Essential Mathematics 2019 v1.1

Subject report 2020

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For all Queensland schools
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Introduction

The first summative year for the new Queensland Certificate of Education (QCE) system was unexpectedly challenging. The demands of delivering new assessment requirements and processes were amplified by disruptions to senior schooling arising from the COVID-19 pandemic. This meant the new system was forced to adapt before it had been introduced — the number of summative internal assessments was reduced from four to three. The three included the common internal assessment (CIA). Schools and the QCAA worked together to implement the new assessment processes and the 2020 Year 12 cohort received accurate and reliable subject results.

Queensland's innovative new senior assessment system combines the flexibility and authenticity of school-based assessment, developed and marked by classroom teachers, with the rigour and consistency of external assessment set and marked by QCAA-trained assessment writers and markers. The system does not privilege one form of assessment over another, and both teachers and QCAA assessors share the role of making high-stakes judgments about the achievement of students. Our commitment to rigorous external quality assurance guarantees the reliability of both internal and external assessment outcomes.

Using evidence of student learning to make judgments on student achievement is just one purpose of assessment. In a sophisticated assessment system, it is also used by teachers to inform pedagogy and by students to monitor and reflect on their progress.

This post-cycle report on the summative assessment program is not simply being produced as a matter of record. It is intended that it will play an active role in future assessment cycles by providing observations and findings in a way that is meaningful and helpful to support the teaching and learning process, provide future students with guidance to support their preparations for summative assessment, and promote transparency and accountability in the broader education community. Reflection and research are necessary for the new system to achieve stability and to continue to evolve. The annual subject report is a key medium for making it accessible to schools and others.

Background

Purpose

The annual subject report is an analysis of the previous year's full summative assessment cycle. This includes endorsement of summative internal assessment (IA) instruments and the implementation of the CIA.

The report provides an overview of the key outcomes of one full teaching, learning and assessment cycle for each subject, including:

- information about the application of the syllabus objectives through the design of internal assessments and the CIA.

It also provides advice to schools to promote continuous improvement, including:

- identification of effective practices in the design of valid, accessible and reliable assessments
- identification of areas for improvement and recommendations to enhance the design of valid, accessible and reliable assessment instruments.

Audience and use

This report should be read by school leaders, subject leaders and teachers to inform teaching and learning and assessment preparation. The report is to be used by schools and teachers to assist in assessment design practice.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can learn about the assessment practices for Applied (Essential) subjects.

Report preparation

The report includes analyses of data and other information from endorsement processes and CIA development, and advice from the chief endorser. It was developed in consultation with and support from QCAA subject matter experts.

Subject data summary

Subject enrolments

Number of schools offering the subject: 434.

Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	13 287	14 761	15 003

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory	Not rated
Unit 1	10 601	2420	266
Unit 2	12 137	2378	246

Final standards allocation

The number of students awarded each standard across the state are as follows.

Standard	A	B	C	D	E
Number of students	1014	5212	7257	1365	155

Internal assessment

The following information and advice pertain to the assessment design for Units 3 and 4 instruments IA1, IA3 and IA4, which are developed by schools. These instruments have undergone quality assurance processes informed by the attributes of quality assessment.

Endorsement

Endorsement is the quality assurance process based on the attributes of validity and accessibility. These attributes are categorised further as priorities for assessment and each priority can be further broken down into assessment practices. Data presented in the assessment design sections identifies the reasons why IA instruments were not endorsed at Application 1, by the priority for assessments. An IA may have been identified more than once for a priority for assessment, e.g. it may have demonstrated a misalignment to both subject matter and to the assessment objective. Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

Total number of items endorsed in Application 1

Number of items submitted each event	IA1	IA3	IA4
Total number of instruments	438	438	438
Percentage endorsed	57	39	15

Internal assessment 1 (IA1)

Problem-solving and modelling task

This problem-solving and modelling task must use subject matter from the Fundamental topic: Calculations and at least one of the following topics in Unit 3:

- Topic 1: Measurement
- Topic 2: Scales, plans and models
- Topic 3: Summarising and comparing data.

The problem-solving and modelling task is an assessment instrument where students provide a response to a mathematical investigative scenario or context. It requires students to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Students must provide a response to a specific task or issue that is set in a context that highlights a real-life application of mathematics. The task requires students to use relevant stimulus material involving the selected subject matter and must have sufficient scope to allow students to address all the stages of the problem-solving and modelling approach. Technology must be used.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	74
Authentication	28
Authenticity	64
Item construction	11
Scope and scale	43

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- tasks or issues that allowed students to use simple and complex subject matter from Unit 3 in their response
- realistic contexts that were accessible to students, e.g. constructing a scale plan of a designed garden, comparing student-collected data to census data
- an opportunity for unique student responses, e.g. providing students with individualised datasets and/or values, or asking students to design their own plan or model.

Practices to strengthen

It is recommended that assessment instruments:

- explicitly align to subject matter from the Fundamental topic and within Unit 3 Topics 1, 2 and/or 3
- correctly indicate which topic is being assessed on the cover sheet in the Endorsement application
- address a specific task or issue set in a real-world context
- avoid scaffolding that indicates to students how to solve the problem, e.g. 'measure the dimensions to calculate the perimeter and area of the garden, and the volume of soil required'
- focus on interpretation, analysis and evaluation of ideas and information rather than having research (to locate, gather, record and analyse information to develop understanding) as a focus, e.g. avoid students having to research the cost of various materials
- provide opportunity for students to develop a unique response, e.g. by providing different datasets to each student, or requiring students to develop their own design/model
- ensure checkpoints clearly reflect the school's assessment policy and indicate when and how teachers provide feedback on one draft
- do not mirror textbook or QCAA sample tasks.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	18
Language	14
Layout	3
Bias avoidance	4

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- scenarios or contexts that were directly related to the task
- tasks or issues that
  - were written in a straightforward manner and explicit about the nature of the problem
  - used appropriate language, diagrams and images
  - were free from grammatical, punctuation and spelling errors.

Practices to strengthen

It is recommended that assessment instruments:

- only include relevant information
- follow correct language conventions, and are free of punctuation, grammatical, spelling and typographical errors
- are viewed using Print Preview prior to uploading to ensure that the layout is clear and not distracting (e.g. avoiding misaligned text), and that items such as tables appear in their entirety on the page.

Internal assessment 3 (IA3)

Problem-solving and modelling task

This problem-solving and modelling task must use subject matter from the Fundamental topic: Calculations and at least one of the following topics in Unit 4:

- Topic 1: Bivariate graphs
- Topic 2: Probability and relative frequencies
- Topic 3: Loans and compound interest.

The problem-solving and modelling task is an assessment instrument where students provide a response to a mathematical investigative scenario or context. It requires students to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Students must provide a response to a specific task or issue that is set in a context that highlights a real-life application of mathematics. The task requires students to use relevant stimulus material involving the selected subject matter and must have sufficient scope to allow students to address all the stages of the problem-solving and modelling approach. Technology must be used.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	125
Authentication	59
Authenticity	123
Item construction	24
Scope and scale	34

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- tasks or issues that allowed students to use simple and complex subject matter from Unit 4 in their response
- realistic contexts that were accessible to students, e.g. creating a game of chance for a fundraiser, comparing investment options, using bivariate sporting data to predict a future result
- an opportunity for unique student responses, e.g. providing the students with individualised datasets and/or values, or a choice of investigative options.

Practices to strengthen

It is recommended that assessment instruments:

- explicitly align to subject matter from the Fundamental topic and within Unit 4 Topics 1, 2 and/or 3
- correctly indicate which topic is being assessed on the cover sheet in the Endorsement application
- address a specific task or issue set in a real-world context
- avoid scaffolding that indicates to students how to solve the problem, e.g. 'construct a scatterplot of the data and use technology to find the line of best fit and the correlation coefficient'
- focus on interpretation, analysis and evaluation of ideas and information rather than having research (to locate, gather, record and analyse information to develop understanding) as a focus, e.g. avoid students having to research different median house prices for a large range of suburbs
- provide opportunity for students to develop a unique response, e.g. by providing different datasets to each student, or requiring students to develop their own model or choose their investigation focus
- ensure checkpoints clearly reflect the school's assessment policy and indicate when and how teachers provide feedback on one draft
- do not mirror textbook or QCAA sample tasks.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	11
Language	22
Layout	4
Bias avoidance	8

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- scenarios or contexts that were directly related to the task
- tasks or issues that
  - were written in a straightforward manner and explicit about the nature of the problem
  - used appropriate language, diagrams and images
  - were free from grammatical, punctuation and spelling errors.

Practices to strengthen

It is recommended that assessment instruments:

- only include relevant information
- follow correct language conventions, and are free of punctuation, grammatical, spelling and typographical errors
- are viewed using Print Preview prior to uploading to ensure that the layout is clear and not distracting (e.g. avoiding misaligned text), and that items such as tables appear in their entirety on the page.

Internal assessment 4 (IA4)

Examination — short response

This assessment is a supervised examination in two parts: simple (Part A) and complex (Part B).

The examination assesses the application of a range of cognitions to a number of items, drawn from all Unit 4 topics. Student responses must be completed individually, under supervised conditions and in a set timeframe.

The examination representatively samples subject matter from all Unit 4 topics. Where relevant, the focus of this assessment should be on subject matter not assessed in the problem-solving and modelling task.

The percentage allocation of marks must match the degree of difficulty specifications: ~80% Simple familiar, ~10% Complex familiar, ~10% Complex unfamiliar.

Assessment design

Validity

Validity in assessment design considers the extent to which an assessment item accurately measures what it is intended to measure and that the evidence of student learning collected from an assessment can be legitimately used for the purpose specified in the syllabus.

Reasons for non-endorsement by priority of assessment — validity practices

Validity priority	Number of times priority was identified in decisions*
Alignment	257
Authentication	0
Authenticity	58
Item construction	49
Scope and scale	141

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- a representative sample of the subject matter in Unit 4, i.e. questions that assessed a selection of subject matter that accurately reflected the intended learning of all Unit 4 topics
- correct use of complex subject matter (identified in syllabus by '[complex]') for complex familiar and complex unfamiliar questions, and simple subject matter for simple familiar questions
- questions that explicitly provided opportunities to address all assessment objectives
- realistic contexts
- stimulus, where appropriate, that was relevant to the question and necessary in order to solve the problem
- an appropriate number of questions that allowed students to respond in the time conditions.

Practices to strengthen

It is recommended that assessment instruments:

- are explicitly aligned to the Unit 4 subject matter
- representatively sample subject matter across all three Unit 4 topics
- do not go beyond the syllabus scope and scale, e.g. the syllabus does not require students to 'determine the gradient of a line', 'use probability rules', 'calculate expected frequency' and 'calculate straight-line or diminishing-value depreciation'
- provide complex unfamiliar opportunities for students by
  - avoiding scaffolding, e.g. not splitting questions into parts that step students through the problem
  - removing diagrams and tables that simplify the nature of the problem
  - removing cues that indicate the procedure the student needs to undertake in order to complete the question
- provide opportunities for students to respond to assessment objective 4: 'evaluate the reasonableness of solutions'
- provide opportunities for students to respond to assessment objective 5: 'justify procedures and decisions by explaining mathematical reasoning'
- be of an appropriate length to allow students to respond in the time conditions
- are sufficiently different from textbook questions and QCAA sample questions to ensure students cannot rehearse responses.

Accessibility

Accessibility in assessment design ensures that no student or group of students is disadvantaged in their capacity to access an assessment.

Reasons for non-endorsement by priority of assessment — accessibility practices

Accessibility priority	Number of times priority was identified in decisions*
Transparency	24
Language	65
Layout	30
Bias avoidance	32

*Total number of submissions: 438. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- simple familiar questions where what was being asked was clearly identifiable
- the language of the assessment objectives, e.g. 'evaluate the reasonableness of ...' instead of 'discuss limitations of …'
- correct language conventions, such as correct spelling, grammar and punctuation
- correct mathematical notation and symbols
- limited use of bold and italics

- adequate response space for each question
- clear, relevant images where appropriate.

Practices to strengthen

It is recommended that assessment instruments:

- follow correct language conventions, and are free of punctuation, grammatical, spelling and typographical errors
- are reviewed using the Print Preview button prior to uploading to ensure that the layout is clear and not distracting (e.g. avoiding misaligned text), and that items such as tables appear in their entirety on the page
- contain correct mathematical notation
- are of appropriate scope and scale
- provide adequate space for students to respond to each question.

Common internal assessment (CIA): Internal assessment 2 (IA2)

The CIA is common to all schools and is developed by the QCAA. Schools are able to administer this assessment during the CIA phase chosen by the school in Unit 3 once it has been provided by the QCAA. It is administered flexibly under supervised conditions and is marked by the school according to a QCAA-developed common marking scheme. The CIA is not privileged over the school-developed summative assessment.

2020 COVID-19 adjustments
To support Queensland schools, teachers and students to manage learning and assessment during the evolving COVID-19 pandemic in 2020, the QCAA Board approved the administration of two CIA phases, instead of the originally scheduled four phases, for Applied (Essential) subjects.
Schools that did not administer the CIA1 in Term 1 implemented a CIA single phase in October.
Schools were able to administer the CIA at any time during the three-week phase.

Assessment design

Assessment description

The Essential Mathematics CIA assesses learning from Unit 3. The CIA has two parts: simple (Part A) and complex (Part B). The percentage allocation of marks matches the degree of difficulty specifications: ~80% Simple familiar, ~10% Complex familiar, ~10% Complex unfamiliar. Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment conditions

- Time: 60 minutes plus 5 minutes perusal
  - Part A: simple
  - Part B: complex
- Length: the number of short-response items should allow students to complete the responses in the set time.
- Short-response format, consisting of a number of items that ask students to respond to the following activities
  - calculating using algorithms
  - drawing, labelling or interpreting graphs, tables or diagrams
  - short items requiring single-word, term, sentence or short paragraph responses
  - justifying solutions using appropriate mathematical language where applicable
  - responding to seen or unseen stimulus materials
  - interpreting ideas and information.
- Other
  - only the QCAA formula sheet must be provided
  - notes are not permitted
  - use of technology is required.

Assessment objectives

This assessment was used to determine student achievement in the following assessment objectives

1. select, recall and use facts, rules, definitions and procedures drawn from all Unit 3 topics
2. comprehend mathematical concepts and techniques drawn from all Unit 3 topics
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from all Unit 3 topics.

Short response items (2020 single-phase CIA)

The 2020 single-phase CIA consisted of two parts:

- Part A — nine short response items (simple familiar, 40 marks)
- Part B — two short response items (complex familiar, 5 marks; complex unfamiliar 5 marks)

Item: Question 3 — Part A

Assessment objectives: 1, 2 and 3 — Simple familiar

The context of this question was chocolates being made by pouring liquid chocolate into a mould in the shape of a square-based pyramid.

Students were required to demonstrate knowledge and understanding of the following simple subject matter:

- Fundamental topic: Calculations
  - solve practical problems requiring basic number operations
  - apply arithmetic operations according to their correct order
  - ascertain the reasonableness of answers to arithmetic calculations
  - use a calculator for multi-step calculations
  - round up or round down numbers to the required number of decimal places
- Topic 1: Measurement
  - use metric units of volume (cubic millimetres, cubic centimetres, cubic metres), their abbreviations (mm^3, cm^3, m^3), conversions between them and appropriate choices of units
  - understand and use the relationship between volume and capacity, recognising that $1\ cm^3 = 1$ mL (millilitre), $1000\ cm^3 = 1$ L (litre), $1\ m^3 = 1$ kL (kilolitre), 1000 kL = 1 ML (megalitre)
  - calculate the volume and capacity of right pyramids, including square-based and rectangular-based pyramids, and spheres.

This question also illustrated the familiar nature of the simple familiar degree of difficulty. All of the information to solve the problem is identifiable, that is, the required procedure is clear from the way the problem is posed or is in a context that has been a focus of prior learning. Students are not required to interpret, clarify and analyse problems to develop responses.

Effective student responses:

- correctly substituted into an appropriate rule
- calculated volume in cubic centimetres
- converted cubic centimetres to millilitres
- converted litres to millilitres
- rounded down to calculate the number of moulds that can be filled from 1 L of liquid chocolate.

Item: Question 11 — Part B

Assessment objectives: 4 and 5 — Complex unfamiliar

The context of this question was the heights of a sample of pine trees growing in two plantations. Students were required to use statistical measures to evaluate a claim about comparative heights shown in a back-to-back stem plot.

This question required students to demonstrate knowledge and understanding of the following complex subject matter:

- Topic 3: Summarising and comparing data
  - investigate the suitability of measures of central tendency in various real-world contexts [complex]
  - calculate and interpret statistical measures of spread, such as the range, interquartile range and standard deviation [complex]
  - compare parallel box plots and back-to-back stem plots for different datasets [complex]

This question also illustrated the unfamiliar nature of the complex unfamiliar degree of difficulty. All the information to solve the problem is not immediately identifiable, that is, the required procedure is not clear from the way the problem is posed, and in a context in which students have had limited prior experience. Students interpret, clarify and analyse problems to develop responses.

Effective student responses:

- correctly determined a measure of central tendency for each plantation
- compared measures of central tendency to identify a larger measure for Plantation A compared to Plantation B
- correctly determined a measure of spread for each plantation
- compared measures of spread to identify a larger measure for Plantation A compared to Plantation B
- made a justified conclusion by linking reasoning to statistical measures.