and feedback throughout. All require analytical thinking and creative thinking. The figures below compare the problem-solving processes for science, engineering, art, and math.



Career & Technical Education

Intermediate Technology Education

Technology Education Level I

Level I Course Description

The Intermediate Technology Education Level I program is designed to introduce students to working and learning in a technology education environment. Students will experience working with a variety of tools and materials to develop solutions to technical problems. Students will be introduced to the concept of design as a creative process that allows people to plan, create, modify, and/or build products, systems, or solutions to problems. Students will begin to use the engineering design process to solve simple tasks or problems. The focus of the course is on building technical skill, learning through failure, and redesigning past solutions to problems. Students are expected to be working safely and responsibly in a technical classroom, building technically proficient skills involving hand tools and materials, following safe work procedures when operating power tools, and engaging with the work with a spirit of curiosity, critical thinking, and innovation.

Level I Taxonomy Table

Technical Skill Dimension					Intermediate Technology Education Level I	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension				
					Recall	Remembering			
						Understanding			
C.1, C.2		B.1 A.1, A.2, B.4 B.3		B.2	Procedural	Applying		A.1, A.2, B.1, B.2, B.4, C.1	C.2
						Analysing		B.3	
					Critical Thinking	Evaluating			
						Creating			

Career & Technical Education

Intermediate Technology Education

Technology Education Level II

Level II Course Description

The Intermediate Technology Education Level II program is designed to challenge the abilities of students to use the engineering design process to develop creative and innovative solutions to complex technical problems. Building on their prior knowledge, students will document and record their process: from clearly defining the problem(s) and identifying criteria and constraints through to building and evaluating design solutions. The focus of the course is on building technical skill, learning through failure, and designing technical solutions to problems. Students are expected to be working safely and responsibly in a technical classroom, building technically proficient skills involving the safe use of a variety of tools and materials, and engaging with the work with a spirit of curiosity, critical thinking, and innovation.

Level II Taxonomy Table

Technical Skill Dimension					Intermediate Technology Education Level II	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension				
					Recall	Remembering			
						Understanding			
A.2,		A.1, B.2			Procedural	Applying		A.1, A.2,	
						Analysing		B.2	
B.1 B.3, C.1, C.2		B.2 B.4			Critical Thinking	Evaluating		B.1	
						Creating		B.3, B.4, C.1	C.2

UNIT A: Safety

General Safety

Technical Skill Dimension					General Safety	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall				
					Remembering			1.2, 1.9, 1.10, 1.11, 1.12,	
					Understanding		1.4, 1.5, 1.7, 1.8		
				A.1	Procedural	Applying		1.1	1.3, 1.6, 1.13
						Analysing			
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO A.1

apply general safety practices and policies.

Achievement Indicators

Students who have achieved this outcome should be able to

- A.1.1 use terminology associated with workplace hazards and safe work practices;
- A.1.2 follow regulations and standards pertaining to workplace hazards and safe work practices;
- A.1.3 apply the procedures used to maintain a safe work environment and to remediate potential dangers within the CTE facility;
- A.1.4 discuss fire safety including the classes of fires, fire triangle, and procedures and equipment related to fire safety;
- A.1.5 identify procedures and fire safety equipment related to the prevention, detection, and warning of fires;
- A.1.6 apply the 3 rights of workers to students' work in technology education;
- A.1.7 identify safety hazards as either personal hazards, workplace hazards, and/or environmental hazards;
- A.1.8 describe safe work practices and equipment to address safety hazards (personal, workplace, environmental);
- A.1.9 locate fire exits;
- A.1.10 locate electrical shut-off switches;
- A.1.11 locate eyewash station;
- A.1.12 locate first aid stations; and
- A.1.13 report potential dangers related to workplace hazards.

UNIT A: Safety

General Safety

Technical Skill Dimension					General Safety	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension	Factual	Conceptual	Procedural	Metacognitive
					Recall				
					Remembering			1.2, 1.9, 1.10, 1.11, 1.12,	
					Understanding		1.4, 1.5, 1.7, 1.8		
					Applying		1.1	1.3, 1.6, 1.13	
					Analysing				
					Evaluating				
					Creating				

Students are expected to ...

SCO A.1

apply general safety practices and policies.

Achievement Indicators

Students who have achieved this outcome should be able to

- A.1.1 use terminology associated with workplace hazards and safe work practices;
- A.1.2 follow regulations and standards pertaining to workplace hazards and safe work practices;
- A.1.3 apply the procedures used to maintain a safe work environment and to remediate potential dangers within the CTE facility;
- A.1.4 discuss fire safety including the classes of fires, fire triangle, and procedures and equipment related to fire safety;
- A.1.5 identify procedures and fire safety equipment related to the prevention, detection, and warning of fires;
- A.1.6 apply the 3 rights of workers to students' work in technology education;
- A.1.7 identify safety hazards as either personal hazards, workplace hazards, and/or environmental hazards;
- A.1.8 describe safe work practices and equipment to address safety hazards (personal, workplace, environmental);
- A.1.9 locate fire exits;
- A.1.10 locate electrical shut-off switches;
- A.1.11 locate eyewash station;
- A.1.12 locate first aid stations; and
- A.1.13 report potential dangers related to workplace hazards.

Please note: The specific curriculum outcome (A.1) and related achievement indicators are the same for both Level I and Level II for the General Safety outcome. Students who have completed Level I have begun to develop their knowledge and skills related to general safety practices. Students enrolled in Level II are expected to continue to develop and deepen their understanding of the importance of safety and are expected to be more precise when implementing safe work practices.

UNIT A: Safety

Safety Regulations

Technical Skill Dimension					Safety Regulations	Knowledge Dimension							
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive				
Innovative	Complex		Simple	Cognitive Dimension									
				Recall						Remembering			
										Understanding	2.1		
	A.2			Procedural	Applying		2.5	2.2, 2.3, 2.6, 2.7, 2.8, 2.9					
					Analysing		2.4						
				Critical Thinking	Evaluating								
					Creating								

Students are expected to ...

SCO A.2

practise safe work habits to provide for personal safety and the safety of others, and to prevent accidents.

Achievement Indicators

Students who have achieved this outcome should be able to

- A.2.1 identify personal protective equipment (PPE) required for particular applications;
- A.2.2 apply procedures for proper maintenance and storage of PPE;
- A.2.3 use the appropriate PPE when working within the CTE facility;
- A.2.4 demonstrate a positive attitude and work ethic towards their work, instructors, and classmates;
- A.2.5 practise effective time management skills;
- A.2.6 maintain a clean and organized workspace;
- A.2.7 practise procedures used to store, transport, and dispose of materials;
- A.2.8 practise the emergency action plan to follow in the event of an emergency within the CTE facility; and
- A.2.9 apply safe working procedures for tools, equipment, and general practice within the CTE facility.

UNIT A: Safety

Safety Regulations

					Safety Regulations	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding	2.1		
A.2					Procedural	Applying		2.5	2.2, 2.3, 2.6, 2.7, 2.8, 2.9
						Analysing		2.4	
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO A.2

practise safe work habits to provide for personal safety and the safety of others, and to prevent accidents.

Achievement Indicators

Students who have achieved this outcome should be able to

- A.2.1 identify personal protective equipment (PPE) required for particular applications;
- A.2.2 apply procedures for proper maintenance and storage of PPE;
- A.2.3 use the appropriate PPE when working within the CTE facility;
- A.2.4 demonstrate a positive attitude and work ethic towards their work, instructors, and classmates;
- A.2.5 practise effective time management skills;
- A.2.6 maintain a clean and organized workspace;
- A.2.7 practise procedures used to store, transport, and dispose of materials;
- A.2.8 practise the emergency action plan to follow in the event of an emergency within the CTE facility; and
- A.2.9 apply safe working procedures for tools, equipment, and general practice within the CTE facility.

Please note: The specific curriculum outcome (A.2) and related achievement indicators are the same for both Level I and Level II for the Safety Regulations outcome. Students who have completed Level I have begun to develop their knowledge and skills related to general safety practices. Students enrolled in Level II are expected to continue to develop and deepen their understanding of the importance of safety and are expected to be more precise when implementing safe work practices.

Elaboration

The outcomes in this unit are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the CTE facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Students should be formatively assessed on these outcomes on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to these outcomes.

Developing Safety Practices

Fire Safety


- Identifying the location of all fire alarms, fire extinguishers, fire blankets, and other fire safety equipment in the facility.
- Locating all emergency fire exits, and discuss the fire drill procedures to follow in the event of a fire.
- Describing how to properly handle a fire extinguisher, fire blanket, and fire alarm.

Personal Protective Equipment (PPE)

- Identifying the location of all personal protective equipment (safety glasses, ear protection) in the facility.
- Describing the function of PPE and providing examples of the injuries that PPE can prevent.
- Demonstrating the proper handling, care, and use of PPE.
- Developing classroom rules governing the use of PPE.

Student Rights (Employee Rights and Responsibilities)

- Discussing the three rights of employees and how they apply to the students in the technology education classroom (the right to training, the right to a safe work environment, and the right to refuse dangerous work).
- Identifying safety hazards in the technology education facility.



CTE Safety Code of Conduct

The safety code of conduct should be kept short and ideally be developed by each class, as students tend to adhere to codes of conduct they have had a hand in creating better than those imposed on them. The code should also be written in such a way as to indicate the desired behaviour (what students will do) as opposed to the undesired (what students will not do). A sample safety code of conduct is below:

- We will respect others' right to work and learn in a safe environment and report any safety concerns to the teacher.
- We will wear safety glasses and any other required PPE when in the shop to complete the work.
- We will maintain a neat and well-organized workspace.
- We will ask for permission and/or instruction before using any tools, equipment, or material in the shop.
- We will use common sense.

Maintaining a Safe Environment

Regular safety inspections are an essential part of providing a safe environment for students and instructors. The purpose of the inspection is to spot potential hazards before an incident occurs and to make changes and/or corrections to improve the overall operation of the facility.

The following is an excerpt from the Manitoba Department of Education publication, “Keeping Your Facilities Safe.” Refer to this text for more information on safety inspections.



Types of Inspection

Periodic Inspection - A safety and health inspection is thorough and systematic. These inspections can be conducted monthly or bimonthly. This type of inspection covers all areas (e.g. operations, equipment, etc.).

Continuous Inspection - Continuous inspections should be conducted by students, teachers, department heads, or supervisors as part of their instructional, supervisory, or assigned duties. Continuous inspections provide an immediate chance to examine and, if necessary, to correct or to report any unsafe situations (if correction is not possible).

Who Should Make Inspections

Teachers must make continuous inspections and be aware of changing conditions, operations, and work methods. These inspections may have to be made several times a day (i.e. at the beginning of each day and, for certain equipment, at the beginning of each class).


A school or school division that has a department head or supervisor for Technology Education has a further advantage in safety and health inspections. The department head or supervisor may record any unsafe conditions and practices and forward this information to the teacher and or maintenance personnel if required.

Students should be encouraged to be active participants in ensuring the CTE facility is a safe environment to learn and work within. Students have a responsibility report safety concerns and can be challenged to develop their own (group/class) safety inspection report(s).

Design Briefs

Technology design briefs require specific instruction related to the safety practices students are to follow as well as the specific assessment related to the safety practices. When teachers are introducing the elements of the design brief, consider the following items as they relate to safety.

- Demonstrating and describing the use of the appropriate PPE required by the Design Brief.
- Demonstrating the safe operation of any tools and/or equipment the students will be expected to use to complete their design brief(s).



Daily Cleanup Duties

Develop a cleanup schedule and procedure to ensure the class is kept in good order and help students to develop a sense of responsibility for the maintenance and running of the technology education facility. Below is a list of possible jobs and/or tasks that would be appropriate for an effective cleanup schedule.

Foreperson (1 person)

- Call cleanup with 10-15 minutes left in class.
- Make sure that all of the jobs are completed properly.
- Fill in for any absences or areas that need extra attention.
- Report directly to the teacher.

Project Manager (1-2 people)

- Set out the projects at the beginning of class and return the projects to the class cupboard at the end of class.
- Sweep out the project area.
- Keep the class cupboard neat and organized.
- Make sure each individual returns their project in an organized fashion.

Tool Clerk (1-2 people)

- Return all tools and equipment to the tool room.
- Report any missing or damaged tools to the teacher.
- Keep the tool room neat and organized.

Shop Area (1-2 person)

- Help tool clerk gather tools.
- Sweep off all equipment and machines.
- Sort any scrap material into usable and unusable storage.

Work Counters (2 people)

- Help tool clerk gather tools.
- Brush off all work benches.
- Sort any scrap material into usable and unusable storage.

Classroom (1 person)

- Put all desks back in rows and push all chairs into desks.
- Sort paper recycling.

Sweepers (2 people)

- Sweep and pick up the entire room after all counters and machines have been brushed off.

Storage Room (1 person)

- Return all usable materials to the storage room.
- Keep the storage room neat and organized.

Spare (1-2 people)

- Fill in for anyone who is absent and help out in areas that need extra attention.
- Do anything that the foreperson requests.

Formative Assessment Guide

As students begin to take responsibility for both their own and others' safety, they become more responsible and take a more proactive approach to safety. Below is a sample of a formative assessment rubric that can be used by teachers to develop customized rubrics, observation charts, or other formative assessment tools. Teachers can also use this language when providing descriptive feedback to students on how well they are progressing towards the learning outcomes defined by this unit.

Simple	Imitation	Students can locate key areas in the facility related to safety and explain the procedures to follow in the event of a safety incident. Students select the appropriate PPE for a given task, recall the rights and responsibilities of workers, and follow the safety code of conduct. Students participate in the routine maintenance of the facility.
	Manipulation	
Complex	Precision	Students can locate key areas in the facility related to safety and take action to remediate potential safety hazards. Students use PPE appropriately and inspect the condition of PPE. Students are able to relate the rights of workers to students' rights within the CTE facility and are able to develop a safety code of conduct as part of a group. Students perform routine inspections of the facility and participate in routine maintenance.
Innovative	Articulation	Students examine potential safety hazards within the facility and design possible solutions to prevent accidents. Students demonstrate a proactive approach to their personal safety and the safety of others. This approach includes the use of PPE, application of the rights of workers, and participation in the routine inspection and maintenance of the facility. Students demonstrate leadership qualities among their peers in all aspects of safety.
	Naturalization	

UNIT B: Technical Skills

Hand Tools

Technical Skill Dimension					Hand Tools	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension						
			Recall	Remembering					
				Understanding	1.1		1.2		
	B.1		Procedural	Applying		1.4	1.3, 1.5		
				Analysing					
			Critical Thinking	Evaluating					
				Creating					

Students are expected to ...

SCO B.1

apply correct procedures for the safe and effective use of common hand tools.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.1.1 identify a variety of measuring tools, cutting tools, and assembling tools;
- B.1.2 explain safety precautions for hand tools;
- B.1.3 apply correct procedures to properly handle, store, and maintain hand tools;
- B.1.4 choose the appropriate hand tools to complete specific tasks; and
- B.1.5 complete tasks safely and effectively using hand tools.

UNIT B: Technical Skills

Hand Tools

Technical Skill Dimension					Hand Tools	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding			
					Procedural	Applying			
						Analysing		1.1, 1.2	
B.1				Critical Thinking	Evaluating		1.3	1.4	
					Creating				

Students are expected to ...

SCO B.1

perform tasks using hand tools skillfully to solve technical problems.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.1.1 demonstrate safety precautions when using hand tools to complete specific tasks;
- B.1.2 demonstrate correct procedures to properly handle, store, and maintain hand tools;
- B.1.3 select the appropriate hand tools to complete specific tasks; and
- B.1.4 perform tasks skillfully, safely, and effectively using hand tools.

UNIT B: Technical Skills

Power Tools

Technical Skill Dimension					Power Tools	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding	2.1	2.4	2.2, 2.3
				B.2	Procedural	Applying			2.5, 2.6, 2.7
						Analysing			
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO B.2

practice the safe and proper use of stationary and portable power tools to complete design briefs.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.2.1 identify a variety of stationary and portable power tools;
- B.2.2 explain safety precautions for portable power tools;
- B.2.3 explain safety precautions for stationary power tools;
- B.2.4 choose the appropriate power tool for a given task;
- B.2.5 practise proper handling and storage of portable power tools;
- B.2.6 practise safe and proper operating procedures for stationary and portable power tools; and
- B.2.7 complete tasks safely and effectively using power tools.

UNIT B: Technical Skills

Power Tools

Technical Skill Dimension					Power Tools	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding			2.1, 2.2
		B.2			Procedural	Applying			
						Analysing		2.3	2.4, 2.5
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO B.2

demonstrate technical skills safely and effectively when using stationary and portable power tools to complete design briefs.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.2.1 explain safety precautions and procedures for portable power tools;
- B.2.2 explain safety precautions and procedures for stationary power tools;
- B.2.3 select the appropriate power tool for a given task;
- B.2.4 demonstrate proper handling and storage of portable power tools; and
- B.2.5 demonstrate safe and proper operating procedures for stationary and portable power tools when completing design tasks and/or shop projects.

UNIT B: Technical Skills

Construction & Fabrication

Technical Skill Dimension					Construction & Fabrication	Knowledge Dimension							
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive				
Innovative	Complex	Simple	Cognitive Dimension										
			Recall	Remembering									
				Understanding						3.1			
	B.3		Procedural	Applying			3.2, 3.6						
				Analysing			3.3, 3.4, 3.5						
			Critical Thinking	Evaluating									
				Creating									

Students are expected to ...

SCO B.3

demonstrate construction and fabrication techniques accurately, and in the correct sequence to complete a given task or design challenge.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.3.1 identify materials (solid wood products, manufactured products, metals, plastics) commonly used to solve technical problems;
- B.3.2 use drawings when working on technical projects;
- B.3.3 demonstrate tool proficiency through selected technical projects using a variety of materials and techniques;
- B.3.4 construct projects in accordance with specifications;
- B.3.5 assemble project components in a logical and efficient sequence; and
- B.3.6 apply appropriate quality-control measures to ensure precise dimensions, correct assembly, and a finished product.

UNIT B: Technical Skills

Construction & Fabrication

Technical Skill Dimension					Construction & Fabrication	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension						
			Recall	Remembering					
				Understanding					
			Procedural	Applying					
				Analysing					
B.3			Critical Thinking	Evaluating		3.1, 3.2	3.3, 3.6, 3.7		
				Creating			3.4, 3.5, 3.8		

Students are expected to ...

SCO B.3

design projects to solve technical challenges, individually or in small groups, applying a design process to plan, develop, and evaluate the project.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.3.1 select materials (solid wood products, manufactured products, metals, plastics) to solve technical problems;
- B.3.2 interpret drawings accurately when working on technical projects;
- B.3.3 enhance tool proficiency through selected technical projects using a variety of materials and techniques;
- B.3.4 design projects in accordance with specifications;
- B.3.5 fabricate project components in a logical and efficient sequence;
- B.3.6 perform quality-control measures to ensure precise dimensions, correct assembly, and a finished product;
- B.3.7 troubleshoot problems/solutions in all aspects of the project (input, process, output); and
- B.3.8 create solutions to technological problems using the engineering design process.

UNIT B: Technical Skills

Technical Drawing

Technical Skill Dimension					Technical Drawing	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall				
					Remembering				
					Understanding		4.2		
		B.4			Procedural	Applying	4.1	4.3, 4.4, 4.5	
						Analysing			
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO B.4

produce technical drawings to support solutions to design challenges.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.4.1 apply mathematical skills involving fractions, decimals, estimation, and geometry to support solutions to design challenges;
- B.4.2 describe the function of basic drawing equipment;
- B.4.3 use drafting equipment to complete geometric exercises;
- B.4.4 produce orthographic drawings of simple design solutions; and
- B.4.5 produce perspective drawings of simple design solutions.

UNIT B: Technical Skills

Technical Drawing

Technical Skill Dimension					Technical Drawing	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension	Factual	Conceptual	Procedural	Metacognitive
					Recall	Remembering			
						Understanding			
					Procedural	Applying		4.2	
						Analysing			
	B.4				Critical Thinking	Evaluating	4.1		
						Creating		4.3, 4.4	

Students are expected to ...

SCO B.4

create technical drawings to solve technological challenges.

Achievement Indicators

Students who have achieved this outcome should be able to

- B.4.1 perform mathematical skills involving fractions, decimals, estimation, and geometry to support solutions to design challenges;
- B.4.2 use drafting equipment effectively to communicate design ideas;
- B.4.3 create orthographic drawings of solutions to technological challenges; and
- B.4.4 create three-dimensional drawings of solutions to technological challenges.

Elaborations

CTE Tool Use (Stationary, Portable, Hand)

The tools used within the CTE program will be determined by the Design brief(s) that the students will be completing. It is important that students experience working with a variety of measuring, cutting, assembling, drilling, and shaping tools and select tools appropriately for the intended operations.

Consider the following when designing a lesson to introduce students to a particular stationary, portable, or hand tool:

- Describing the specific safety precautions.
- Describing the function.
- Demonstrating the application and use.
- Using drawings/diagrams/photographs to identify parts and proper settings.
- Including a small hands-on activity for students to complete that will prepare them to use the particular tool efficiently.

When working on design brief(s) students must demonstrate the ability to operate all necessary tools in a safe and productive manner. Instructors may consider creating a sign-off list for the appropriate tools related to each design brief. Students must have this signed off by the instructor prior to finishing the design brief(s).

Consider the following when designing and preparing demonstrations on the safe operation of stationary, portable power, and/or hand tools:

- Performing demonstrations to small groups when necessary.
- Modeling how to wear/use appropriate PPE.
- Reviewing all related safety precautions and features.
- Ensuring all students can see the demonstration and that all students are also wearing the appropriate PPE.
- Using diagrams, models, or photos to enhance the demonstration.

Measuring Tools	Cutting Tools	Assembling Tools
framing square combination square angle (speed) square tri-square, spirit level marking gauge chalk line plumb bob sliding t-bevel compass & dividers centre punches self-centering punches	Stationary & Portable Tools sliding compound mitre saw (crosscutting, mitre) band saw (curves, angles, relief cuts) jigsaw circular saw Hand Tools handsaws (crosscut, rip, back, coping, keyhole, hacksaw) chisels bevel utility knives sheers and aviation snips	hammers (claw, ripping) staple gun, hammer tacker nail sets & nail pullers screwdrivers (various styles) pliers, wrenches, vice grips (various styles) bar clamps spring clamps c-clamps hand screw clamps web or band clamps flat bars

Drilling Tools	Planing & Shaping Tools	Other Tools
Stationary & Portable Tools drill press (boring holes, changing bits) cordless and corded drills screw guns biscuit joiners electric/pneumatic powered nailers Hand Tools geared hand drill various systems for drill bit sizing (fractional, imperial, metric)	Stationary & Portable Tools disc and belt sanders thickness planer jointer router table & routers portable belt sanders finishing sanders & disc sanders grinders Dremel tools Hand Tools planes (jointer, jack, smoothing, block, spoke shave) files and rasps sanding blocks, sandpaper (grit identification)	box and pan brake metal rollers metal shears welders

Materials

The materials used will be determined by the design brief(s) the students will be completing. It is important the students be provided with the opportunity to use a variety of raw materials. Some examples of appropriate materials are below; other materials may be required as defined by the design brief.

- softwoods and hardwoods
- manufactured wood products
- ferrous and non-ferrous metals
- plastics

Consider the following when designing and preparing lessons/demonstrations to introduce a particular material:

- Defining the characteristics of the material.
- Clearly defining any safety precautions that apply to the application of the material.
- Demonstrating methods of cutting, fastening, or finishing the material in a manner that is consistent with the materials application in the design brief(s).
- Using drawings or illustrations to help describe how the material is produced, packaged, bought, and/or stored.

Technical Drawing

Technical drawing, also called drafting or mechanical drawing, is considered to be the international language of industry. Technical drawing is a graphic language with the ability to span all languages while delivering information to the intended reader.

Three types of technical drawing appropriate for the Intermediate Technology Education program are listed below.

- orthographic projection (2-D) — multi view drawings
- perspective drawing (3-D) — single-point and two-point drawings
- isometric drawing (3-D) — accurate (scale) dimensions

Consider the following when designing and preparing lessons/demonstrations to introduce students to a particular method of technical drawing:

- Identifying the various technical drawing tools (scales, T-squares, triangles, etc.) that are required.
- Demonstrating the proper handling, storage, and application of the appropriate technical drawing tools.
- Demonstrating proper method of setting up a drawing sheet.
- Providing sample drawings for students to practise.
- Including a requirement for technical drawings in the design brief.

Formative Assessment Guide

Below is a sample of a formative assessment rubric that can be used by teachers to develop customized rubrics, observation charts, or other formative assessment tools. Teachers can also use this language when providing descriptive feedback to students on how well they are progressing towards the learning outcomes defined by this unit.

Simple	Imitation	Students practise the safe operation of a variety of hand tools, portable, and stationary power tools primarily used for boring and finishing. Students wear the appropriate PPE and can identify components and features of the tools and equipment. Students describe the characteristics and demonstrate the safe handling of the materials used for the completion of design briefs, and produce single-view sketches using the appropriate drawing tools.
	Manipulation	
Complex	Precision	Students demonstrate the safe operation of all hand tools required to complete a given task and demonstrate the safe operation of portable and stationary power tools primarily used for cutting, boring, shaping, and finishing. Students demonstrate safe work habits with all tools and materials and select the correct tool for a given task. Students produce multi-view technical drawings and 3-D sketches.
Innovative	Articulation	Students select the appropriate tool for a given task and demonstrate the ability to adjust settings and safety features of portable and stationary power tools to safely complete the task. Students demonstrate the ability to cut, bore, shape, and finish materials used to complete design briefs. Students are able to discuss the reasons for selecting one material over another and demonstrate the ability to complete quality work. Students produce quality multi-view technical drawings and 3-D drawings.
	Naturalization	

UNIT C: Design Thinking Engineering Design Process

Technical Skill Dimension					Engineering Design Process	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension	Factual	Conceptual	Procedural	Metacognitive
					Recall	Remembering			
						Understanding	1.1		
	C.1				Procedural	Applying	1.2		
						Analysing	1.3	1.4	
					Critical Thinking	Evaluating			
						Creating			

SCO C.1

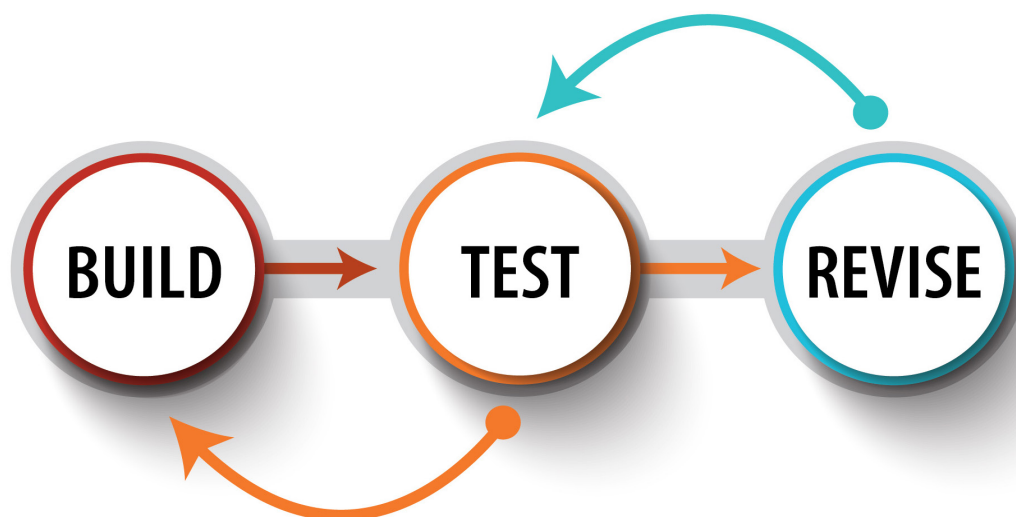
Students are expected to ...

demonstrate basic design and critical thinking strategies to solve technological problems.

Achievement Indicators

Students who have achieved this outcome should be able to

- C.1.1 understand the role of design when solving technological problems;
- C.1.2 distinguish between the criteria and constraints of a technological problem;
- C.1.3 propose a variety of design solutions to technological problems; and
- C.1.4 demonstrate the build-test-revise model to solve technological problems.



UNIT C: Design Thinking Engineering Design Process

Technical Skill Dimension					Engineering Design Process	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex	Simple	Cognitive Dimension						
			Recall	Remembering					
				Understanding					
			Procedural	Applying					
				Analysing		1.1, 1.2			
C.1			Critical Thinking	Evaluating					
				Creating		1.3	1.4		

Students are expected to ...

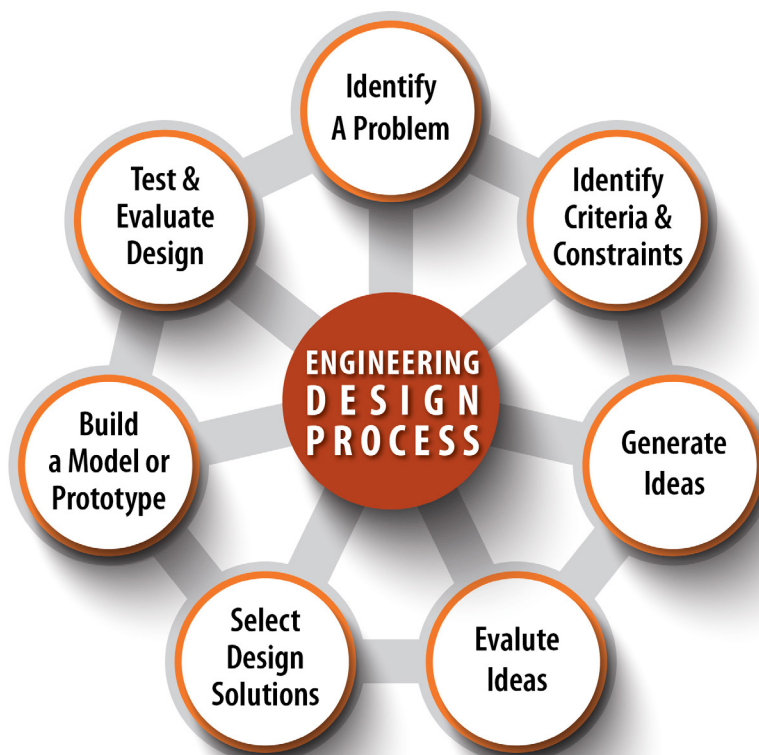
SCO C.1

develop technological solutions to problems using the engineering design process.

Achievement Indicators

Students who have achieved this outcome should be able to

- C.1.1 examine design problems, using the engineering design process;
- C.1.2 examine the criteria and constraints of a technological problem to better design solutions;
- C.1.3 develop a variety of detailed design solutions to technological problems; and
- C.1.4 create solutions to technological problems using the engineering design process.



UNIT C: Design Thinking

Critical Thinking

Technical Skill Dimension					Critical Thinking	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative	Complex		Simple		Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding	2.1	2.2,	2.3
		C.2			Procedural	Applying			2.4
						Analysing			
					Critical Thinking	Evaluating			
						Creating			

Students are expected to ...

SCO C.2

apply research strategies to support solutions to technological problems.

Achievement Indicators

Students who have achieved this outcome should be able to

- C.2.1 research past solutions to technological problems;
- C.2.2 discuss ideas and information about technological solutions, using appropriate terminology;
- C.2.3 determine the effectiveness of technological solutions to given problems; and
- C.2.4 produce models and sketches to support/defend their solutions to technological problems.

UNIT C: Design Thinking

Critical Thinking

Technical Skill Dimension					Critical Thinking	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding			
					Procedural	Applying			
						Analysing			
C.2					Critical Thinking	Evaluating	2.1	2.2, 2.3	2.4
						Creating			2.5

Students are expected to ...

SCO C.2

evaluate solutions to technological challenges.

Achievement Indicators

Students who have achieved this outcome should be able to

- C.2.1 evaluate past solutions to technological problems;
- C.2.2 debate ideas and information about technological solutions using appropriate terminology;
- C.2.3 evaluate the effectiveness of technological solutions to given problems;
- C.2.4 design models and sketches to support or defend solutions to technological problems; and
- C.2.5 reflect on their own learning related to their solutions to technological challenges.

Elaboration

Problem Solving

Design is the core problem-solving process for technology education. Design is as integral to technology education as inquiry is to science. To be design literate means to understand and apply the cognitive and procedural skills required to solve a problem. Design with respect to technology education is different from design with respect to art education. Students should be encouraged to work as effective members of design teams to solve practical, authentic problems outlined in design briefs.

Design is not a linear process; rather, it should be iterative—allowing for exploration of ideas in a pragmatic and systematic manner. The design process is never considered to be final, and multiple solutions and adjustments are always possible.

Design Criteria and Constraints

Design in technology education consists of a goal, problem, or purpose and is bounded by a set of criteria and constraints. “Learning to work within criteria and constraints is a challenge that students will face throughout life and is an important concept to understand at an early age” (*Standards for Technological Literacy*, 2007).

The table below describes common criteria and constraints.

Criteria	Constraints
<ul style="list-style-type: none">• required elements• desired outcomes• product size	<ul style="list-style-type: none">• expected features• cost of materials• space• time

Students should be provided with real-world, current technological problems and discuss some of the criteria and constraints to support their learning and progress related to these outcomes (e.g., oil spill cleanup, safe traffic around construction, sustainable farming or fishing methods).

Generating Ideas

The ability to generate ideas is integral to the design process, and the realization that there are multiple solutions to problems is key. Provide students with the opportunity to consider similar problems and/or past solutions to similar problems.

“At the beginning of this process, it is important that students gather as much information as they can find. This wide open consideration of all ideas will help as they seek the best solution for their problem” (*Standards for Technological Literacy*, 2007).

The design process unlocks creative thinking as students critically consider all ideas. Below are some methods to support students in generating ideas:

- Brainstorming allows for the free flow of ideas.
- Lists provide written descriptions of ideas or details related to the design.
- Webs are graphic representations of solutions organized around the central design problem.
- Free writing is an individual process where students write for a set amount of time (3-5 mins) about the design problem and possible solutions. This activity will help to activate the students’ prior knowledge and is a fast simple activity to help focus a group prior to a brainstorming session.

- Thumbnail sketches are small, simple quick drawings of possible design solutions. They can be either 2-D or 3-D. Students should be given about 5-10 minutes to generate as many sketches as possible,. This rapid generation of ideas is great way to start a design process.

Engineering Design Process

Encourage students to continually evaluate, critique, and revise their work as they move through the design process. The design brief is a structure that allows teachers to guide students through a variety of problem-solving processes ranging from a natural trial-and-error approach through to a more complex and critical thinking model such as the engineering design process.

Encourage students to use their natural curiosity and problem-solving skills while working on related design briefs. Students at Level I should be capable of using a simple build-test-revise model as a method for solving design challenges. As the design briefs increase in complexity, the limitations of the build-test-revise model are reached, and students need to begin to explore critical thinking models such as the engineering design process. Provide students with the opportunity to reflect on their final solutions to design briefs and comment on any alterations made to the original design idea, and why these changes were considered.

The design process is fundamental to technology and to engineering. Also referred to as technological design, the engineering design process demands critical thinking, the application of technical knowledge, creativity, and an appreciation of the effects of a design on society and the environment. (*Standards for Technological Literacy 2007*)

The engineering design process is not a linear model, and steps do not necessarily need to be completed in a set order. Students should use the steps and provide evidence of each step in a way the best suits the individual as well as the problem. When creating design briefs, explore ways to engage the students in all steps in the engineering design process. The technology education learning environment should open and encourage creative and critical thinking.

Communication


Consider the following when creating design briefs or when students are actively solving problems while working on design briefs:

- Encouraging conversation about the problem within a group environment.
- Encouraging the use of proper terminology (literacy strategies, technology word wall).
- Providing time for students to write (learning Journals, reflections, free writing).
- Encouraging students to sketch their ideas. Sketches are an effective way to communicate ideas around the size, shape and function of design solutions.
- Encouraging students to build prototypes or scale models. Models provide three-dimensional and functional information about the design solution.

Design Brief Evaluation

“Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly” (*Standards for Technological Literacy, 2007*).

The process of evaluation and revision is ongoing throughout the engineering design process. Encourage students to engage in and record critical evaluations of their designs throughout the process. Learning journals, technical drawings, group discussions and/or presentations are effective ways to document these ideas. Students should be able to speak to the effectiveness of their design solution within the context of the original design brief.



When creating design briefs include a self and group evaluation for students to reflect on their design solution. This allows students to think critically about their work and/or the work of the design team. Consider the following when developing a self/group evaluation:

- Provide a rubric with clearly defined descriptors for the students; ensure this is provided as part of the original design brief.
- Have an expectation that students write about their solution and their contribution to the work. This can take the form of a learning journal or a reflective writing exercise.
- When students are commenting on the contributions of group members, challenge them to comment in a positive manner on what each member contributed to the group.

Technology Education Research

“Knowing the history of technology -- the major eras, along with specific events and milestones — helps people to understand the world around them and by seeing how inventions and innovations have evolved and how they in turn produced the world as it exists today.” (*Standards for Technological Literacy, 2007*)

In studying past solutions to technological problems, students can discover patterns or ideas that will help them to develop new and innovative ideas. Many inventions and innovations have evolved by using slow and methodological processes of tests and refinements. In today’s world, this process still exists, but it takes on different forms; for example new software is often released in a beta form first and then released as version 1.0. As problems are identified and solved, new versions of the software are released.

Technological activity is purposeful, directed towards specific goals, and influenced by a wide range of factors. To understand these factors and the criteria and constraints of any technological design problem, students must be able to research previous solutions and discuss their impact on the current problem.

“Through their innovations, people have modified the world around them to provide necessities and conveniences. A technologically literate person understands the significance of technology in everyday life and the way in which it shapes the world.” (*Standards for Technological Literacy, 2007*)

Students can apply creative and innovative ideas to redesign existing technologies for new situations or to develop new ideas. One of the most valuable skills any student can develop from the study of technology education is the ability to think purposively, analytically, and critically about solutions to technological problems. In a rapidly moving field such as technology, facts and explanations change constantly. Developing the ability to learn new skills, examine new facts, evaluate new theories, and formulate their own interpretations is essential for students to keep up in a changing world.

Critical thinking is thinking that moves students

- to more meaningful learning instead of rote learning;
- to higher levels of learning (application, analysis, synthesis, and evaluation);
- to apply concepts and principles to real-world experiences and situations;
- to make judgments about knowledge and values claims; and
- to enhance problem solving skills.

Formative Assessment Guide

Below is a sample of a formative assessment rubric that can be used by teachers to develop customized rubrics, observation charts, or other formative assessment tools. Teachers can also use this language when providing descriptive feedback to students on how well they are progressing towards the learning outcomes defined by this unit.

Simple	Imitation	Students can identify the problem in a design brief and will look to follow a very linear pattern or process when developing a solution. Students describe the difference between a constraint and a criteria and develop 3-5 ideas to design briefs. Students actively engage in the build-test-revise method of problem solving and begin to incorporate ideas discovered researching past solutions into their design solutions. Students begin to think critically about their own design solutions and identify components of the design that require further development.
	Manipulation	
Complex	Precision	Students can describe each stage of the engineering design process and approach the engineering design process as a linear process. Students are active participants of design teams and use multi-view drawings and correct terminology to help explain ideas. Students can identify constraints and criteria related to the design brief and develop 5-10 ideas to design briefs. Students incorporate research and development practices into the design process to inform their decisions and ideas and connect research to the critical analysis of both their own design solutions and those of other students in a respectful and constructive manner.
Innovative	Articulation	Students document each stage of the engineering design process and recognize the contribution of each of the members of the design team. Students speak and write about design solutions using the correct terminology, recognize the relationship between criteria and constraints and can communicate design decisions based on criteria and constraints. Students develop 10+ ideas to design solutions, can discuss reasons for revisions to ideas, and begin to anticipate design flaws, making adjustments as needed. Students adjust the engineering design process to suit the nature of the design challenge and can critically analyse the effectiveness of the design solution. Students maintain accurate reflections/notes or learning journals and use technical drawing and 3-D modeling to communicate information about design solutions. Students effectively use research and development to better understand the scope of the problem they are trying to solve and document this research in clear and articulate forms. Students think critically about their designs throughout the entire design process and are constantly looking for ways to improve upon the effectiveness of their design solutions.
	Naturalization	