Graduation Numeracy Assessment
DESIGN SPECIFICATIONS

BRITISH COLUMBIA | Ministry of Education

SEPT 2017

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Graduation Numeracy Assessment

The Graduation Numeracy Assessment has been informed and shaped by multiple stakeholders – including the Advisory Group on Provincial Assessment, educators from across the province, and post-secondary colleagues. The Graduation Numeracy Assessment also reflects the directions of the education transformation in curriculum, the redesign of the Foundation Skills Assessment and research on best practices in large-scale assessments.

The following table identifies key directions applied in the Graduation Numeracy Assessment.

Education Direction	Graduation Numeracy Assessment
Core Competencies	The Core Competencies underscore the whole assessment.
Curricular Competencies	The curricular competencies across Areas of Learning informed the definitions for the numeracy processes.
Personalization	The assessment includes Student-Choice Components, thereby allowing all students to show what they know, understand, and are able to do, while maintaining rigorous provincial standards.
First Peoples	The First Peoples Principles of Learning have helped to shape the development of the assessments and First Peoples content is included in the contextualized situations.
Collaboration	The assessment offers students an opportunity to interact with pre-assessment preparation materials and collaborate with others.
Self-Reflection	The assessment asks students to reflect on their performance on the assessment.

Assessment Design

Ability in numeracy is developed throughout the curriculum and is applied in many contexts. The curricular competencies across a number of Areas of Learning have informed the definition of numeracy and its related processes. The following definition is at the heart of the Graduation Numeracy Assessment and has guided its development:

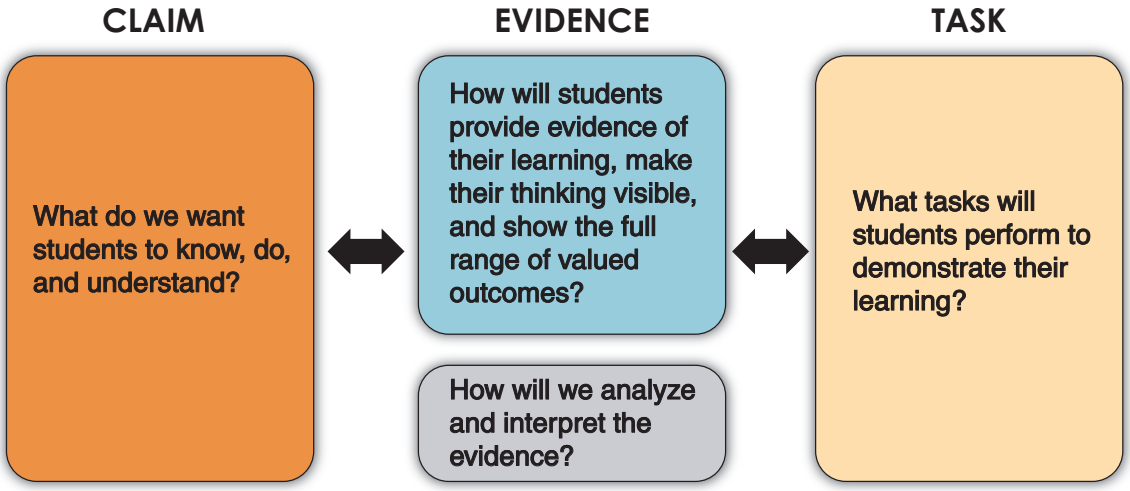
Numeracy Numeracy is the ability, willingness, and perseverance to interpret and apply mathematical understanding to solve problems in contextualized situations, and to analyze and communicate these solutions in ways relevant to the given context.

The Graduation Numeracy Assessment uses an evidence-centred design (ECD), as shown in the figure below (Pellegrino, DiBello, & Brophy, 2014; Riconscente, Mislevy, & Corrigan, 2016).

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; and
- **writing task specifications** to create tasks that will allow students to demonstrate the depth of their learning.

ECD strengthens the validity of assessments by (1) supporting the inclusion of tasks that elicit higher levels of cognitive processing, and (2) enhancing score interpretation through the increasing comparability of assessment scores across forms (Lane & Iwatani, 2016; Riconscente, Mislevy, & Corrigan, 2016).

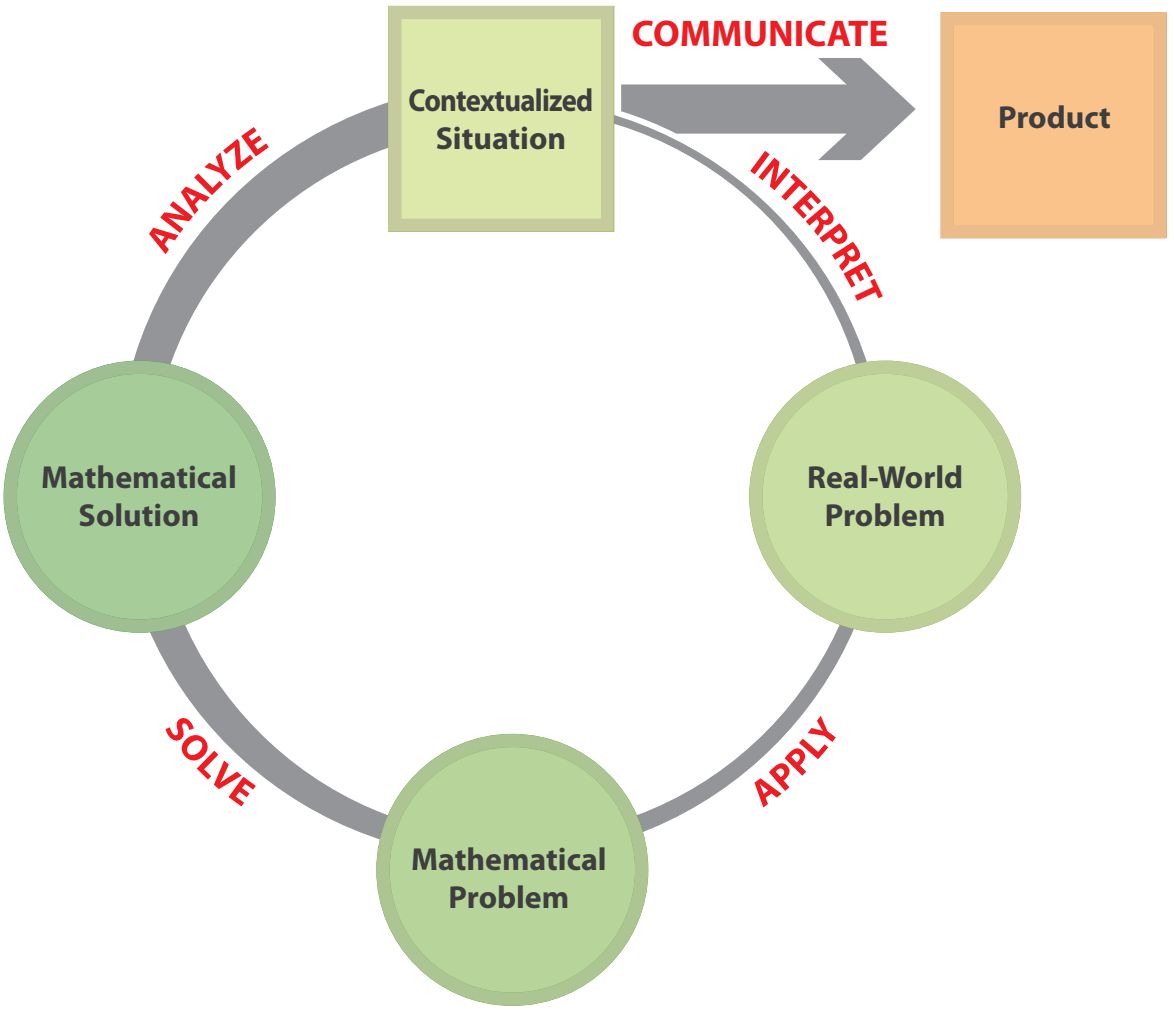


(Adapted from Pellegrino, DiBello, & Brophy, 2014)

Process for Solving Numeracy Tasks

The figure below illustrates the numeracy processes involved in solving a numeracy task.

- The task starts with a **contextualized situation** to provide context.
- The contextualized situation is then interpreted to identify the **real-world problem**. From that, one or more mathematical approaches are applied ("mathematized") to create a relationship (or several) to solve the **mathematical problem**.
- The mathematical problem is solved, and the resulting **mathematical solution** is analyzed and evaluated in context to determine if another cycle is needed.
- Once the contextualized situation is resolved, a solution or recommendation is communicated.

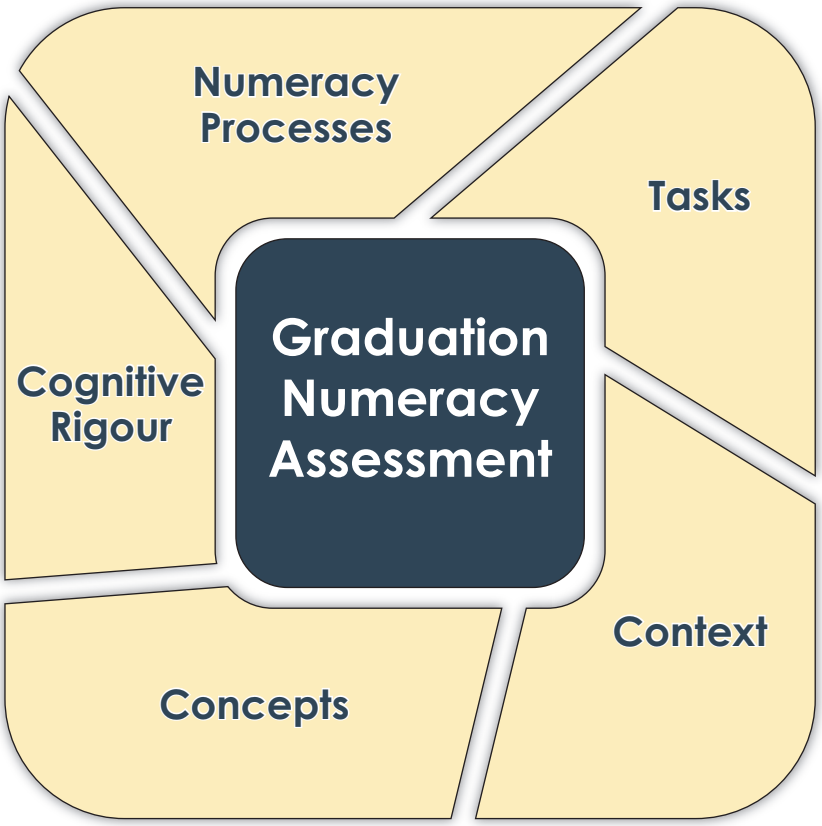


One may need to go through the cycle several times or go back and forth between the numeracy processes prior to communicating a solution or recommendation.

(This process is based on a mathematical modelling cycle. See, for example, Perrenet & Zwaneveld, 2012.)

Five Dimensions

The Graduation Numeracy Assessment will address five interrelated dimensions, shown below:



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

While the previous Grade 10 Mathematics examinations focused only on the content knowledge within the Grade 10 Mathematics curriculum, the Graduation Numeracy Assessment focuses more on students applying sophisticated mathematical reasoning, understanding, and insight across Areas of Learning (see, for example, Pead, 2012).

Numeracy Processes

The Graduation Numeracy Assessment will assess five numeracy processes (the five processes in the Assessment Model).

Interpret

Students are able to read and decode a range of contextualized situations in order to identify real-world problems that need to be solved. These situations may contain insufficient or excess information, where students will need to decide what information is relevant to solving the problem. This process is about students making decisions. Contextualized situations may require students to identify constraints and ambiguities, and make decisions about next steps.

Apply

Students are able to identify and activate their mathematical understanding in order to translate real-world problems into mathematical problems (mathematize). This involves choosing mathematical tools, determining how to organize the information, and creating one or more relationship(s) in order to represent the real-world problems. This involves being able to flexibly apply mathematical tools to a range of real-world problems.

Solve

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

Analyze

Students are able to interpret mathematical solutions in context, such that the solutions make sense within the contextualized situations. Students may need to assess the practicality and possible limitations of solutions, identify possible improvements to an approach, or identify alternate situations to which solutions can be applied. In doing this, students consider how contextual factors may impact 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

A balanced mixture of the following types of tasks will be used on the Graduation Numeracy Assessment (Liljedahl, 2016; Pead, 2012; 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., travelling to Australia).
- Plan and Design – These tasks may require students to analyze time, space, cost, and people in order to make a recommendation (e.g., shipping several containers).
- Fair Share – These tasks require students to decide how to best share something fairly (e.g., giving out bonuses).
- 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., ranking criteria).

Numeracy tasks may contain more than one type of task – for example, requiring students to plan and share fairly. Tasks may have students respond as designers, planners, commentators, evaluators, managers, and so on.

Numeracy tasks will be embedded in contextualized situations, and a narrative is constructed throughout each task based on that contextualized situation. Contextualized situations can be categorized according to the context.

Context

The numeracy tasks on the Graduation Numeracy Assessment will connect mathematical understanding with a variety of contextualized situations. 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 such as Science and Social Studies.

Tasks will be situated across the following four contexts related to daily life: personal, career, societal, and scientific (OECD, 2013). 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 – These tasks focus on one's self, family, or peer group. Tasks may be situated in (but are not limited to) personal health, finance, scheduling, games, travel, food preparation, fashion, shopping, popular music, and sports (e.g., bentwood boxes, weaving, Olympics, dieting, budget, Internet packages, museum cost, bus schedules).
- Career – These tasks focus on employment. Problems may involve (but are not limited to) measuring, costing and ordering of materials, accounting, quality control, scheduling, or design (e.g., payroll, construction estimates, carving).
- Societal – These tasks focus on one's community. Problems may involve (but are not limited to) elections, media, public transportation, government, public policies, demographics, advertising, statistics, evolution, and economics (e.g., circle dwellings, ethics in sports).
- Scientific – These tasks focus on the environment, science, and technology. Problems may be situated in (but are not limited to) ecology, agriculture, medicine, and weather (e.g., mould, fish traps, global warming, science experiments, infectious diseases, invasive species, extreme weather events).

Concepts

Numeracy is about using mathematical concepts, tools, and approaches flexibly to resolve contextualized situations. For each contextualized situation, 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 contextualized situations.

Cognitive Rigour (Webb's Depth of Knowledge)

Webb's Depth of Knowledge (DOK) is used to describe cognitive rigour. Webb's DOK categorizes tasks to four levels according to the complexity of thinking required.

The assessment includes questions at the first three levels of Webb's DOK, as shown in the table below. (Level 4 is not part of the assessment, as this level cannot be measured within the constraints of a provincial assessment.)

	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 contextualized situation p. Develop a model for a contextualized situation

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

Assessment Components

The following figure shows the components of the 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 common components consisting of selected and short constructed response questions; student-choice components consisting of extensive constructed response questions; and a self-reflection component.

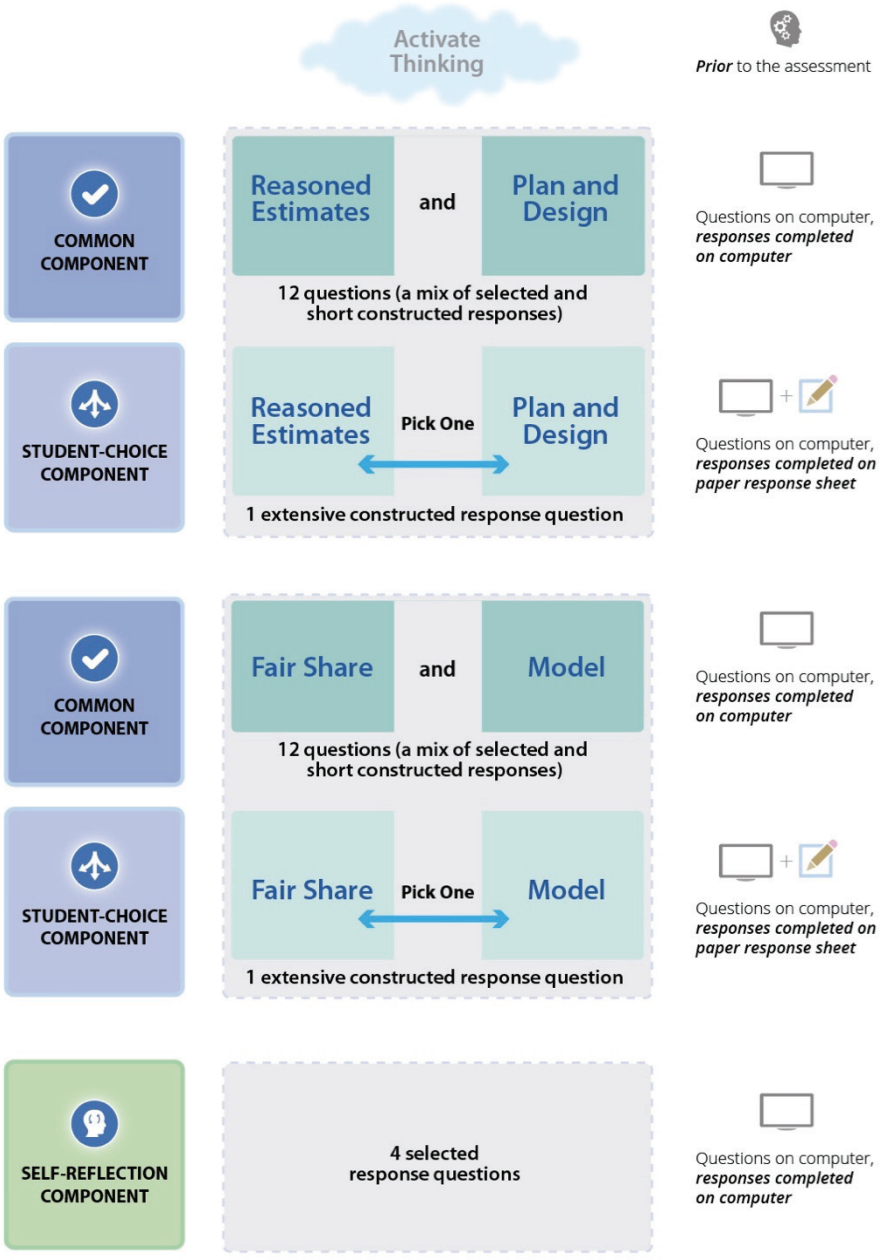


Table of Specifications

Each Graduation Numeracy Assessment will include:

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

This adds up to 26 questions.

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):

- ☑ A maximum 1/3 of the questions will be at DOK Level 1.
- ☑ A minimum 2/3 of the questions will be at DOK Levels 2 and 3.

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 extensive constructed response questions (each scored on 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.

Types of Questions

The Graduation Numeracy Assessment will include a variety of questions that assess the application of the five numeracy processes (interpret, apply, solve, analyze, communicate). Questions will be either:

- *selected response*, which provide answer choices; or
- *constructed response*, which require students to develop answers.

Types of Questions	Description
Selected response	**... in which students:**
Multiple choice	Select, from several choices, a single correct response.
Multiple correct responses multiple choice (check boxes)	Select, from several choices, multiple correct responses.
Matching/sorting	Drag and drop one or several elements to the desired positions.
Highlight	Select a desired response.
Hot spot	Select a desired spot in a figure.
Constructed response	**... in which students:**
Short	Manipulate or complete a graph (e.g., plot points, draw lines, or move points on a sliding scale), enter a numeric response, or write an equation.
Extensive	Create diagrams, graphs, equations, or expressions and compose sentences to explain response.

Reporting

The proficiency scale will be used to report overall performance on the Graduation Numeracy Assessment. It will describe what students can do at each level.

The scale below will be further elaborated following the first assessment administration and standard setting session, and will be available in the spring of 2018.

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

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