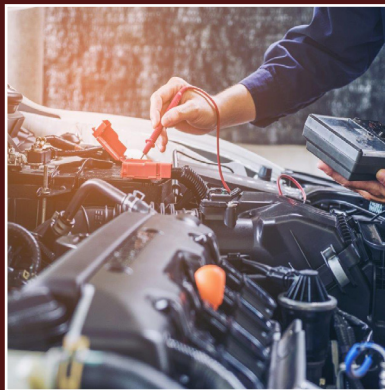


AUT 801E



Career and Technical Education

Automotive Technology

Suspension Systems



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.

Course Descriptions

AUT701A - Introduction to Auto Service (prerequisite for all 800 level CTE-Automotive courses)

Introduction to Auto Service introduces students to tools, equipment, theories, and practices common to the trade with a constant emphasis on safe work habits. In this course, students will learn how to communicate effectively and present themselves professionally; assemble components using a variety of fasteners and adhesives; perform basic heating, cutting, and welding procedures; diagnose and service wheels and tires, and perform basic maintenance.

AUT801A - Basic Powertrain

A basic working knowledge of the major systems of a vehicle is essential for any auto service technician. The basic powertrain course introduces students to engine operation, cooling systems, and vehicle drivelines. Students will learn about the operation of internal combustion engines and various fuel types and practice performing accurate measurements using a variety of common measuring tools. Students will conduct tests and service vehicle cooling systems and learn to diagnose and repair problems related to vehicle drivelines.

AUT801B - Brake Systems

Brakes are one of the most fundamental safety systems on a vehicle. This course focuses on the components, types, service, and diagnosis of brake systems. Students will develop a clear knowledge of the fundamentals of friction and hydraulics related to brake component function. They will learn to service, repair, and diagnose drum brake systems, disc brake systems, and power brakes, and will be introduced to anti-lock brake systems.

AUT801C - Electrical Systems

Today's automobiles use electricity to operate many different devices and systems. During this course, students will develop a basic understanding of electrical principles, fundamentals of magnetism, and scientific principles related to vehicle electrical systems. They will learn to service, test, and diagnose problems related to batteries. They will service and repair basic electrical circuits and use electrical meters and scan tools to test and diagnose vehicle electrical systems.

AUT801D - Steering Systems

The steering gear mechanism is an integral component of any vehicle system. Students will learn how to diagnose and correct problems related to vehicle steering components. They will also learn about the service and repair of manual and power steering systems, steering columns, and basic frame construction.

AUT801E - Suspension Systems

Suspension and steering components are second only to brakes among the most crucial safety systems in any vehicle. Students will learn about common steering angles and how each affects vehicle handling, and about basic alignment procedures. They will also learn to diagnose and correct problems related to vehicle suspension and steering components and perform a standard motor vehicle inspection.

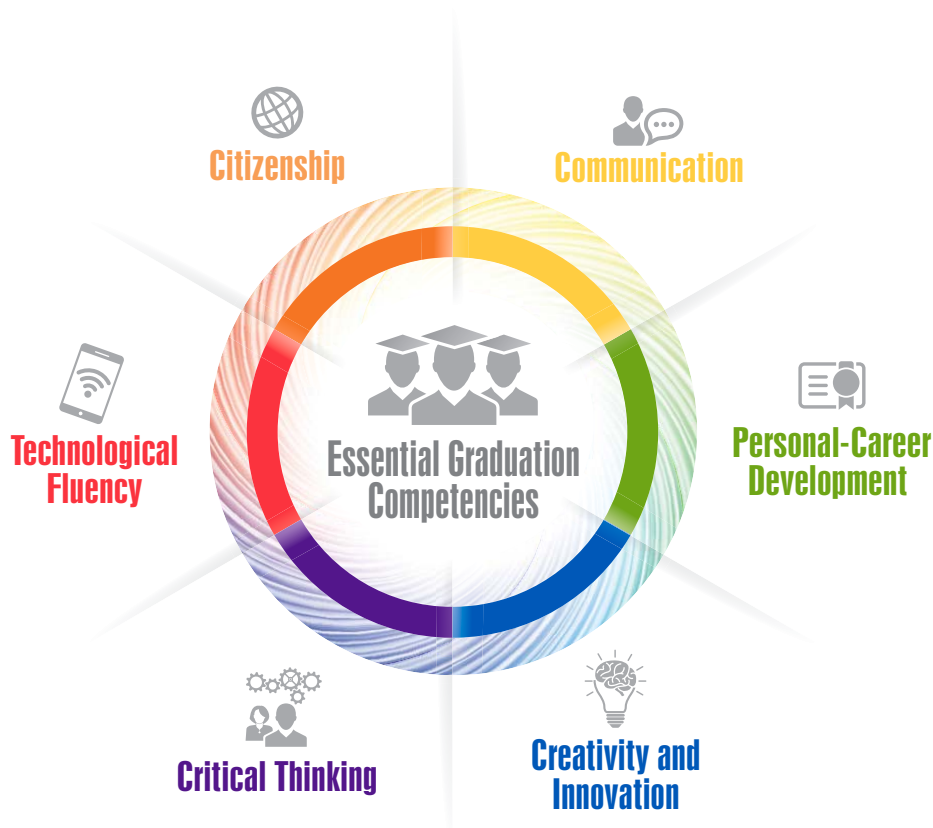
Students wanting to challenge the Level 1 Apprenticeship Exam for Auto Service Technician will require a minimum of 5 CTE-Automotive courses. The student's average in all courses must be at or above 70% to qualify to challenge the Apprenticeship Exam.

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 technological fluency (Figure 1). Achievement of the essential graduation competencies (EGCs) will be addressed through the assessment and evaluation of curriculum outcomes developed for individual courses and programs.



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.

Technological Fluency



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

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 referenced in 71(a) of the PEI Education Act. 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 a specific curriculum outcome

- 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

Suspension Systems
AUT801E

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

Targeted Level for Assessment of SCO

SCO - Specific Curriculum Outcome

Unit A: Safety Worksite Safety

A.1

Students are expected to ...

ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.

Achievement Indicators

Students who have achieved this outcome should be able to

- A.1.1 demonstrate the selection and use personal protective equipment (PPE);
- A.1.2 evaluate workplace safety at all times;
- A.1.3 demonstrate the ability to prevent fires and to prevent accidents;
- A.1.4 perform the correct procedures when working with exhaust gases; and
- A.1.5 perform the correct procedures when hoisting and jacking vehicles.

Als - Set of Achievement Indicators for SCO

Elaboration

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.

Performance Indicators

Performance indicators are located in the Elaboration section of the guide. They are intended to provide the teacher with a wide range of activities, ideas, and/or tasks that students may be engaged with as they progress towards mastery of an outcome. Performance indicators are not prescriptive and are not a checklist. The list of performance indicators is by no means an exhaustive list of possible tasks a student may engage in as they are working towards the outcome. Performance indicators help teachers to connect the work the students are engaged in to particular outcomes within a course.

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.

National Occupational Analysis

Each elaboration will also contain a reference to the National Occupational Analysis (NOA), for the trade. This is provided to highlight which Tasks, Required Knowledge, and Sub-tasks are aligned to a particular set of outcomes. Teachers are encouraged to familiarize themselves with the NOA for their trade. The NOA is designed to facilitate understanding of the occupation and the work performed by tradespersons.

Bloom's Taxonomy

In 1956, Bloom, et.al., published a framework for the purpose of classifying expectations for student learning as indicated by educational 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 a specific curriculum outcome, 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	• 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	• knowledge of classifications and categories (e.g., types of tools, equipment, and materials) • knowledge of theories, models, and structures (e.g., electrical theory, hydraulics)
Procedural How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods KNOWING HOW	• knowledge of subject-specific skills and algorithms (e.g., technical skills with tools, repair procedures) • 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 orders, AllData)
Metacognitive Knowledge of cognition in general as well as awareness and knowledge of one's own cognition KNOWING HOW TO KNOW	• 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 all six automotive curricula. There is also a subject-specific definition of each cognitive process dimension that relates directly to automotive technology.

Explanation of Cognitive Process Dimension	
Remembering	Retrieve, recall, and/or recognize specific information or knowledge from memory
define, identify, locate	Students define terminology and locate equipment, tools, and safety requirements. Students follow protocols and procedures established within the automotive facility. Students locate parts and/or components of an automotive system.
Understanding	Construct meaning from different sources and types of information, and explain ideas and concepts
choose, describe, explain	Students can describe and/or explain the function and operation of automotive systems by reading, writing, and speaking. Students choose the correct procedure, tool, or resource to support 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, communicate, complete, maintain, practise, read, service, use	Students execute a given task or work order when the repair procedure is provided. Students deepen their understanding of concepts by engaging their hands and practising their skills. Students communicate both orally and in writing, and are able to access information related to the automotive tasks they are engaged in.
Analysing	Break information into component parts and determine how the parts relate or interrelate to one another or to an overall structure or purpose
analyse, compare, demonstrate, inspect	Students make the connection between the theory and the practice. Students begin to put together their understanding of automotive concepts with their ability to complete tasks. Students will start to make connections between tasks and begin to transfer their knowledge to new situations. For example, when a student is demonstrating a repair or service they should be able to clearly demonstrate an understanding of both the theory and skills required to successfully complete the task.
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
enhance, ensure, evaluate, interpret, perform, reflect, select, troubleshoot	Students make decisions and select and adjust the working parameters independently to complete automotive tasks. Students begin to respond to challenges and perform tasks with a combination of both skill and precision. For example, when a student is performing a task will interpret information and troubleshoot problems as they arise. Students will reflect on jobs and critique their own, and others performance.
Creating	Form a coherent functional whole by skillfully combining elements together and generating new knowledge to guide the execution of the work
create, develop, diagnose and repair	Students develop an approach to diagnosing vehicle problems and perform the repair safely, efficiently, and precisely. Students begin to take responsibility for their own knowledge and skill as a mechanic, approach their work in an independent manner, and with a proficiency of skill.

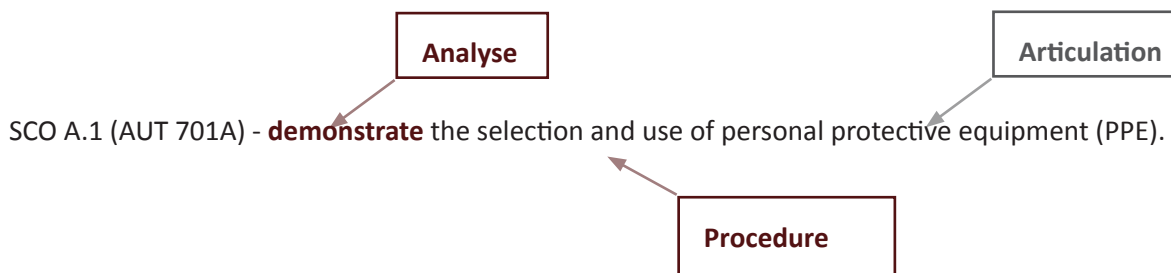
Technical Skill Dimension

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 modelled), 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

SCO Structure

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.

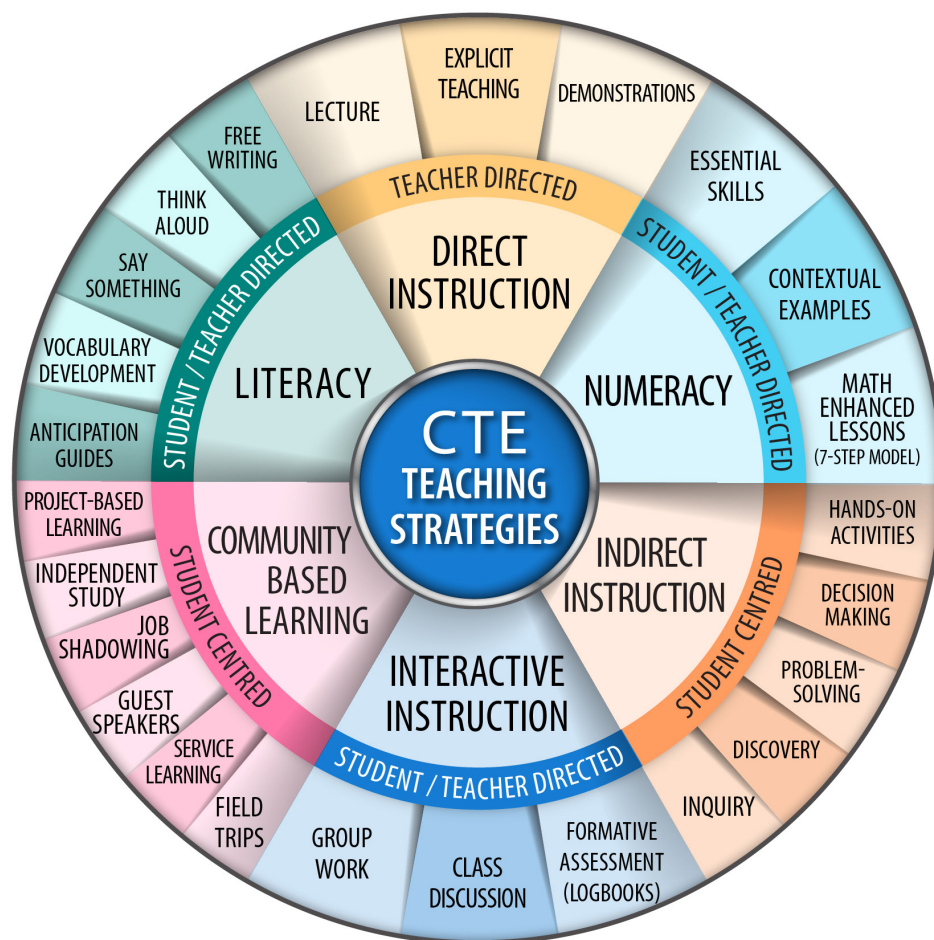
The taxonomy table for AUT 801E appears on page 25. Each outcome also has a taxonomy table that is specific to that outcome and the given achievement indicators. The table is located on the upper right-hand corner.

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 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 re-read.*
- **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 re-read a section of text, you must first set the activity up for success.
 - *Prove to students that re-reading 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 re-read a section.*
 - *Review the text as a group after everyone has re-read 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.

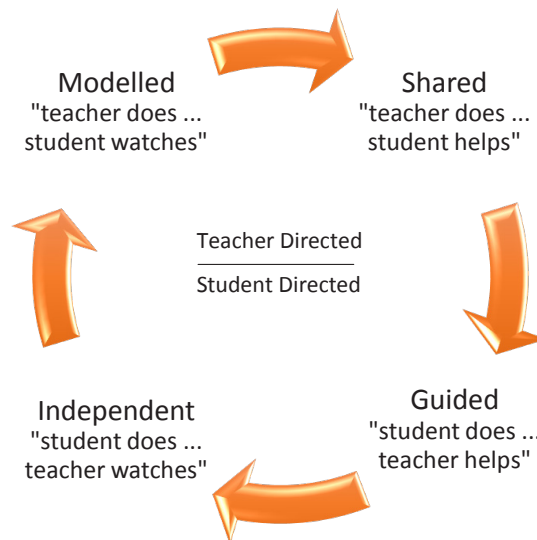
Assign a formal assessment.

- 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.	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: • 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

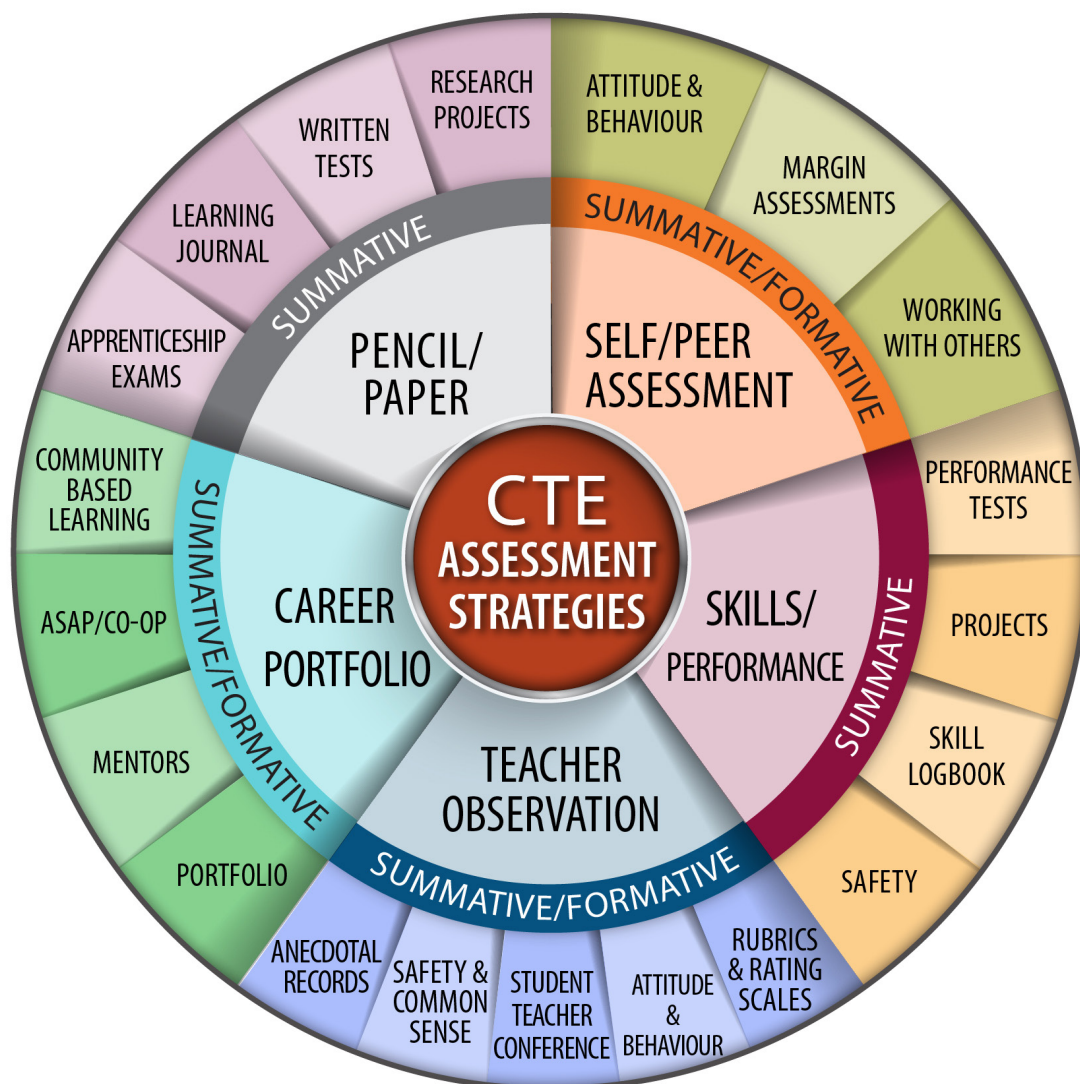
- are appropriate for the purposes of instruction, the needs and experiences of the students, and learning strategies used;
- assist teachers in selecting appropriate instruction and intervention strategies to promote the gradual release of responsibility;
- reflect where the students are in terms of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

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.

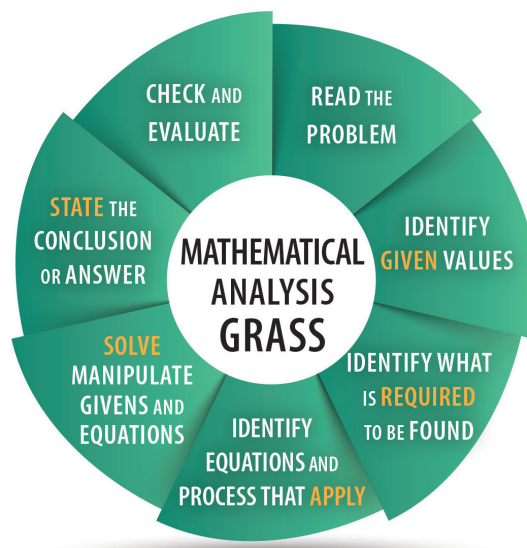
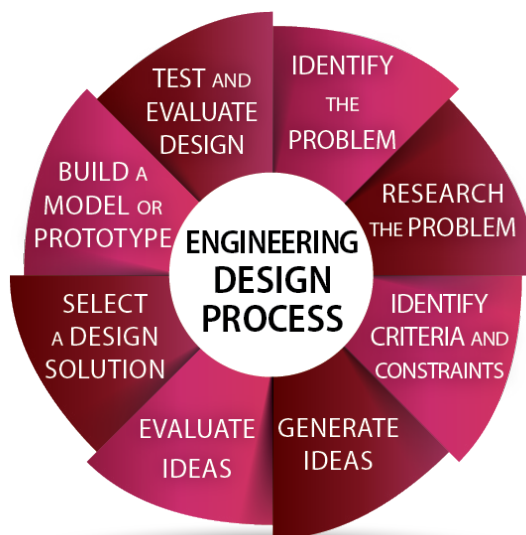
Selected Habits of Mind and Skills Encouraged by STEAM

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

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

Automotive Technology

Suspension Systems

Course Description

Suspension and steering components are second only to brakes among the most crucial safety systems in any vehicle. Students will learn about common steering angles and how each affects vehicle handling, and about basic alignment procedures. They will also learn to diagnose and correct problems related to vehicle suspension and steering components and perform a standard motor vehicle inspection.

Taxonomy Table

Technical Skill Dimension					AUT 801E	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension				
D.1					Recall	Remembering			
						Understanding		D.1	
					Procedural	Applying			
						Analysing			
A.1, B.1, B.2, B.3 B.4, C.1, C.2, D.2, D.3, D.4					Critical Thinking	Evaluating		B.2	A.1, B.3, C.1, C.2, D.2, D.4
						Creating			D.3
									B.1
								D.3	B.4

Unit A: Safety Worksite Safety

Technical Skill Dimension					Worksite Safety	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		1.3	1.1	
A.1				Critical Thinking	Evaluating			1.2, 1.4, 1.5	
					Creating				

A.1

Students are expected to...

ensure work practices are followed to provide for personal safety, the safety of others, and to prevent accidents.

Achievement Indicators

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

- A.1.1 demonstrate the selection and use of personal protective equipment (PPE);
- A.1.2 evaluate workplace safety at all times;
- A.1.3 demonstrate the ability to prevent fires and to prevent accidents;
- A.1.4 perform the correct procedures when working with exhaust gases; and
- A.1.5 perform the correct procedures when hoisting and jacking vehicles.

Elaboration

The safety outcome is considered as an integrated outcome and therefore cannot be taught or learned in isolation from the ongoing work within the automotive facility. Students should be assessed on an ongoing basis and should be given timely formative feedback to enable them to deepen their knowledge and develop their skills related to working safely in the CTE-Automotive classroom.

Assessment of safety should focus on the following key areas.

- student's use of personal protective equipment
- student's active participation in the evaluation of their own, and others' safe work practices
- student's critical thinking in regards to their personal safety skills, others' safety skills, and the emergency action plans within the facility
- student's ability to hoist and lift vehicles in a safe and appropriate manner consistent with the safety procedures in the automotive facility

While the factual knowledge required for these outcomes will be directly instructed at the beginning of the course, the assessment of these outcomes is ongoing throughout the course.

Students who are expressing an interest in continuing their learning in CTE should begin to consider purchasing their own PPE (safety glasses, hearing protection); however, the CTE facility must have a set of PPE equipment available for students.

Health and safety laws can be broken down into three categories:

- Acts - Establish legal authority (general principles, responsibilities, rights)
- Regulations - Outlines the legal rules (safety requirements, exposure limits, WHMIS)
- Guidelines and Codes - Outlines details (testing procedures, record keeping)

Student should be familiar with the responsibilities of government, employers, and employees as it relates to OH&S and be accountable for their rights as workers/students (the Right to Know, the Right to Participate, and the Right to Refuse).

Developing a safe attitude contributes significantly to an accident-free environment. Safe working procedures and conditions will support accident prevention and promote a healthy work environment. Safety in CTE is of primary importance at all times.

It is critical that students are aware of the application and capacity of the hoisting and lifting equipment in the automotive shop and that each piece of lifting equipment is only used for the purpose, and within the limits, for which it is designed. Some of the many different types of hoisting and lifting equipment within an automotive shop include floor jacks, jack stands, engine hoists, and vehicle hoists. Each piece of equipment is designed for a particular purpose within the trade and engineered to particular standards and specifications. Students need to be aware of the procedures and inspection schedule as required by the CTE facility.

Performance Indicators

- Describing the PPE required for particular applications within the trade.
- Explaining the proper use of PPE required for particular tasks and/or applications.
- Demonstrating the proper use and selection of PPE at all times when working in the CTE facility.
- Identifying defects in PPE and report accordingly.
- Explaining key areas of responsibility a student has in regards to safety.
- Explaining the roles and responsibilities of Occupational Health and Safety within a workplace.
- Applying the rights of employees within the CTE worksite (the Right to Know, the Right to Participate, and the Right to Refuse).
- Explaining the three components of the Workplace Hazardous Materials Information System (WHMIS).
- Interpreting WHMIS labels to understand the procedure to follow to avoid associated hazards.
- Evaluating an emergency action plan in the event of an emergency within the CTE facility.
- Explaining the basic composition and dangers of exhaust gases.
- Demonstrating the proper procedures for ventilating the work area.
- Demonstrating the proper installation and operation of exhaust ventilation equipment required to remove exhaust gases from the work area.
- Locating fire exits.
- Explaining the classes of fires and the appropriate fire extinguishers to fight each class of fire.
- Identifying procedures and fire-safety equipment related to the prevention, detection, and warning of fires.
- Locating electrical shut-off switches.
- Locating eyewash station.
- Locating first aid stations.
- Defining terminology associated with hoisting and lifting.
- Identifying types of hoisting and lifting equipment and accessories.
- Identifying hazards and describing safe work practices pertaining to hoisting and lifting.
- Explaining information pertaining to hoisting and lifting found on drawings and specifications.
- Locating the lift points on vehicles.
- Practising operating the vehicle hoist safely and efficiently.
- Practising the correct procedures required for the safe and efficient operation of a range of hoisting and lifting equipment.
- Practising procedures used to visually inspect and properly store hoisting and lifting equipment.

Red Seal Occupational Standard 2016 Reference

Task A-1 - Performs safety-related functions	
A-1.01 - Maintains safe work environment	
Code	Performance Criteria
A-1.01.01P	recognize potential worksite hazards and hazardous materials
A-1.01.02P	apply jurisdictional safety regulations
A-1.01.03P	handle, remove, and dispose of hazardous materials
A-1.01.04P	perform sensory inspection of vehicles
A-1.01.05P	maintain clean and clutter-free work area
A-1.01.06P	adhere to manufacturers' safety guidelines
A-1.01.07P	remove, repair, or replace defective equipment
A-1.01.08P	report hazards and safety concerns to supervisor
A-1.02 - Uses personal protective equipment (PPE) and safety equipment	
A-1.02.01P	select PPE and safety equipment required for specific tasks
A-1.02.02P	recognize workplace hazards that require the use of PPE and safety equipment
A-1.02.03P	inspect and maintain PPE and safety equipment
A-1.02.04P	operate safety equipment
A-1.02.05P	recognize, remove, and replace defective PPE
A-1.02.06P	recognize, remove, service, or replace defective safety equipment
A-1.02.07P	report defective PPE and safety equipment to supervisor
Task A-2 - Uses tools, equipment, and documentation	
A-2.03 - Uses hoisting and lifting equipment	
A-2.03.01P	determine vehicle or item lifting points and required adapters and extensions
A-2.03.02P	determine type and capacity of hoisting and lifting equipment required for vehicle or item to be lifted
A-2.03.03P	operate vehicle hoists and lifting equipment
A-2.03.04P	operate shop lifting equipment

Internet Search

For more details on information related to these outcomes, use the following key word searches for current sites.

- Canadian Centre for Occupational Health and Safety-Young Workers
- WHMIS (webpage and/or image search)
- Young Workers Canada (webpage, image, and/or video search)
- Classes of fires (webpage and/or image search)
- Fire Equipment Manufacturers Association (search site for portable fire extinguishers)

Unit B: Career Development Employability Skills

Technical Skill Dimension					Employability Skills	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		1.4	
B.1					Critical Thinking	Evaluating		1.3	1.1, 1.2
						Creating			

B.1

Students are expected to...

exhibit personal and essential workplace employability skills.

Achievement Indicators

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

- B.1.1 exhibit a positive attitude towards themselves, their work, instructors, and classmates;
- B.1.2 reflect on their personal work ethic skills taking necessary steps to grow and improve;
- B.1.3 perform tasks using effective time management skills; and
- B.1.4 demonstrate project management skills to allow for projects to progress on schedule.

Unit B: Career Development Numeracy

Technical Skill Dimension					Numeracy	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
					Understanding		Factual	Conceptual	Procedural
					Procedural	Applying			
					Analysing		Factual	Conceptual	Procedural
					Evaluating				
					Creating		Factual	Conceptual	Procedural

B.2	Students are expected to...
	perform essential numeracy skills to solve automotive service problems.

Achievement Indicators

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

- B.2.1 perform mathematical skills involving fractions to trade related problems;
- B.2.2 perform mathematical skills involving decimals to trade related problems;
- B.2.3 perform mathematical skills involving percent to trade related problems;
- B.2.4 perform mathematical skills involving rate and ratio to trade related problems; and
- B.2.5 perform mathematical skills involving geometry to trade related problems.

Unit B: Career Development Literacy

Technical Skill Dimension					Literacy	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding		3.8, 3.9	
					Procedural	Applying		3.1, 3.2, 3.7	
						Analysing		3.5, 3.6	
B.3					Critical Thinking	Evaluating		3.4	3.3
						Creating			

B.3

Students are expected to...

perform essential literacy skills to work effectively within the trade.

Achievement Indicators

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

- B.3.1 use standard terms and units of measure for components and operations within a given course;
- B.3.2 communicate trade-related information with customers and other tradespeople effectively;
- B.3.3 interpret electronic service information to diagnose, service, or repair vehicles;
- B.3.4 interpret vehicle repair forums for diagnostic purposes;
- B.3.5 reference work orders and other trade-related documents accurately and effectively;
- B.3.6 reference equipment and safety manuals describing safe operating procedures;
- B.3.7 maintain a logbook or portfolio of technical work;
- B.3.8 discuss class assignments with peers and teachers to understand expectations; and
- B.3.9 discuss ideas about tasks and safety issues within the CTE facility.

Unit B: Career Development Career Portfolio

Technical Skill Dimension					Career Portfolio	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	4.2, 4.3, 4.4		
					Critical Thinking	Evaluating			4.1
						Creating			4.5

B.4	Students are expected to...
	create a personal CTE Portfolio to document and record employability and technical skills.

Achievement Indicators

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

- B.4.1 reflect on individual progress related to specific technical skills and knowledge as well as transferable skills acquired within the CTE-Automotive course;
- B.4.2 research opportunities available and related careers connected to the automotive service technician trade using relevant trade documents (NOA, NOC, Red Seal website, IPG);
- B.4.3 research secondary and post-secondary opportunities to further engage in trade-related occupations;
- B.4.4 research the components of the apprenticeship training model; and
- B.4.5 create a portfolio to document specific technical skills, knowledge, and transferable skills and support their career development and personal goals.

Elaboration

The outcomes in Unit B - Career Development are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Students should be 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 employability skills, numeracy skills, literacy skills, and career development.

The factual knowledge required in Unit B should be presented to the students using relevant, trade related examples and supported by the Employability Skills 2000+ (Conference Board of Canada), the Essential Skills (HRSDC), and the Red Seal Occupational Standard for Automotive Service Technician.

Essential Skills in CTE

Personal Management and Teamwork Skills as defined by the Conference Board of Canada 2000+ Employability Skills.

Demonstrate Positive Attitudes and Behaviours

- feel good about yourself and be confident
- deal with people, problems, and situations with honesty, integrity, and personal ethics
- recognize your own and other people's good efforts
- take care of your personal health
- show interest, initiative, and effort

Be Responsible

- set goals and priorities, balancing work and personal life
- plan and manage time, money, and other resources to achieve goals
- assess, weigh, and manage risk
- be accountable for your actions and the actions of your group
- be socially responsible and contribute to your community

Be Adaptable

- work independently or as part of a team
- carry out multiple tasks or projects
- be innovative and resourceful; identify and suggest alternative ways to achieve goals and get the job done
- be open and respond constructively to change
- learn from your mistakes and accept feedback
- cope with uncertainty

Learn Continuously

- be willing to continuously learn and grow
- assess personal strengths and areas for development
- set your own learning goals
- identify and access learning sources and opportunities
- plan for and achieve your learning goals

Work with Others

- understand and work within the dynamics of a group
- ensure that a team's purpose and objectives are clear
- be flexible; respect, and be open to and supportive of the thoughts, opinions, and contributions of others in a group
- recognize and respect people's diversity, individual differences, and perspectives
- accept and provide feedback in a constructive and considerate manner
- contribute to a team by sharing information and expertise
- lead or support when appropriate, motivating a group for high performance
- understand the role of conflict in a group to reach solutions
- manage and resolve conflict when appropriate

Participate in Projects and Tasks

- plan, design, or carry out a project or task from start to finish with well-defined objectives and outcomes
- develop a plan, seek feedback, test, revise, and implement
- work to agreed-upon quality standards and specifications
- select and use appropriate tools and technology for a task or project
- adapt to changing requirements and information continuously to monitor the success of a project or task and identify ways to improve

Numeracy in CTE

Success in any trade or technology requires that students develop strong number sense and proficiency when performing automotive tasks requiring mathematical skills. Number sense develops when students connect numbers to real-life experiences, thereby allowing them to apply mathematical operations in a concrete manner to solve real contextual problems.

The intention of Numeracy in CTE is not to directly teach the math skills defined by the achievement indicators; rather it is to intentionally challenge the students with real-world technical problems that will require them to use/develop their math skills.

To support teachers in the instruction and assessment of contextual mathematics, there is a 7-step lesson planning progress call Math-in-CTE that was developed by the National Research Centre for Career and Technical Education.

Literacy in CTE

Success in any trade or technical field requires that students develop strong literacy and communication skills. Students need to be able to communicate effectively and appropriately within all aspects of the automotive service technician trade in verbal, non-verbal, electronic, and written forms.

Literacy skills as defined by the Conference Board of Canada 2000+ Employability Skills.

Communicate

- read and understand information presented in a variety of forms (e.g., words, graphs, charts, diagrams)
- write and speak so others pay attention and understand
- listen and ask questions to understand and appreciate the points of view of others
- share information using a range of information and communication technologies (e.g., voice mail, e-mail, computers)
- use relevant scientific, technological, and mathematical knowledge and skills to explain or clarify ideas

Manage Information

- locate, gather, and organize information using appropriate technology and information systems
- access, analyse, and apply knowledge and skills from various disciplines (e.g., the arts, languages, science, technology, mathematics, social sciences, and the humanities)

CTE Career Portfolio

The purpose of the CTE Career Portfolio is for students to begin to discover the purpose and relevance of their learning in the CTE environment and how it connects to their current and future goals. CTE programs offer students the opportunity to gain valuable experience working on real and relevant projects all the while building technical skills within the discipline. These experience and technical skills can open a wide range of doors for students as they progress through high school, enter the labour market, and consider their post-secondary options. It is critical that CTE teachers engage students in meaningful conversations related to the CTE-Portfolio so students are able to articulate their experience and value their learning with the CTE program.

Formative Assessment Guide

Naturalization/Articulation	Precision	Manipulation	Imitation	
Innovative (end of 6th course)	Complex (end of 3rd course)		Simple (end of 1st course)	
Students communicate and discuss solutions to automotive problems using both existing and emerging terminology within trade; strategically apply mathematical reasoning and number sense to solve technical problems.	Students use automotive terminology to help solve problems; use common automotive tools to solve basic complete basic tasks.		Students can communicate with others using common trade language and perform basic mathematical calculations.	Recall
Students demonstrate a work ethic that is expected of an entry level Auto Service Technician Apprentice; adjust work schedules to ensure work is completed.	Students demonstrate a work ethic that shows a commitment to both the task and the others within the group; determine work schedules and timelines to ensure work is completed.		Students can follow workplace protocols such as arriving on time, remaining on-task to complete assigned work, and working effectively as member of a group.	Procedural
Students have a clear understanding of their next steps and leverage the CTE-Portfolio to help them activate their plan for either a transition to the labour market or to post-secondary training (Apprenticeship, College, University).	Students use the evidence in their CTE Portfolio to determine their next steps; they continue to collect evidence and deepen their understanding of career and post-secondary options available through the automotive program.		Students can collect and record relevant information to begin to build their CTE Portfolio.	Critical Thinking

Essential Skills for Automotive Service Technicians

Reading Automotive service technicians must read and comprehend a variety of materials including repair manuals, manufacturers' bulletins, and safety documents. They refer to government regulations, vehicle inspection procedures, hazardous material handling and disposal, and safety requirements of vehicles.	Numeracy Automotive service technicians take a variety of measurements using digital and analog equipment. They estimate the amount of time required to complete repairs. Automotive service technicians compare measurements of energy, dimension, speed, horsepower, temperature, and torque to specifications. They analyse pressure, power, torque, compression, and electrical readings to assess vehicle performance and troubleshoot faults.
Document Use Automotive service technicians interpret technical drawings and flowcharts. They locate data such as classifications, product and material specifications, identification numbers, quantities, and costs. Automotive service technicians often use specification tables. They scan a variety of manufacturers' labels for part numbers, serial numbers, sizes, colours, and other information and adhere to hazard and safety icons.	Writing Automotive service technicians complete workplace documents such as written explanations to the client, work orders, inspection reports, and incident reports.
Working with Others Most automotive service technicians work independently on jobs outlined in work orders. They may assist others with jobs that require two people or are within their specific area of expertise. They collaborate effectively with colleagues including salespersons, parts persons, and management to resolve concerns, situations, and problems.	Digital Technology Automotive service technicians use computerized scanning equipment, onboard vehicle diagnostics, and hand-held diagnostic tools to gain operational information about vehicles. They access the Internet and databases to retrieve repair information. Automotive service technicians use digital technology to exchange information with other technicians, service managers, colleagues in other locations, and manufacturer support specialists. Keyboarding and basic computer skills are an asset.
Thinking Automotive service technicians use thinking skills and visual analysis to diagnose and repair problems. They evaluate the severity of vehicle defects and deficiencies and the quality of repairs. Automotive service technicians decide the most efficient course of action to complete a job.	Oral Communication Automotive service technicians gather information from different sources about vehicle faults and needed repairs, explain the results of inspections and repairs, and discuss maintenance procedures. They exchange technical repair and troubleshooting information with others such as service managers, apprentices, co-workers, colleagues, and suppliers.
Continuous Learning Constant change in the industry makes it vital for automotive service technicians to stay current with the latest technology. They learn on the job, in organized information activities, and in work discussion groups. Their training is provided by vehicle manufacturers, parts suppliers, employers, and associations. They also advance skills by reading work-related magazines, periodicals, and automotive websites.	

Red Seal Occupational Standard 2016 Reference

Task A-2 - Uses tools, equipment, and documentation	
A-2.04 - Uses technical information	
A-2.04.01P	access technical diagnostic and repair information
A-2.04.02P	interpret and apply technical information
A-2.04.03P	create parts and labour lists and work orders
Task A-3 - Uses communication and mentoring techniques	
A-3.01 - Uses communication techniques	
A.3.01.01P	demonstrates two-way communication practices one-on-one and in a group
A.3.01.02P	listens using active listening practices
A.3.01.03P	receives and responds to feedback on work
A.3.01.04P	explains and provides feedback
A.3.01.05P	uses questioning to improve communication
A.3.01.06P	participates in discussions
A-3.02 - Uses mentoring techniques	
A.3.02.01P	identify and communicate learning objective and point of lesson
A.3.02.02P	link lesson to other lessons and the job
A.3.02.03P	demonstrates performance of a skill to learner
A.3.02.04P	set up conditions required for learner to practice a skill
A.3.02.05P	assess ability to perform tasks with increasing independence
A.3.02.06P	give supportive and corrective feedback
A.3.02.07P	support learner in pursuing technical training opportunities
A.3.02.08P	support equity groups; workplace is harassment and discrimination-free

Unit C: Tools and Equipment Tool Use

Technical Skill Dimension					Tool Use	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall				
					Remembering				
					Understanding				
					Procedural	Applying			1.4
						Analysing			1.2, 1.3
					Critical Thinking	Evaluating		1.5	1.1, 1.7
						Creating			1.6

C.1

Students are expected to...

enhance their tactile skills involving the use and selection of tools and equipment to solve technical problems related to automotive technology.

Achievement Indicators

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

- C.1.1 perform automotive tasks safely and effectively using hand tools;
- C.1.2 demonstrate standard operations using portable power tools safely and effectively;
- C.1.3 demonstrate standard operations using stationary power tools safely and effectively;
- C.1.4 complete assembly tasks using component fasteners, adhesives, and sealers safety and effectively;
- C.1.5 select the correct tool to perform a given task;
- C.1.6 reflect on their use of tools and equipment; and
- C.1.7 enhance their tactile skills in the proficient use of tools and equipment.

Unit C: Tools and Equipment Measurement

Technical Skill Dimension					Measurement	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	2.1, 2.2		
					Critical Thinking	Evaluating		2.3, 2.4	
						Creating			

C.2

Students are expected to...

perform accurate measurements of automotive components using measuring tools that are common to the trade.

Achievement Indicators

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

- C.2.1 demonstrate the ability to convert numbers from decimals to fractions;
- C.2.2 perform linear measurements in imperial and SI units;
- C.2.3 demonstrate the correct care and use of measuring tools; and
- C.2.4 perform proper torque measurements and procedures using imperial and SI units.

Elaboration

The outcomes in Unit C - Tools and Equipment are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the career and technical education facility. These outcomes require the students to actively participate in all projects, tasks, and learning opportunities related to the course.

Developing students' skill and proficiency in working with their hands is critical to the success of anyone interested in pursuing a career in the skilled trades. Students need to be provided time to practise their skills using hand tools, power tools, and stationary power equipment on a variety of projects and applications.

The outcomes in this unit are integrated outcomes and therefore cannot be taught or learned in isolation from the ongoing work within the automotive facility. This outcome requires the students to use hand tools, portable tools, and stationary power tools in a safe and appropriate manner consistent with the safety procedures in the CTE facility.

While the factual knowledge and use of hand tools, power tools, and stationary equipment required in these outcomes will be directly instructed and demonstrated, these outcomes should be assessed on an ongoing basis and students should be given timely, formative feedback to enable them to deepen their knowledge and develop their skills related to the use of these tools.

Teachers should consider developing an instructional plan that provides students with a broad overview of all the hand tools, power tools, and stationary equipment they will need during the course. This should be followed up with specific instruction, direction, and demonstration of the skill when the task is required.

Vehicles are assembled with a great variety of fasteners, adhesives, and sealants. The student should be able to correctly identify, select, remove, and replace fasteners common to the automotive trade. Proper knowledge and use of fasteners is required to maintain vehicle integrity, operation, and safety.

Performance Indicators

- Demonstrating converting fractions to decimals, rounding off to three decimal places.
- Converting decimals to fractions, rounding off to the nearest $1/64$, and expressing them in the simplest form.
- Demonstrating reading a ruler and measuring tape to the smallest graduation on the scale, (normally to $1/64$ " or 0.5 mm), developing proficiency in both imperial and SI measuring.
- Demonstrating using feeler gauges to measure clearances between components.
- Demonstrating using vernier calipers to measure inside, outside, and depth dimensions.
- Demonstrating obtaining precise measurements, and demonstrating the proper use and care of micrometers.
- Demonstrating the setup, use, and reading of dial indicators.
- Interpreting the results of their measurements with tolerances obtained from industry charts and tables.
- Demonstrating the use and limitations of the common transfer-type measuring tools.
- Demonstrating the use of inside and outside calipers.
- Demonstrating the use of small hole gauges and telescoping gauges.
- Demonstrating how a bearing clearance measurement can be obtained using a Plastigage.
- Explaining the most common cause of damage to precision measuring tools.
- Demonstrating basic care of precision measuring tools.

- Inspecting precision tools for damage and basic calibration.
- Defining torque and explaining why it is important for automotive components.
- Explaining the common units of torque in imperial and SI units.
- Determining the value of torque using the formula $\text{torque} = \text{lever length} \times \text{force}$.
- Identifying various types of torque wrenches.
- Explaining how to check a torque wrench for calibration.
- Demonstrating using and caring for torque wrenches.

Red Seal Occupational Standard 2016 Reference

Task A-2 - Uses tools, equipment, and documentation	
A-2.01 - Uses tools and equipment	
A-2.01.01P	organize and store personal tools and equipment
A-2.01.02P	organize and store shop tools and equipment
A-2.01.03P	inspect tools and equipment regularly to recognize wear, damage, defects, or expiry
A-2.01.04P	clean, lubricate, and maintain tools and equipment
A-2.01.05P	identify, remove, repair, or replace defective equipment
A-2.01.06P	calibrate measuring tools
A-2.01.07P	operate shop tools and equipment
A-2.01.01L	demonstrate knowledge of hand and power tools, their applications, maintenance, and procedures for use
A-2.01.02L	demonstrate knowledge of measuring and testing devices, their applications, maintenance, and procedures for use
A-2.01.03L	demonstrate knowledge of shop tools and equipment, their applications, maintenance, and procedures for use
A-2.01.04L	demonstrate knowledge of welding, cutting, and heating equipment and their applications

Unit D: Automotive Service Steering Angles

Technical Skill Dimension					Steering Angles	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
D.1					Recall	Remembering			
					Understanding		1.1, 1.2, 1.3, 1.4, 1.5	1.6, 1.7	
					Procedural	Applying			
						Analysing			
					Critical Thinking	Evaluating			
						Creating			

D.1

Students are expected to...

describe the common steering angles and how each affects vehicle handling.

Achievement Indicators

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

- D.1.1 describe the function and effect of caster in vehicle operation;
- D.1.2 describe the function and effect of camber in vehicle operation;
- D.1.3 describe the function and effect of steering axis inclination in vehicle operation;
- D.1.4 describe the function and effect of toe in vehicle operation;
- D.1.5 describe the effect of thrust angle in vehicle operation;
- D.1.6 describe the measurement procedures for each wheel alignment angle; and
- D.1.7 describe the adjustment procedures for each wheel alignment angle.

Performance Indicators

- Listing the three main design characteristics manufacturers try to optimize in steering alignment design.
- Describing the location of the steering axis.
- Defining caster and explaining the purpose of caster, as related to steering stability.
- Explaining how caster could be set to adjust for road crown.
- Explaining how positive and negative caster affect the vehicle during turning.
- Describing the process for measuring caster.
- Defining camber.
- Listing the four main purposes of camber and describing how camber affects directional control.
- Describing the process to measure camber.
- Listing three effects of incorrect camber.
- Defining steering axis inclination (SAI) and listing six purposes of SAI.
- Explaining how SAI affects directional control.
- Describing the process to measure SAI.
- Explaining the included angle and how it is calculated.
- Describing scrub radius and listing effects of positive and negative scrub radius.
- Defining toe.
- Explaining the concept of zero toe.
- Describing the process to measure toe.
- Listing the effects of incorrect toe.
- Explaining how turning radius relates to toe and how turning radius is incorporated in a vehicle's design.
- Describing the process to measure turning radius.
- Defining thrust angle.
- Explaining the three lines of reference: vehicle centreline (VCL), geometric centreline (GCL), thrust line.
- Describing how to measure thrust angle.
- Explaining the effects of incorrect thrust angle.
- Demonstrating pre-alignment inspection and describing the alignment procedure to measure all five steering angles.
- Demonstrating a thorough comprehension of angle measurement in decimals, fractions, degrees, minutes, and seconds.
- Identifying rear camber and toe adjustments and demonstrating the procedure to adjust rear toe and camber.
- Identifying rear wheel camber/toe shims.
- Identifying front wheel caster and camber adjustments.
- Demonstrating the procedures to adjust front caster and camber.
- Consulting service manuals to obtain manufacturer's specifications and instructions for caster and camber.
- Demonstrating the procedures to adjust front toe angles.
- Locating manufacturer's specifications and instructions to adjust toe angles (ALLDATA).

Unit D: Automotive Service Pre-alignment Inspection

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

D.2

Students are expected to...

perform a pre-alignment inspection and determine alignment settings.

Achievement Indicators

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

- D.2.1 perform a pre-alignment inspection to locate and identify faulty components;
- D.2.2 select the most appropriate alignment settings within specifications for a given vehicle type and load condition;
- D.2.3 perform a wheel alignment to adjust the alignment angles according to guidelines;
- D.2.4 perform adjustments to steering linkage to establish the correct toe setting and properly centre the steering wheel; and
- D.2.5 describe a road test procedure to verify alignment or alignment problems.

Performance Indicators

Vehicle alignment procedures are designed to restore the vehicle's handling characteristics to manufacturer's specifications. The alignment technician must follow all of the steps in sequence to properly align the vehicle.

- Listing and describing the steps and sequence involved in performing a wheel alignment.
- Performing a pre-alignment inspection.
- Conducting a customer interview.
- Performing a visual inspection.
- Describing a road-test procedure.
- Inspecting wheels and tires.
- Performing measurements to check vehicle tracking.
- Performing a shock absorber test and inspection.
- Performing a ride height inspection and collect vehicle measurement data.
- Performing a ball joint inspection.
- Inspecting the CV boots and joints.
- Inspecting the control arm bushings.
- Performing a steering linkage inspection.
- Inspecting strut rods and stabilizer bars.
- Inspecting rear suspension members.
- Inspecting the steering gear.
- Performing an under-hood inspection.
- Demonstrating proficiency in the use of units of measurement (degrees expressed using minutes and seconds, degrees expressed using fractions and decimals, linear (metric, imperial)).
- Interpreting service manuals to determine the specification range for alignment angles.
- Describing and listing the three alignment angle selection rules.
- Using the caster-camber selection chart.
- Performing calculations to determine alignment angles for specified vehicles.
- Measuring and adjusting all steering angles.
- Explaining the importance of centring the steering wheel.
- Making necessary adjustments to centre the steering wheel.
- Demonstrating the procedure to follow when performing final road test.

Unit D: Automotive Service Suspension System Diagnosis

Technical Skill Dimension					Suspension System Diagnosis	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding	4.1		
					Procedural	Applying			
						Analysing			
D.3				Critical Thinking	Evaluating		4.2, 4.3	4.5	
					Creating			4.4	

D.3

Students are expected to...
diagnose and repair suspension systems and steering linkages.

Achievement Indicators

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

- D.3.1 describe the diagnosis of suspension and steering problem(s);
- D.3.2 troubleshoot problem(s) related to suspension systems;
- D.3.3 troubleshoot problem(s) related to steering systems;
- D.3.4 select an appropriate repair method to correct suspension or steering problem(s); and
- D.3.5 diagnose and repair suspension and steering systems to correct problem(s).

Performance Indicators

Suspension and steering components are second only to brakes among the most critical safety feature on any vehicle. The apprentice must be able to diagnose and service the steering and suspension systems, maintaining the vehicle to original specifications.

- Listing typical steering complaints.
- Demonstrating an inspection of the steering linkage.
- Demonstrating the procedure to check the steering gears for looseness, roughness, and binding.
- Listing two things that should be checked first when diagnosing power steering noise.
- Performing power steering belt inspection and tension check.
- Demonstrating the procedure to pressure-test a power steering system.
- Demonstrating power steering pull and demonstrating a check for this condition.
- Inspecting a power steering system for leakage and suggesting appropriate repair procedures.
- Diagnosing problems related to an off centre steering wheel.
- Describing conditions of understeer and oversteer.
- Listing four conditions to check in response to complaints of understeer or oversteer.
- Demonstrating the condition of bump steer, discussing possible causes, and suggesting a diagnosis path.
- Demonstrating torque steer, discussing possible causes, and suggesting a diagnosis path.
- Demonstrating memory steer, discussing possible causes, and suggesting a diagnosis path.
- Stating causes for tire squeal.
- Explaining how to check turning radius and inspecting steering arms.
- Explaining how noises may be used to identify suspension problems.
- Describing which defective components could cause excessive body roll.
- Describing which defective component would cause vehicle bounce.
- Listing common conditions responsible for vibrations and shimmy.
- Explaining three conditions that would cause brake-induced pull.
- Explaining three conditions that would cause tire pull.
- Listing factors to consider while diagnosing bent or damaged steering and suspension components.
- Analysing a steering system to determine how and where adjustments are made to camber.
- Demonstrating checking for a bent strut or steering knuckle.
- Demonstrating checking for cradle shift.
- Demonstrating checking for a bent control arm.
- Explaining why suspension components should never be straightened by using heat.
- Consulting and interpreting manufacturers' service manuals and on-line services to obtain appropriate service procedures.
- Demonstrating replacing suspension and steering components while consulting the appropriate service manual information.

Unit D: Automotive Service Motor Vehicle Inspection

Technical Skill Dimension					Motor Vehicle Inspection	Knowledge Dimension			
Naturalization	Articulation	Precision	Manipulation	Imitation		Factual	Conceptual	Procedural	Metacognitive
Innovative		Complex		Simple	Cognitive Dimension		Factual	Conceptual	Procedural
					Recall	Remembering			
						Understanding		4.1	
					Procedural	Applying		4.2	
						Analysing			4.3
					Critical Thinking	Evaluating			4.4
						Creating			

D.4

Students are expected to...
perform a routine motor vehicle inspection.

Achievement Indicators

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

- D.4.1 understand current provincial legislation and regulations that pertain to motor vehicle inspections;
- D.4.2 communicate results of an inspection to customers;
- D.4.3 record details of required repairs; and
- D.4.4 perform inspections on cars and light trucks.

Performance Indicators

Motor vehicles must pass an inspection by a provincially licensed technician each year. The inspection is required to assess the safety of the mechanical systems of the vehicle.

- Inspecting and recording concerns related to each of the following vehicle systems:
 - *windshield and other glazing, washer and wipers;*
 - *horn;*
 - *rearview mirrors;*
 - *brakes;*
 - *steering system;*
 - *suspension system;*
 - *exhaust system including catalytic converter on 1990 and newer models;*
 - *fuel system;*
 - *tires and wheels;*
 - *body components;*
 - *frame and cross members;*
 - *odometer and speedometer function;*
 - *headlight aiming and lighting equipment;*
 - *coupling devices and towing connections (if so equipped); and*
 - *seat belts.*
- Accurately recording the odometer reading on the inspection form.
- Communicating the results of the inspection accurately and providing the relative details relating to the required repairs.

Red Seal Occupational Standard 2016 Reference

Task F-18 - Diagnoses steering and suspension, braking, control systems, tires, wheels, hubs, and wheel bearings	
F-18.01 - Diagnoses steering, suspension, and control systems	
F-18.01.01P	verify concern to determine diagnostic strategy
F-18.01.02P	select and use diagnostic tools and equipment
F-18.01.03P	perform road test(when safe to do so)to identify braking concerns (<i>high school students will not perform the road test</i>)
F-18.01.04P	determine type of steering system
F-18.01.05P	determine type of suspension system
F-18.01.06P	determine type of control systems for steering and suspension systems
F-18.01.07P	inspect steering, suspension, and control components
F-18.01.08P	perform tests
F-18.01.09P	interpret and analyse results of tests and inspections
F-18.01.01L	demonstrate knowledge of suspension systems, their components and operation
F-18.01.02L	demonstrate knowledge of the procedures used to diagnose suspension systems
F-18.01.03L	demonstrate knowledge of steering systems, their components and operation
F-18.01.04L	demonstrate knowledge of the procedures used to diagnose steering systems
F-18.01.05L	demonstrate knowledge of electronically controlled suspension systems, their components and operation
F-18.01.06L	demonstrate knowledge of the procedures used to diagnose and perform wheel alignments
Task F-19 - Repairs steering and suspension, braking, control systems, tires, wheels, hubs, and wheel bearings	
F-19.01 - Repairs steering, suspension, and control systems	
F-19.01.01P	select and use repair tools and equipment
F-19.01.02P	select repair materials
F-19.01.03P	remove, replace, and service steering and suspension system components
F-19.01.04P	verify functionality of control systems
F-19.01.05P	perform adjustments and calibrations
F-19.01.06P	verify repair by system re-test and road test (<i>high school students will not perform the road test</i>)

