Grade 10 Graduation Numeracy Assessment: Specifications

English Language Version

BRITISH COLUMBIA | Ministry of Education

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1 Grade 10 provincial graduation assessments

The Grade 10 provincial graduation assessments require students to apply their numeracy and literacy skills in realistic contexts. Standards and expectations are set with the educated citizen in mind – that is, we ask what we should expect a Grade 10 student to know, do, and understand in a variety of contexts that require the application of literacy and numeracy skills.

Rather than assess specific course curricula, the Grade 10 graduation assessments – like the Programme for International Student Assessment (PISA) – measure the application of numeracy and literacy skills to realistic situations, requiring students to employ the competencies considered to be essential for future success. The Grade 10 graduation assessments look at students' ability to apply their knowledge and skills and to analyze, reason, and communicate effectively as they examine, interpret, and solve problems. Like PISA, these assessments also emphasize the importance of the context in which students should be able to use their skills (e.g., home, employment, society).

The Grade 10 provincial assessments of literacy and numeracy provide part of the information that supports the certification of graduation:

- Along with acquiring 80 course credits for graduation, students are required to complete provincial assessments in numeracy at Grade 10 and in literacy at Grades 10 and 12.
- Students have opportunities to rewrite the graduation assessments to set goals for improving their proficiency levels.

Purpose of the graduation assessments

The purpose of the assessments is to measure the extent to which students are literate and numerate and to provide students with information about their proficiency.

Use of information from the graduation assessments

The assessment instruments are not defined as formative or summative in nature; rather, information from the new graduation assessments can be used both summatively and formatively. Formative assessment (assessment *for* learning) and summative assessment (assessment *of* learning) can work together to improve student learning. For example, making formative use of summative assessment results involves using information drawn from a summative assessment to improve future student performance.

> The terms 'formative,' 'diagnostic,' 'summative' and 'evaluative' are generally used as if they describe kinds of assessments, but of course the outcomes of the same assessment might be used to serve more than one function. These terms are therefore not descriptions of kinds of assessment but rather of *the use to which information arising from the assessments is put*.
>
> (Wiliam, 2000, 2, citing Wiliam and Black, 1996)

The Grade 10 graduation assessment results:

can be used formatively or summatively to:

- support individual students by providing descriptive information for goal setting (i.e., using the information in the proficiency scale and the detailed student report to set new learning goals)
- provide additional information for educators, allowing them to identify areas of strength and weakness
- provide schools, districts, and the Ministry of Education with system-level information regarding the extent to which students are proficient in literacy and numeracy
- provide students with evidence of their literacy and numeracy skills for use after graduation
- describe the proficiency levels of subgroups of a population (e.g., Aboriginal students) for use by schools, districts, Ministry of Education, and key stakeholder groups
- help inform decision making at all levels of the educational system regarding performance in literacy and numeracy
- provide information for schools, districts, and the Ministry of Education regarding trends in performance over time

2 The grade 10 graduation numeracy assessment

The design and development of the Grade 10 Graduation Numeracy Assessment, an assessment requirement in the B.C. Graduation Program, was guided by advice received from the Advisory Group on Provincial Assessment (AGPA) and consultations with B.C. educators, representatives from post-secondary institutions and the First Nations Education Steering Committee (FNESC). (The final AGPA report for the graduation learning years is available from curriculum.gov.bc.ca.) The Grade 10 Graduation Numeracy Assessment reflects the directions of B.C.'s New Curriculum and is based on best practices in teaching, learning, and large-scale assessment. The development teams of educators designing and reviewing the assessment are drawn from a range of disciplines and perspectives to represent the various contexts in which numeracy is developed.

Table 1 identifies key directions applied in the Grade 10 Graduation Numeracy Assessment. The design makes use of interactive elements found within technology-based assessments, allowing for the measurement of new constructs, the assessment of deeper thinking, and more effective reporting.

Table 1: Education directions

Education Direction	Implications for the Grade 10 Graduation Numeracy Assessment
Core Competencies	The Core Competencies of the curriculum shape the design of and questions in the assessment, with emphases on Communication, Creative Thinking, and Critical Thinking.
Personalization	The assessment offers students a choice of options in the written constructed response section of the assessment, thereby allowing them to better show what they know, understand, and are able to do, while maintaining rigorous provincial standards.
Deeper thinking	The questions on the assessment target a variety of complex thinking and analysis skills.
Student engagement	The assessment employs question types designed to be engaging and interactive for students.
Cross-curricular skills	The assessment reflects numeracy skills acquired and applied across all areas of learning.
First Peoples	Every assessment contains context(s) based on First Peoples perspectives. Development is shaped by the First Peoples Principles of Learning.
Collaboration	Students can work through pre-assessment preparation materials with others (available on the Ministry's Graduation Numeracy Assessment website).
Self-reflection	A section of the assessment asks students to reflect on their performance.

The Grade 10 Graduation Numeracy Assessment is a technically sound and rigorous measure that assesses students' foundational aspects of learning in inclusive and personalized ways, with results providing detailed and relevant information for students, their parents, and educators.

Defining numeracy

Student ability in numeracy is developed throughout the curriculum and applied in a variety of situated contexts. The following definition of numeracy, which guides the structure and content development of the Grade 10 Graduation Numeracy Assessment, was informed by the curricular competencies from Areas of Learning and embodies the assessment's cross-curricular nature.

Numeracy Numeracy is the ability to interpret information within a given situation, apply mathematical understanding to solve an identified problem, and to analyze and communicate a solution.

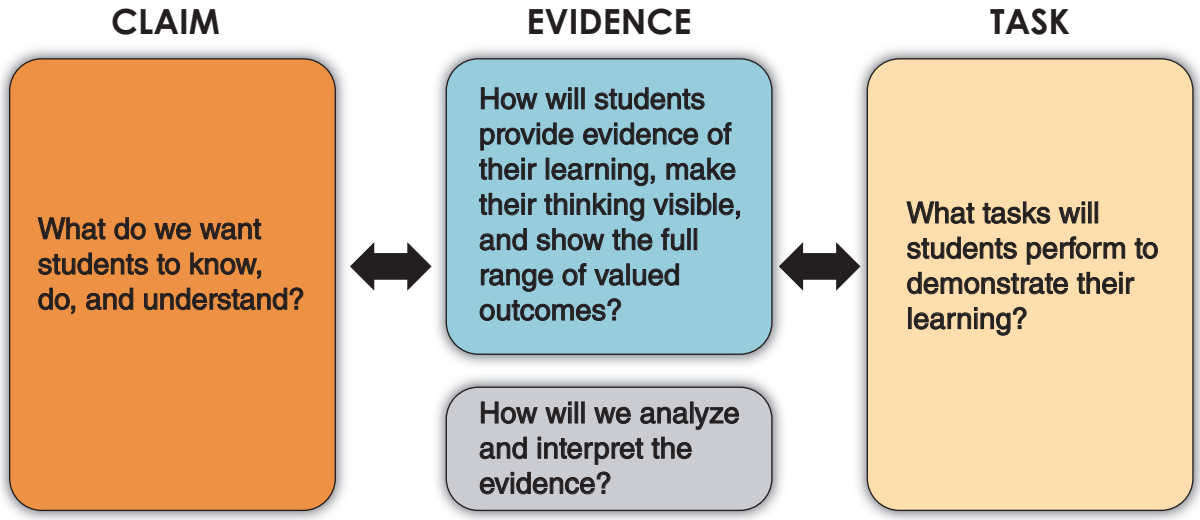
Design

The Grade 10 Graduation Numeracy Assessment uses an evidence-centred design (ECD), as illustrated in Figure 1.

ECD focuses on:

- **making claims** about student learning (what we want students to know, do, and understand) based on the purpose of the assessment
- **determining the evidence** that needs to be demonstrated to provide support for the claims and how this evidence will be analyzed and interpreted
- **writing task specifications** to create tasks that will allow students to demonstrate the depth of their learning

Figure 1: Evidence-centred design



(Adapted from Pellegrino, DiBello, & Brophy, 2014)

ECD strengthens the validity of assessments by:

- supporting the inclusion of tasks that elicit higher levels of cognitive processing
- enhancing score interpretation through the increasing comparability of assessment scores across forms

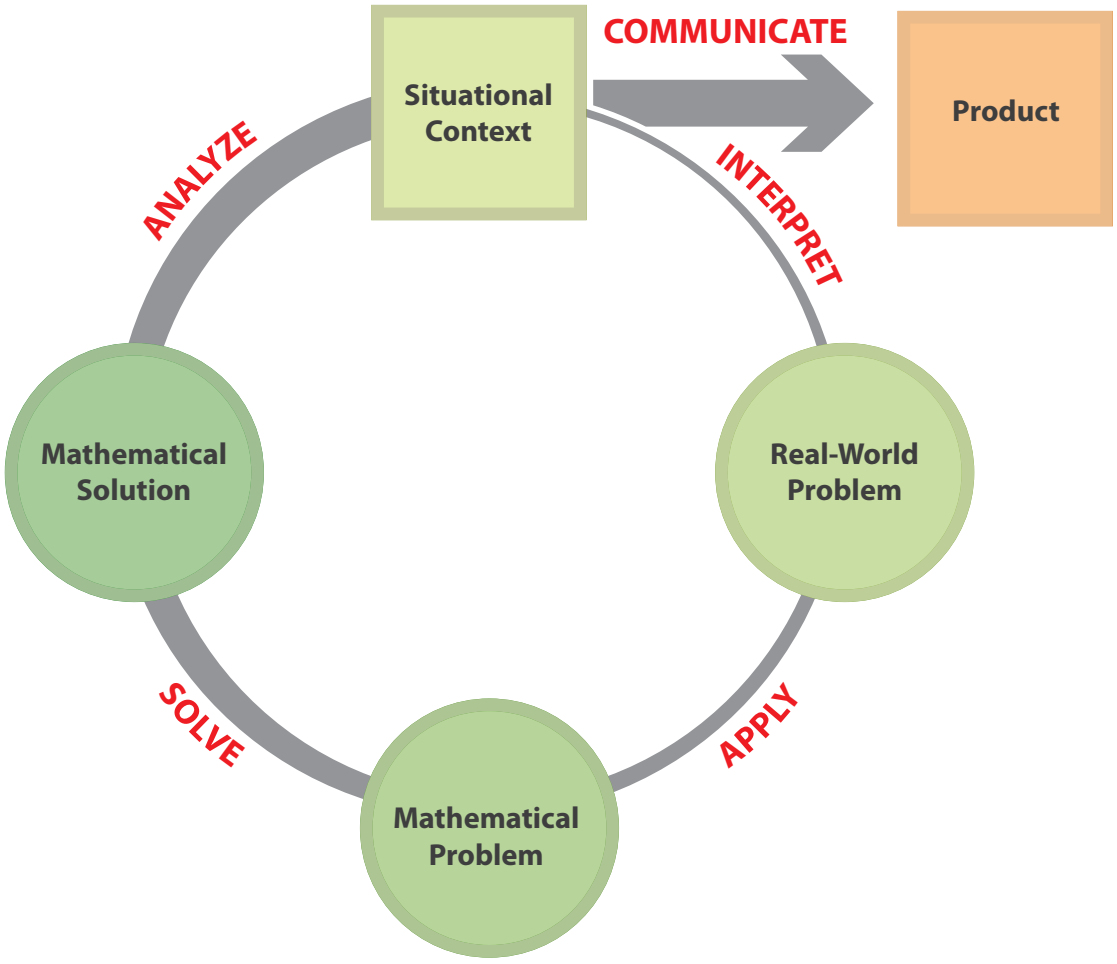
(Lane & Iwatani, 2016; Riconscente, Mislevy & Corrigan, 2016)

Solving a numeracy task

Figure 2 illustrates the series of processes used to solve a numeracy task.

- The task is based on a **situational context** (a scenario or open-ended challenge that connects mathematics with everyday life).
- The student *interprets* the situational context as a **real-world problem**. One or more mathematical approaches are *applied* to this problem, thereby linking it to the mathematics involved ("mathematizing" it) such that it is framed as a **mathematical problem**.
- The mathematical problem is then *solved*, and the resulting **mathematical solution** is *analyzed* and evaluated within context. If the solution is not resolved (determined to be sensible or reasonable), the processes can be revisited.
- Once the situational context is resolved with a sensible solution, it is *communicated* with any assumptions or limitations made, or as a recommendation.

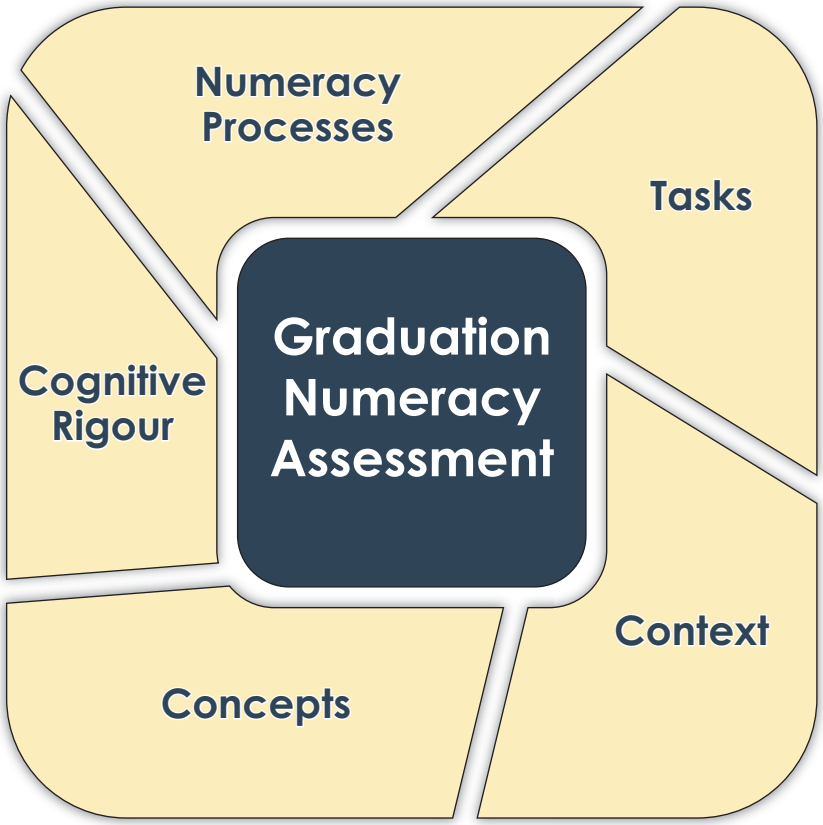
Figure 2: The processes used to solve a numeracy task



(This process is based on a mathematical modelling cycle. Refer to Liljedahl, 2016; OECD, 2019; and Perrenet & Zwaneveld, 2012.)

Five dimensions

The Grade 10 Graduation Numeracy Assessment is centred on five interrelated dimensions: Numeracy Processes, Tasks, Context, Concepts, and Cognitive Rigour.



The assessment contains numeracy tasks embedded in situational contexts. Some of these situations may be based on contexts unfamiliar to students and include non-routine tasks.

While previous Grade 10 Mathematics examinations focused only on the content knowledge within the Grade 10 Mathematics curriculum, the Grade 10 Graduation Numeracy Assessment emphasizes the application of sophisticated mathematical reasoning, understanding, and insight across areas of learning.

Numeracy processes

The Grade 10 Graduation Numeracy Assessment assesses five numeracy processes.

Interpret

Students are able to read and decode a range of situational contexts by identifying the real-world problems to be solved. Given insufficient or excess information, students will need to decide what information is relevant to solve the problem. This process is about students making decisions. Situational contexts may require students to identify constraints and ambiguities, and decide on next steps.

Apply

Students are able to identify and activate their mathematical understanding by translating real-world problems into mathematical problems (mathematizing). This process involves choosing a mathematical tool, determining how to organize the information, and creating relationship(s) in order to represent the real-world problem. (Students will need to flexibly use mathematical tools for a host of real-world problems.)

Solve

Students are able to solve mathematical problems through a variety of approaches and representations. Students may also need to check mathematical solutions to determine if their solutions make mathematical sense.

Analyze

Students are able to interpret mathematical solutions in context, such that the solutions are reasonable within the situational contexts. Students may need to assess the practicality and possible limitations of solutions, identify possible improvements to an approach, or identify other situations to which solutions can be applied. In doing so, students consider how contextual factors may affect the results. For example, students may reflect on their solutions to assess risks and address social, ethical, and environmental implications.

Communicate

Students are able to clearly and precisely construct valid logical arguments to defend their decisions and assumptions, explain the tools and approaches they used, and present their solutions in context. This may require students to make recommendations and use a variety of ways (e.g., tables, graphs, diagrams, equations, symbols) to visibly represent their thinking and solution.

Tasks

The Grade 10 Graduation Numeracy Assessment contains four tasks, one from each of the following categories (adapted from Liljedahl, 2016; Smarter Balanced Assessment Consortium, 2015):

- Reasoned Estimates – These tasks require students to make or use estimates across multiple variables in order to build a logical argument for a possible solution (e.g., planning a vacation).
- Plan and Design – These tasks may require students to analyze time, space, cost, and people in order to make a recommendation (e.g., devise a plan to ship several containers efficiently).
- Fair Share – These tasks require students to decide how to best share something fairly (e.g., a team bonus).
- Model – These tasks require students to come up with a model or strategy, given a data set; and then to apply this model or strategy to a new data set and, if necessary, to refine the model (e.g., extrapolate data to predict a future trend).

Although each task type appears once in an assessment, the task may contain elements from more than one category (e.g., after students have designed a product they would propose how to share the product fairly). Tasks may have students respond from the perspective of, for example, a designer, planner, or manager.

Tasks are embedded in situational contexts and a narrative is constructed throughout each task based on that particular scenario.

Context

The numeracy tasks on the Grade 10 Graduation Numeracy Assessment connect mathematical understanding to a variety of situational contexts. Situations will be based on contexts that offer relevant and natural settings for generating evidence for the five numeracy processes, including applications in areas of learning (e.g., science, social studies).

Tasks will be situated across the following four contexts related to daily life: personal, career, societal, and scientific (OECD, 2019). These contexts may be connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures.

- *Personal* — Tasks focus on one's self, family, or friends.
  Topics: personal health, finance, scheduling, games, travel, food preparation, shopping, popular music, sports
  Example situations: trip planning, dieting, budgeting, comparing products
- *Career* — Tasks focus on employment.
  Topics: measuring, costing and ordering materials, accounting, quality control, scheduling, or design
  Example situations: payroll, construction project estimates, carving
- *Societal* — Tasks focus on one's community.
  Topics: elections, media, public transportation, government policies, demographics, advertising, statistics, evolution, and economics
  Example situations: circle dwellings, election polling, ethics in sports
- *Scientific* — Tasks focus on the environment, science, and technology.
  Topics: ecology, agriculture, medicine, and weather
  Example situations: weather events, climate change, lab experiments, infectious diseases, invasive species

Note: Descriptions are not intended to be a complete list of tasks found on the assessment.

Concepts

Numeracy is about using mathematical concepts, tools, and approaches flexibly to resolve situational contexts. For each situational context, there is no one best tool to choose to resolve the situation, but rather a range of tools with various levels of sophistication that can be used.

The Mathematics curriculum provides the range of concepts that will be assessed within the numeracy tasks. Most of the numeracy tasks will include concepts up to and including Grade 8 (i.e., a range of mathematics topics from the following five areas: number sense, patterns, geometry and measurement, data and probability, and financial literacy). As well, the assessment may include the following concepts from Grade 9 or 10:

- operations with rational numbers
- linear relations
- spatial proportional reasoning
- statistics in society
- experimental probability (simulations)
- financial literacy (simple budgets, transactions, and gross and net pay)

The focus of this assessment is on the application of math concepts in situational contexts.

Cognitive rigour

The cognitive rigour of the questions in the Grade 10 Graduation Numeracy Assessment are classified based on Webb's Depth of Knowledge (DOK). This system categorizes tasks to four levels according to the complexity of thinking required. (Given the constraints of the provincial assessment design, Level 4 cognitive rigour is not assessed.)

The assessment includes questions written to Levels 1, 2, and 3 of Webb's DOK, as shown in the table below.

Table 2: Types of questions classified by cognitive rigour

	Level 1 – RECALL The student is able to recall or locate information such as a fact, definition, or term; use a procedure; or apply a formula.	Level 2 – SKILLS AND CONCEPTS The student is able to demonstrate conceptual understanding through models and explanations, and to make decisions on how to approach a problem or activity.	Level 3 – STRATEGIC THINKING The student is able to solve a problem and explain his or her thinking through reasoning, planning, and using evidence.
Interpret ⇨ Apply ⇨ Solve ⇨ Analyze ⇨ Communicate	a. Recall, observe, and recognize facts, principles, and properties b. Recall/identify conversions among numbers and make conversions c. Evaluate an expression d. Locate points on a grid or numbers on a number line e. Solve a one-step problem f. Represent math relationships in words, pictures, or symbols g. Follow simple procedures (recipe-type directions) h. Calculate, measure, and apply a rule (e.g., rounding) i. Apply algorithm or formula (e.g., area, perimeter) j. Solve linear equations k. Retrieve and use information from a table or graph l. Identify a pattern/trend m. Brainstorm ideas, concepts, or perspectives related to a topic	a. Specify and explain relationships (e.g., non-examples/examples; cause-effect) b. Make and record observations c. Explain steps followed d. Summarize results or concepts e. Make basic inferences or logical predictions from data/ observations f. Use models/diagrams to represent or explain concepts g. Make and explain estimates h. Select a procedure according to criteria and perform it i. Apply multiple concepts or decision points to solve problems j. Retrieve information from a table, graph, or figure and use it to solve a problem requiring multiple steps k. Translate between tables, graphs, words, and symbolic notations (e.g., make a graph from table of data) l. Construct models given criteria m. Classify materials, data, and figures based on characteristics n. Organize or order data o. Compare/contrast figures or data p. Select appropriate graph to display data q. Interpret data from a simple graph r. Extend a pattern s. Generate conjectures or hypotheses based on observations or prior knowledge and experience	a. Explain, generalize, or connect ideas using supporting evidence b. Make and justify conjectures c. Explain thinking when more than one response is possible d. Design an approach for a specific purpose e. Perform a designed approach f. Use and show reasoning, planning, and evidence g. Compare information within or across data sets or texts h. Analyze and draw conclusions from data, citing evidence i. Generalize a pattern j. Interpret data from a complex graph k. Describe, compare, and contrast approaches and solutions l. Cite evidence and develop a logical argument for concepts or solutions m. Verify reasonableness of solutions n. Synthesize information within one data set, source, or text o. Formulate an original problem given a situational context p. Develop a model for a situational context

(Adapted from Hess, 2009, and Webb, 2002)

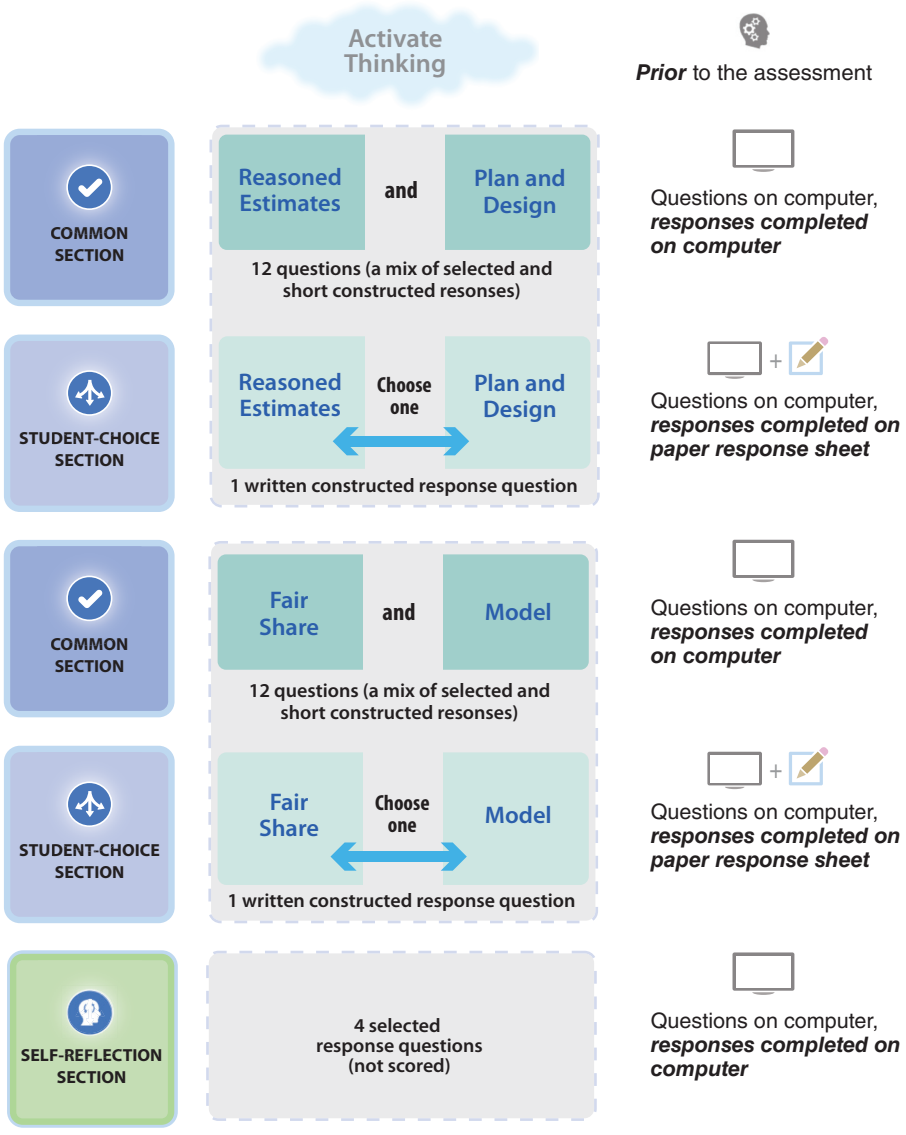
Assessment structure

Figure 3 shows the structure of the Grade 10 Graduation Numeracy Assessment.

Prior to the assessment, students will have an opportunity to activate thinking by interacting with pre-assessment preparation materials and collaborating with others. The assessment will include:

- two common sections, each containing a mix of selected and short constructed response questions;
- two student-choice sections, each involving a choice of two options and completing a written constructed response based on the choice; and
- a self-reflection section, completed after all other sections have been submitted.

Figure 3: Graduation Numeracy Assessment structure



Note: Students may freely navigate back-and-forth through all questions within each common section. In each student-choice section, students will be presented with two options but will only be able to access the question they chose after making their decision. It is thus strongly recommended students complete all questions within each common section preceding each student-choice option as choices cannot be changed once made.

Table of specifications

On the Grade 10 Graduation Numeracy Assessment a student will complete:

- a common section, consisting of four numeracy tasks (six questions per task), for a total of 24 questions; and
- a student-choice section in which students expand on two of the numeracy tasks in the common section.

The numeracy tasks will include questions distributed across the first three levels of Webb's Depth of Knowledge (DOK) following the guidelines outlined in *Criteria for High-Quality Assessment* (Darling-Hammond et al., 2013):

- ☑ Approximately 1/3 of the common section questions are classified as Level 1.
- ☑ Approximately 2/3 of the common section questions are classified as Level 2.

The following table of specifications articulates the number of questions and their relative weighting at each level of cognitive rigour.

Activate Thinking	**Pre-Assessment Activities; Not scored**		
Numeracy Processes	**Cognitive Rigour**[a]		
	Level 1 Recall	**Level 2 Skills and Concepts**	**Level 3 Strategic Thinking**
Interpret Apply Solve Analyze	8 questions (a mix of selected and short constructed responses)	16 questions (a mix of selected and short constructed responses)	2 constructed response questions (each marked using a 4-point rubric)
Communicate[b]			
Weighting	**20%**	**40%**	**40%**
Self-Reflection	**Post-Assessment Reflection; Not scored**		

[a]From Webb's Depth of Knowledge.
[b]Assessed only at Level 3.

Question formats

The Grade 10 Graduation Numeracy Assessment includes a variety of question formats to assess student understanding and application of the five numeracy processes (interpret, apply, solve, analyze, communicate). Formats include:

- *selected response*, which requires the student to choose the best answer(s) from those displayed; or
- *constructed response*, which require students to enter an answer or arrange on-screen elements to create an answer.

Question Format	Description
Selected response	**... in which students:**
Multiple choice	select a single correct response from a list of choices (e.g., menu)
Multiple correct choices	select multiple correct responses from a list of choices (e.g., checkboxes)
Association	drag and drop one or several elements to the desired positions (e.g., match or sort items)
Hotspot	select one or more desired spot(s) or area(s) within the displayed information (e.g., figure)
Constructed response	**... in which students:**
Short answer	• manipulate or complete a graph (e.g., plot points, draw lines, or move points on a sliding scale) • enter a numeric value or values, or • build a mathematical expression (either by direct input or using onscreen objects).
Written	create diagrams, graphs, equations, or expressions and compose sentences to support their solution

Some questions may also combine of one or more of these formats to construct a complete response (e.g., complete a statement by selecting an item from a menu and entering a numeric value that corresponds to the item).

3 Reporting results

Provincial graduation assessments use a four-level proficiency scale for reporting student achievement results. Students receive an overall score based on all of their responses and these results are placed in one of four levels of the Proficiency Scale (Figure 4). The standards (cut points) for the proficiency scale have been established through the professional judgment of educators and are set through detailed analysis of student responses by a standard-setting panel.

Figure 4: Proficiency Scale

Proficiency Scale	Emerging	Developing	Proficient	Extending
	Students demonstrate an initial understanding of the concepts and competencies relevant to the expected learning.	Students demonstrate a partial understanding of the concepts and competencies relevant to the expected learning.	Students demonstrate a complete understanding of the concepts and competencies relevant to the expected learning	Students demonstrate a sophisticated understanding of the concepts and competencies relevant to the expected learning.

The results from the standard-setting panel informed the Graduation Numeracy Assessment Proficiency Scale (Figure 5). The panel consisted of educators from across the province who used assessment data and student responses to create the descriptive information of what students can do at each level: “emerging,” “developing,” “proficient,” or “extending” in relation to the assessment. This information allows students to see where they have progressed in their learning. Teachers and students can use this information to formulate plans for future learning. Students can access their Grade 10 Graduation Numeracy Assessment results and proficiency level score from the StudentTranscripts Service (STS). District and school-based administrators can access results through the School Secure Web (SSW).

Figure 5: Graduation Numeracy Assessment Proficiency Scale

Proficiency Scale

Emerging	Developing	Proficient	Extending
Students demonstrate an initial understanding of the concepts and competencies relevant to the expected learning. Specifically, they can do the following: • retrieve information from sources (e.g., graph, image, table) • attempt to solve a real-world problem • communicate thinking with minimal evidence • use a narrow range of mathematical concepts, tools and approaches	Students demonstrate a partial understanding of the concepts and competencies relevant to the expected learning. Specifically, they can do the following: • apply information from sources (e.g., graph, image, table) • apply a strategy to solve a real-world problem • communicate thinking with limited supporting evidence • use an adequate range of mathematical concepts, tools and approaches	Students demonstrate a complete understanding of the concepts and competencies relevant to the expected learning. Specifically, they can do the following: • analyze and interpret information from sources (e.g., graph, image, table) in a logical manner • select an appropriate strategy to solve a real-world problem • communicate thinking with sufficient supporting evidence • use a broad range of mathematical concepts, tools and approaches	Students demonstrate a sophisticated understanding of the concepts and competencies relevant to the expected learning. Specifically, they can do the following: • adeptly analyze and synthesize information from sources (e.g., graph, image, table) in a logical manner • select an effective strategy to solve a real-world problem • communicate thinking with thorough supporting evidence • use an extensive range of mathematical concepts, tools and approaches

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