General Mathematics General Senior Syllabus 2019 v1.2

Subject report 2020

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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 three to two in all General subjects. 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 instruments, confirmation of internal assessment marks and external assessment.

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 and marking of internal and external assessments
- information about the patterns of student achievement in each subject for the assessment cycle.

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

- identification of effective practices in the design and marking of valid, accessible and reliable assessments
- identification of areas for improvement and recommendations to enhance the design and marking of valid, accessible and reliable assessment instruments
- provision of tangible examples of best practice where relevant, possible and appropriate.

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, in making assessment decisions and in preparing students for external assessment.

The report is publicly available to promote transparency and accountability. Students, parents, community members and other education stakeholders can learn about the assessment practices and outcomes for General subjects (including alternative sequences and Senior External Examination subjects, where relevant) and General (Extension) subjects.

Report preparation

The report includes analyses of data and other information from the processes of endorsement, confirmation and external assessment, and advice from the chief confirmer, chief endorser and chief marker, developed in consultation with and support from QCAA subject matter experts.

Subject data summary

Subject enrolments

Number of schools offering the subject: 440.

Completion of units	Unit 1	Unit 2	Units 3 and 4*
Number of students completed	15 187	17 816	19 747

*Units 3 and 4 figure includes students who were not rated.

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory	Not rated
Unit 1	14 295	865	27
Unit 2	16 143	1649	24

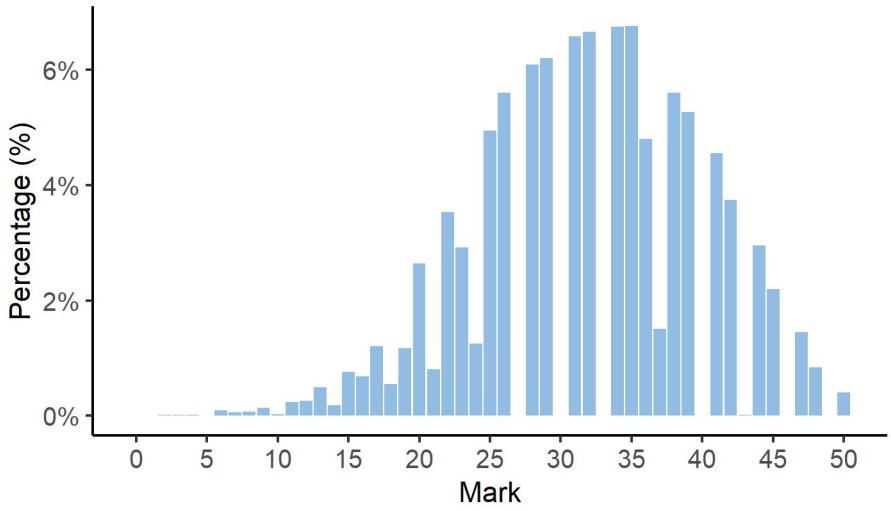
Units 3 and 4 internal assessment results

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 removal of one internal assessment for students completing Units 3 and 4 in General and Applied subjects.

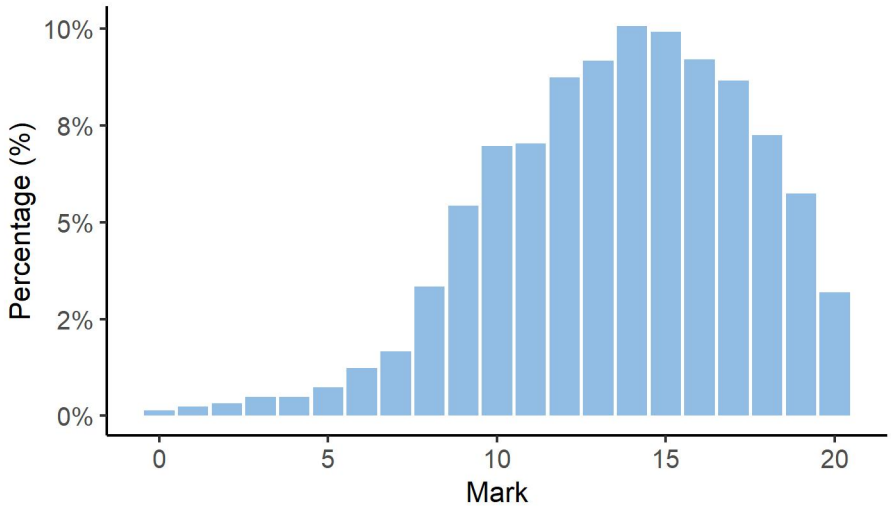
In General subjects, students completed two internal assessments and an external assessment. Schools made decisions based on QCAA advice and their school context. Therefore, across the state some instruments were completed by most schools, some completed by fewer schools and others completed by few or no schools. In the case of the latter, the data and information for these instruments has not been included.

Total results for internal assessment

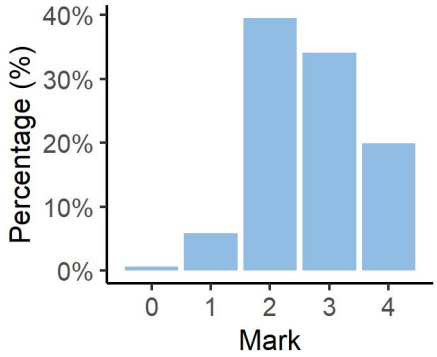


IA1 results

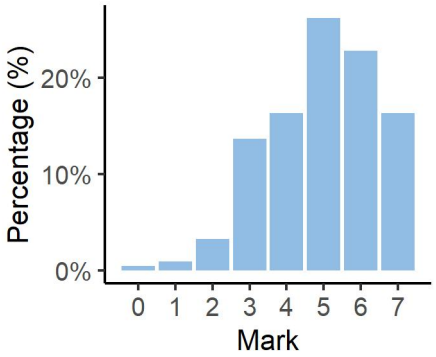
IA1 total



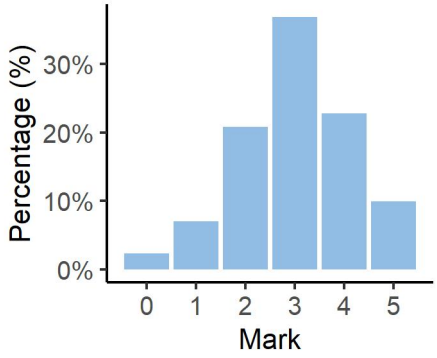
IA1 Criterion 1



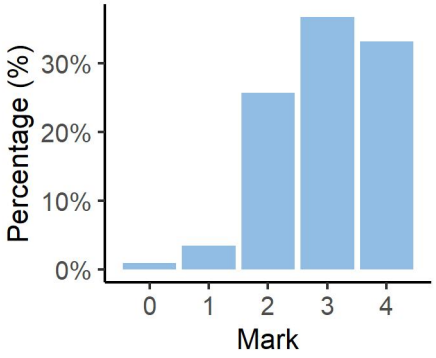
IA1 Criterion 2



IA1 Criterion 3

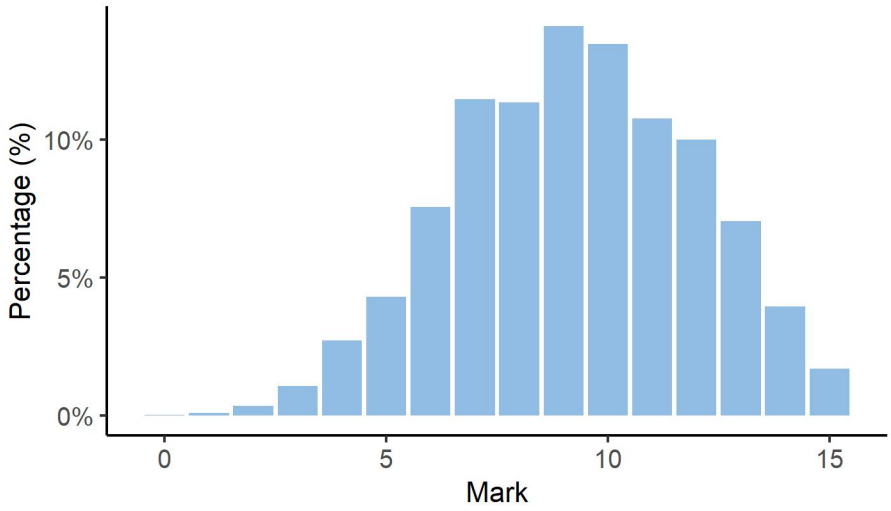


IA1 Criterion 4

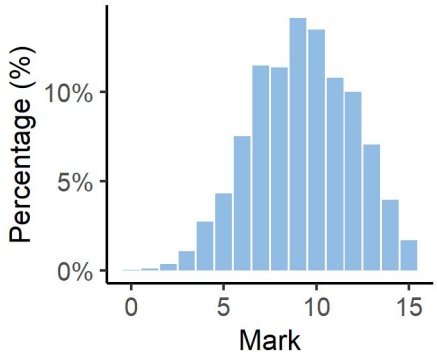


IA2 results

IA2 total

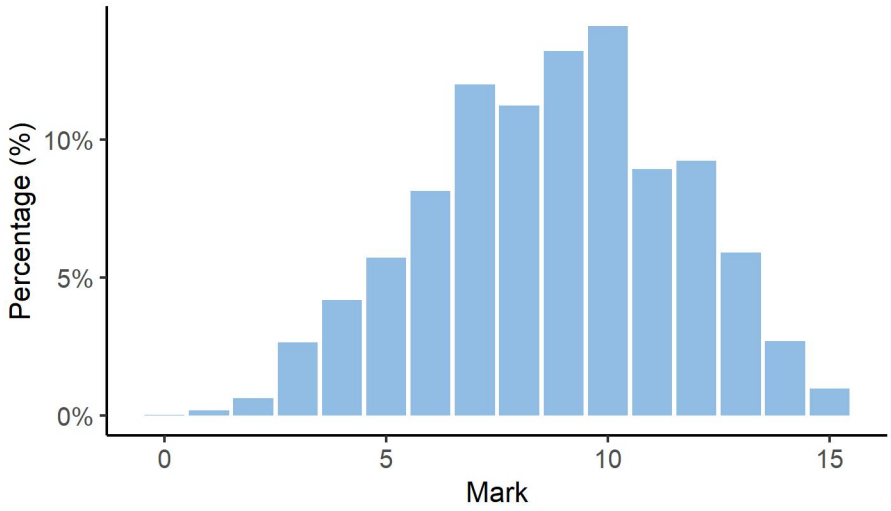


IA2 Criterion 1

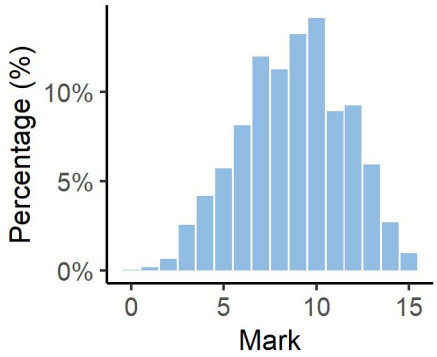


IA3 results

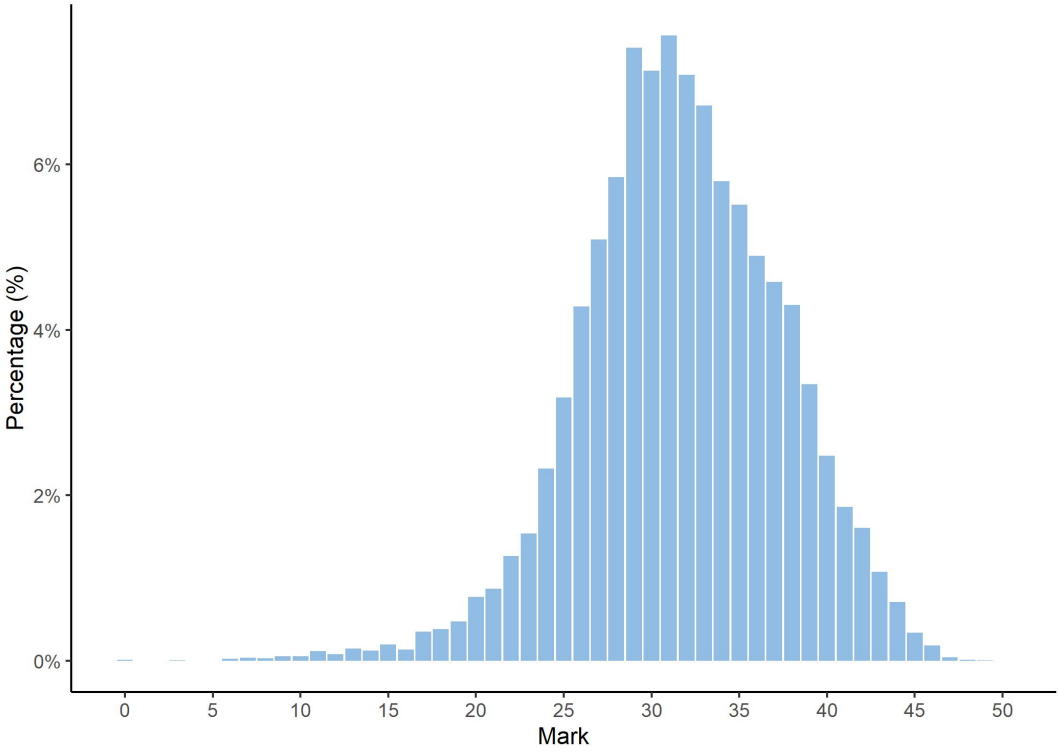
IA3 total



IA3 Criterion 1



External assessment results



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	2027	7970	8536	1000	9

Grade boundaries

The grade boundaries are determined using a process to compare results on a numeric scale to the reporting standards.

Standard	A	B	C	D	E
Marks achieved	100–80	79–64	63–44	43–18	17–0

Internal assessment

The following information and advice pertain to the assessment design and assessment decisions for each IA in Units 3 and 4. These instruments have undergone quality assurance processes informed by the attributes of quality assessment (validity, accessibility and reliability).

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	IA2	IA3
Total number of instruments	443	443	443
Percentage endorsed in Application 1	58	17	28

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. Teachers make judgments about the evidence in students' responses using the instrument-specific marking guide (ISMG) to indicate the alignment of students' work with performance-level descriptors and determine a mark for each criterion. These are provisional criterion marks. The QCAA makes the final decision about student results through the confirmation processes. Data presented in the assessment decisions section identifies the level of agreement between provisional and final results.

Number of samples reviewed at initial, supplementary and extraordinary review

IA	Number of schools	Number of samples requested	Supplementary samples requested	Extraordinary review	School review	Percentage agreement with provisional
1	440	3070	571	324	20	98.63
2	292	2299	0	0	0	99.72
3	155	1048	0	0	0	99.96

Internal assessment 1 (IA1)

Problem-solving and modelling task (20%)

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

- Topic 1: Bivariate data analysis
- Topic 2: Time series analysis
- Topic 3: Growth and decay in sequences.

A problem-solving and modelling task is an assessment instrument developed in 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	91
Authentication	25
Authenticity	36
Item construction	19
Scope and scale	47

*Total number of submissions: 443. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- relevant and useful stimulus material
- clear instructions to students about the requirements of the task, including identification of the topic/s being assessed
- opportunity for students to develop a unique response by providing an open-ended task such that students made choices about how to use the data, what model to develop and what concepts and techniques were relevant to investigate a relationship and/or solve the problem

- realistic contexts that were accessible and relevant to students, e.g. correlation between height and dominant hand reaction time, environmental sustainability issues such as pollution levels, sales figures over a one-month period compared to previous years.

Practices to strengthen

It is recommended that assessment instruments:

- focus on subject matter within Unit 3 Topics 1, 2 and/or 3 and not subject matter outside the scope of the syllabus
- avoid scaffolding or task instructions that indicate to students how to solve the problem (such as 'draw a scatter plot, determine a least-squares line and then complete a residual analysis …') as this interferes with students' ability to demonstrate their knowledge and understanding of the relevant criteria and to provide a unique, authentic response
- primarily focus on interpretation, analysis and evaluation of ideas and information rather than research (locate, gather, record and analyse information to develop understanding) as a focus
- include checkpoints that reflect the school's assessment policy and clearly indicate when and how teachers provide feedback on one draft
- are sufficiently different to textbook practice assessments and QCAA sample assessment instruments so as not to compromise the authenticity of student 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	21
Language	27
Layout	8
Bias avoidance	12

*Total number of submissions: 443. Each priority might contain up to four assessment practices.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that featured:

- a scenario or context that was directly related to the task and accessible to students, e.g. correlation between height and hand span, environmental sustainability issues such as carbon dioxide levels, number of goals in a season compared to previous years
- a specific task or issue that
  - was written in a straightforward manner and explicit about the nature of the problem
  - used appropriate language, diagrams and images
- text that was free from punctuation, grammatical, spelling and typographical errors.

Practices to strengthen

It is recommended that assessment instruments:

- only include information relevant to the problem-solving and modelling task to ensure students focus on what is required and are not distracted by extraneous material
- are viewed using the Print Preview button prior to submission 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.

Additional advice

It is recommended that schools develop their own solutions for problem-solving and modelling tasks prior to endorsement. This does not require writing a full report, but rather, considering what an expected response would demonstrate for all criteria. The advantages of this include:

- ensuring that the task allows students to address all criteria at all performance levels within syllabus conditions
- fuller awareness of strategies to assist students to manage response length, e.g. including an example of calculations in the response but recording repeated calculations and/or spreadsheet data in an appendix
- promoting intra- and inter-marker reliability.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Formulate	96.99	2.93	0.07
2	Solve	98.82	0.87	0.31
3	Evaluate and verify	99.26	0.57	0.17
4	Communicate	99.43	0.08	0.49

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- making judgments about ‘accurate translation of all aspects of the problem …’ vs ‘translation of simple aspects of the problem …’
- making judgments within the upper and middle performance levels of the Solve criterion
  - Responses that unambiguously demonstrated ‘discerning application of mathematical concepts and techniques relevant to the task’ made thoughtful and astute choices as to which concepts and techniques to apply in order to enhance the solution. There was clear evidence in the student work of a discriminating selection of the mathematical methods used and that each technique demonstrated was used to add value to the solution.

- Responses that demonstrated ‘accurate use of complex procedures to reach a valid solution’ attained a valid solution using methods made up of multiple elements and/or interconnected parts.

- making judgments within all the performance levels of the Communication criterion
  - High-level responses adhered to appropriate mathematical, statistical and everyday language conventions and there was evidence of a structured, coherent and organised response that was able to be read and interpreted independently of the instrument task sheet. Student responses were annotated to show the evidence schools used to make decisions.

Samples of effective practices

The following excerpts are from responses that illustrate the characteristics for the criterion at the performance level indicated. The samples may provide evidence for more than one criterion. The characteristics highlighted may not be the only time the characteristics have occurred throughout the response.

Formulate (3–4 marks)
This response demonstrates:
- documentation of appropriate assumptions
- accurate documentation of relevant observations

Observations/ considerations

One observation that was made is that there is a total of 25 rounds, and four weeks of finals. For the purposes of this report, only 24 games worth of data was collected, excluding the finals and one week for a bye. This means there will only be 24 bivariate data sets per season. This is relevant to the model because it is undetermined whether this sample size will be an accurate representation of the population of football games played by the Rabbitohs. It is also considered that every game played is drastically different from the next. Many unpredictable factors can have an influence on how well the Rabbitohs achieve each game. This affects the model because it lessens the reliability of the data obtained. The data collected for this study was retrieved from the official website for the National Rugby League (NRL Australia. 2019). One final consideration is that the data retrieved is based on only the Rabbitohs playing. No other teams line breaks and points scored was observed. This is because it is not assumed that what is true for other teams, is true for the Rabbitohs as well. Therefore, by only considering the singular teams' data, the application of the results is more reliable.

Assumptions

One assumption that was made is that all the data collected is accurate. Another assumption is that extraneous game factors, such as crowd sizes, the weather and the opposition team, does not have a major effect on the line breaks or points scored by the Rabbitohs per game. This is relevant to the model because if it did have a major effect, the data would be far less reliable as these factors may affect either the response or the explanatory variable's correlation differently each game. Another assumption is that there are no outliers in the data collected, therefore all data points can be included in the scatterplot. One final assumption is that the relationship between line breaks per game and points scored per game is a linear relationship. This is relevant because in order to use this data to implement it into future team playing tactics by using the regression line to predict further data, or to use the value of the correlation coefficient, the association must be linear.

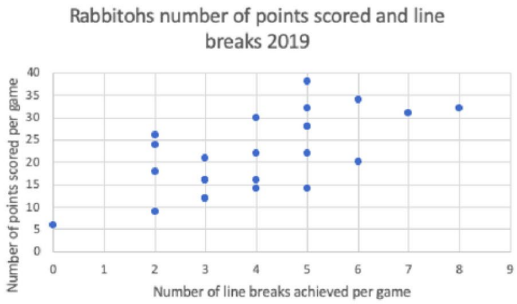


Figure 1

Upon viewing the graph, it can be noted that there is a possible positive weak linear relationship.

Evaluate and verify (4–5 marks)

This response demonstrates:

- evaluation of the reasonableness of solutions by considering the results, assumptions and observations
- documentation of relevant strengths and limitations of the solution and/or model

EVALUATE AND VERIFY

STRENGTHS AND LIMITATIONS

The following strengths were observed:

- One strength is that the r value that was found was a strong-moderate correlation. This is means that it can be used in order to improve team tactics, which is mathematically proven to lead to a higher amount of points scored per game.

The following limitations were observed:

- There was a limited amount of data points that were used as a sample. This means the findings were less reliable as it may not be an accurate representation of all rugby games.
- Another limitation is that when using extrapolation with regards to the regression line, it may not be accurate to predict further outcomes because the prediction is outside the sample data range.
- One final limitation is that the R^2 value found is not considerably strong, therefore a smaller percentage of the points scored per game can be attributed to the line breaks achieved per game, decreasing the reliability of the study.

REASONABLENESS OF THE SOLUTION

It was found upon assessing the data's findings, the correlation was only found to be strong-moderate. To ensure that a linear graph was an accurate method of presenting the data, a residual plot was used.

Using a residual plot by calculating and plotting residual values is a more dependable way of confirming the linearity of the data points. The residual plot was formed using the spreadsheet program Excel and is presented in *Figure 3*.

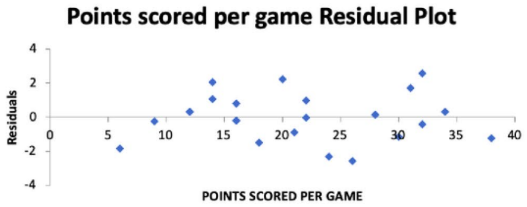


Figure 3

Each data point plotted is either a positive or negative value, showing how far away the point is from the average that was predicted through the line of regression. Relating to this case, the residual values will constitute the number of line breaks achieved per game as above or below the number predicted by the regression line. The residual plot shows an even distribution of data above and below the horizontal axis. Because the data is evenly spread and there is no unlinear trend present, the assumption that the data is linear is to be accepted as correct.

Given the assumptions, observations and results, this solution obtained is to be considered relatively reasonable. The r value showed that there was a strong-moderate positive linear relationship between points scored and line breaks achieved per game by the Rabbitohs. However, the R^2 value showed that only 42.68% of the points scored was due to a higher number of line breaks. There may be many extraneous factors that can also affect the number of points scored in a game.

To further test the correlation between number of points scored and number of line breaks, a revised model was created. This model includes data from 2019, 2018 and 2017 seasons of the Telstra Premiership. It is believed that by including a larger sample size, the reliability of this investigation will increase, therefore increasing the reasonableness of the solution. Figure 4 shows the number of points scored per game against the number of line breaks achieved per game over three seasons. There are approximately 24 rounds included per season, excluding finals rounds.

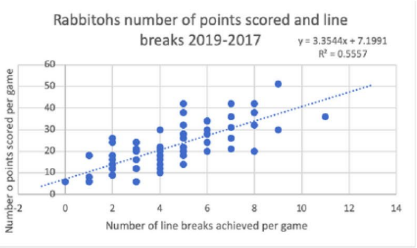


Figure 4

	Figure 4 appears to have a higher correlation upon viewing it. The data is shown to have a number of lower residuals, that are closer to the regression line. The r value for this data is r =0.74544386. This appears to be a stronger correlation than the data that just includes the statistics from 2019. This shows that there is a strong correlation between the number of points scored and the number of line breaks achieved. It is more reliable because it is based on a larger sample size. The R^2 value is $R^2 = 0.55$, which means that, as a percentage, 55 % of the points scored can be explained by the number of line breaks achieved per game. As compared to the 0.4268 R^2 value for the first model, it is a suitable amount larger. Because the graph presenting three seasons worth of data is considered more reliable, it will be used when presented to the Rabbitohs.

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- within the Formulate criterion, the definitions from the syllabus glossary are used to distinguish between the terms 'documentation' and 'statement' when applied to assumptions and observations
  - Responses that unambiguously demonstrated 'documentation of appropriate assumptions' included assumptions related to the model and evidence to support the assumptions, e.g. explanation of the likely effect of important assumptions and how this was considered in the model/solution, or the impact of not making the assumption.
  - Responses that unambiguously demonstrated 'accurate documentation of relevant observations' provided evidence to support observations (information/data) used in a student's model/solution, e.g. explaining how the observations were collected, the source of the observations, what made the observations valid and reliable, or identifying a specific feature of an observation that made it relevant to the model/solution.
- within the Evaluate and verify criterion, judgments align to the performance-level descriptors and their associated characteristics, as described below
  - evaluation of the reasonableness of solutions by considering the results, assumptions and observations
    - To demonstrate these characteristics, it was necessary for students to show that they had considered the results, assumptions and observations to appraise and justify their solutions. Any assumptions and observations introduced throughout the report could be used while evaluating the reasonableness of solutions.
    - The format of the evaluation varied depending on the situation but could include the use of technology to verify solutions or the use of both mathematical and everyday language to justify solutions.
  - documentation of relevant strengths and limitations of the solution and/or model
    - A strength is an aspect or feature of the solution and/or model that makes it useful. A limitation is an aspect or feature of the solution and/or model that limits its usefulness; a weakness. Limitations are often direct consequences of assumptions (making less restrictive assumptions gives opportunities for refinement).
    - For 'documentation' to be awarded, there needed to be evidence in the student work of why elements of their solution and/or model were strengths or limitations.

- Responses that unambiguously demonstrated these characteristics considered whether the solution and/or model fulfilled its intended purpose, how it compared to the real world, its generalisability and overall utility, and/or any caveats or conditions where the solution and/or model was no longer useful.

Additional advice

It is recommended that teachers use and annotate the correct QCAA-formatted ISMG downloaded from the QCAA Portal by clearly highlighting or underlining relevant characteristics and indicating the subsequent mark allocation.

Internal assessment 2 (IA2)

Examination — short response (15%)

The examination assesses the application of a range of cognitions to a number of items using a representative sample of subject matter from all Unit 3 topics. Where relevant, this assessment should focus on subject matter not assessed in the problem-solving and modelling task. Subject matter from Units 1 and 2 is considered assumed knowledge. Student responses must be completed individually, under supervised conditions, and in a set timeframe (120 minutes plus 5 minutes perusal). The percentage allocation of marks must match the degree of difficulty specifications: ~20% Complex unfamiliar, ~20% Complex familiar, ~60% Simple familiar.

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	214
Authentication	0
Authenticity	169
Item construction	28
Scope and scale	79

*Total number of submissions: 443. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- questions that assessed a selection of subject matter that accurately reflected the intended learning of all topics in Unit 3
- questions that explicitly provided opportunities to address all assessment objectives
- stimulus, where used, that was relevant to the question and necessary to solve the problem
- an appropriate number of questions that matched the degree of difficulty specifications in the syllabus and allowed students to respond within the time conditions
- a correct marking scheme that indicated clearly how marks would be allocated; this assists schools to check the scope and scale of the assessment and promotes consistency in the awarding of marks
- QCAA approval for any amendment to an endorsed instrument to uphold the integrity of school-based assessment practices.

Practices to strengthen

It is recommended that assessment instruments:

- require students to demonstrate knowledge and understanding of Unit 3 subject matter and do not include questions that solely assess subject matter from Units 1 and/or 2, e.g. a question on the analysis of univariate data
- assess subject matter within the scope and scale of the syllabus, e.g. the syllabus does not require students to 'calculate the sum of an arithmetic sequence or sum of a geometric sequence using rehearsed formulae'
- provide complex unfamiliar opportunities such that relationships and interactions have a number of elements, and all the information to solve the problem is not immediately identifiable, e.g. avoiding scaffolding by not providing a series of parts that step through a problem, cues that indicate the procedure to use, or diagrams or graphs that simplify the nature of the problem
- 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'
- are designed to ensure that solutions can be obtained under the conditions of the examination, e.g. a question requiring the application of a spreadsheet program must specify use of technology beyond a scientific calculator
- are sufficiently different to textbook questions and QCAA sample questions to ensure responses are authentic and not rehearsed.

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	13
Language	70
Layout	31
Bias avoidance	40

*Total number of submissions: 443. 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 ...' rather than 'discuss limitations of …'
- correct language conventions, and were free of punctuation, grammatical, spelling and typographical errors
- 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:

- contain correct mathematical notation, e.g. use R^2 or $R\text{^}2$ instead of $R2$
- are reviewed using the Print Preview button, prior to submission, 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.

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Foundational knowledge and problem-solving	99.72	0.28	0

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- there was clear alignment between a school's submitted marking scheme and the awarded marks, which was most effective where schools provided marking schemes that detailed where marks were awarded
- annotations were used by teachers within the response to indicate where marks were awarded
- schools recorded on the ISMG the total possible and awarded marks for the examination and the calculated percentage
- the 'greater than x%' cut-offs were correctly applied to the percentage calculations to determine accurate provisional marks, for example:
  - results are not to be rounded to the nearest percentage before applying the ISMG
  - a student who receives > 80% is allocated 13/15, whereas a student who receives 80% (exactly) is allocated 12/15
- only the percentage cut-offs in the ISMG were used to determine the mark out of 15, not the performance-level descriptors. The performance-level descriptors are not used to directly make a judgment or allocate a mark. As the percentage allocation of marks in endorsed examinations must match the degree of difficulty specifications (~20% Complex unfamiliar, ~20% Complex familiar, ~60% Simple familiar), a student who is allocated 14 marks, for example, meets the performance-level descriptor for that performance level.

Samples of effective practices

The following example illustrates appropriate application of the percentage cut-off ISMG to determine the correct mark allocation.

Foundational knowledge and problem-solving

This example shows an annotated ISMG that clearly indicates the response was awarded 60 marks out of a possible 75 marks. This equates to 80% (exactly) and the response is therefore allocated 12 marks.

Instrument-specific marking guide (IA2): Examination (15%)

Criterion: Foundational knowledge and problem-solving

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

$\frac{60}{75} = 80\%$

The student work has the following characteristics:	Cut-off	Marks
• consistently correct selection, recall and use of facts, rules, definitions and procedures; authoritative and accurate command of mathematical concepts and techniques; astute evaluation of the reasonableness of solutions and use of mathematical reasoning to correctly justify procedures and decisions; and fluent application of mathematical concepts and techniques to solve problems in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations.	> 93%	15
	> 87%	14
• correct selection, recall and use of facts, rules, definitions and procedures; comprehension and clear communication of mathematical concepts and techniques; considered evaluation of the reasonableness of solutions and use of mathematical reasoning to justify procedures and decisions; and proficient application of mathematical concepts and techniques to solve problems in simple familiar, complex familiar and complex unfamiliar situations.	> 80%	13
	> 73%	12
• thorough selection, recall and use of facts, rules, definitions and procedures; comprehension and communication of mathematical concepts and techniques; evaluation of the reasonableness of solutions and use of mathematical reasoning to justify procedures and decisions; and	> 67%	11

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- schools update marking schemes for an endorsed instrument to correctly allocate marks to student responses when it is necessary to correct errors in questions or sample responses, change mark allocations and/or accept alternative solutions. The communication of these changes in a timely manner to the QCAA, either through the amendment process or at the time of confirmation submission, is required to assist confirmers to make appropriate decisions during the confirmation process
- the correct marking scheme is used and submitted for a comparable assessment
- schools use internal practices to quality assure judgments and check mark totals, percentage calculations and correct application of the percentage cut-off ISMG.

Internal assessment 3 (IA3)

Examination — short response (15%)

The examination assesses the application of a range of cognitions to a number of items using a representative sample of subject matter from all Unit 4 topics. Subject matter from Units 1, 2 and 3 is considered assumed knowledge. Student responses must be completed individually, under supervised conditions, and in a set timeframe (120 minutes plus 5 minutes perusal). The percentage allocation of marks must match the degree of difficulty specifications: ~20% Complex unfamiliar, ~20% Complex familiar, ~60% Simple familiar.

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	250
Authentication	0
Authenticity	39
Item construction	19
Scope and scale	72

*Total number of submissions: 443. Each priority might contain up to four assessment practices.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that featured:

- questions that assessed a selection of subject matter that accurately reflected the intended learning of all topics in Unit 4
- questions that explicitly provided opportunities to address all assessment objectives
- realistic contexts where appropriate
- stimulus, where used, that was relevant to the question and necessary to solve the problem
- an appropriate number of questions that matched the degree of difficulty specifications in the syllabus and allowed students to respond within the time conditions
- a correct marking scheme that indicated clearly how marks would be allocated; this assists schools to check the scope and scale of the assessment and promotes consistency in the allocation of marks
- QCAA approval for any amendment to an endorsed instrument to uphold the integrity of school-based assessment practices.

Practices to strengthen

It is recommended that assessment instruments:

- are explicitly aligned to the subject matter from Unit 4 and do not include questions that solely assess subject matter from Units 1, 2 and/or 3, e.g. a question on the generation of the terms of a geometric sequence
- provide complex unfamiliar opportunities such that relationships and interactions have a number of elements, and all the information to solve the problem is not immediately identifiable, e.g. avoiding scaffolding by not providing a series of parts that step through a problem, cues that indicate the procedure to use, or diagrams or graphs that simplify the nature of the problem
- 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'
- are designed such that solutions can be obtained under the conditions of the examination, e.g. a question requiring the application of a spreadsheet program must specify use of technology beyond a scientific calculator
- are sufficiently different to QCAA sample questions, textbook questions and practice assessments to ensure responses are authentic and not rehearsed.

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	30
Language	64
Layout	26
Bias avoidance	23

*Total number of submissions: 443. 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 ...' rather than 'explain the associated effect of this assumption …'
- questions that did not reference specialised language or non-accessible contexts
- correct language conventions, and were free of punctuation, grammatical, spelling and typographical errors
- 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:

- contain correct mathematical notation, e.g. use of A_{n+1} and not $An + 1$
- are reviewed using the Print Preview button, prior to submission, 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

Assessment decisions

Reliability

Reliability is a judgment about the measurements of assessment. It refers to the extent to which the results of assessments are consistent, replicable and free from error.

Agreement trends between provisional and final results

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional
1	Foundational knowledge and problem-solving	99.96	0.02	0.02

Effective practices

Accuracy and consistency of the application of the ISMG for this IA was most effective when:

- there was clear alignment between a school's submitted marking scheme and the awarded marks, which was most effective where schools provided marking schemes that detailed where marks were awarded
- annotations were used by teachers within the response to indicate where marks were awarded
- schools recorded on the ISMG the total possible and awarded marks for the examination and the calculated percentage
- the 'greater than x%' cut-offs were correctly applied to the percentage calculations to determine accurate provisional marks, for example
  - results are not to be rounded to the nearest percentage before applying the ISMG
  - a student who receives > 80% is allocated 13/15, whereas a student who receives 80% (exactly) is allocated 12/15
- only the percentage cut-offs in the ISMG were used to determine the mark out of 15, not the performance-level descriptors. The performance-level descriptors are not used to directly make a judgment or allocate a mark. As the percentage allocation of marks in endorsed examinations must match the degree of difficulty specifications (~20% Complex unfamiliar, ~20% Complex familiar, ~60% Simple familiar), a student who is allocated 14 marks, for example, meets the performance-level descriptor for that performance level.

Samples of effective practices

The following example illustrates appropriate application of the percentage cut-off ISMG to determine the correct mark allocation.

Foundational knowledge and problem-solving

This example shows an annotated ISMG that clearly indicates the response was awarded 74.5 marks out of a possible 80 marks. This equates to 93.1% and the response is therefore allocated 15 marks. The calculated percentage is not rounded to the nearest whole number when using the ISMG.

Instrument-specific marking guide (IA2): Examination (15%)

Criterion: Foundational knowledge and problem-solving

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

$\frac{74\frac{1}{2}}{80} = 93.1\%$

The student work has the following characteristics:	Cut-off	Marks
• consistently correct selection, recall and use of facts, rules, definitions and procedures; authoritative and accurate command of mathematical concepts and techniques; astute evaluation of the reasonableness of solutions and use of mathematical reasoning to correctly justify procedures and decisions; and fluent application of mathematical concepts and techniques to solve problems in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations.	> 93%	15
	> 87%	14

Practices to strengthen

To further ensure accuracy and consistency of the application of the ISMG in this IA, it is recommended that:

- schools update marking schemes for an endorsed instrument to correctly award marks to student responses when it is necessary to correct errors in questions or sample responses, change mark allocations and/or accept alternative solutions. The communication of these changes in a timely manner to the QCAA, either through the amendment process or at the time of confirmation submission, is required to assist confirmers to make appropriate decisions during the confirmation process
- the correct marking scheme is used and submitted for a comparable assessment
- schools use internal practices to quality assure judgments and check mark totals, percentage calculations and correct application of the percentage cut-off ISMG.

External assessment

Examination (50%)

Assessment design

Assessment specifications and conditions

Summative external assessment is developed and marked by the QCAA. In General Mathematics it contributes 50% to a student's overall subject result. Summative external assessment assesses learning from Units 3 and 4. Subject matter from Units 1 and 2 is assumed knowledge and may be drawn on, as applicable, in the development of the examination. The external assessment in General Mathematics is common to all schools and administered under the same conditions, at the same time, on the same day.

Conditions

- Time
  - Paper 1 (30%): 90 minutes plus 5 minutes perusal
  - Paper 2 (20%): 90 minutes plus 5 minutes perusal
- Length: the number of short response items should allow students to complete the response 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 multiple choice, single-word, term, sentence or short-paragraph responses
  - justifying solutions using appropriate mathematical language where applicable
  - responding to unseen stimulus materials
  - interpreting ideas and information.
- Other
  - the QCAA formula sheet will be provided for both papers
  - notes are not permitted
  - access to a handheld QCAA-approved scientific calculator is required for Papers 1 and 2 (no other form of technology is permitted).

The assessment instrument consisted of two papers. Paper 1 Section 1 was 15 multiple choice questions; Paper 1 Section 2 was 11 short response questions; and Paper 2 Section 1 was 7 short response questions. Questions were derived from the context of the application of a range of cognitions to a number of items, drawn from Units 3 and 4. Student responses must be completed individually, under supervised conditions, and in a set timeframe. 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 Units 3 and 4

2. comprehend mathematical concepts and techniques drawn from Units 3 and 4
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decision by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from Units 3 and 4.

Assessment decisions

Overall, students responded well to the following assessment aspects:

- Assessment objectives 1, 2 and 3
- Paper 1 — Simple familiar degree of difficulty (consisting of multiple choice and short response items).

Effective practices

The following samples were selected to illustrate highly effective student responses in some of the assessment objectives of the syllabus.

Multiple choice item response

Item: Question 14 — Paper 1

Assessment objectives: 1 and 2 — Simple familiar

This question required students to use a two-way frequency table to determine the associated percentages.

This question highlights the validity arguments of the distractors when designing multiple choice items for possible student responses. The correct answer is the key.

Validity arguments for the options:

(A) The raw data of 12 was stated as a percentage (i.e. 12%) for a two-way frequency table instead of a frequency table with appropriate percentages.

(B) The calculation of 15% (i.e.12/80 × 100%) was used.

(C) The key is 20% (i.e.12/60 × 100%).

(D) The calculation of 40% (i.e.12/30 × 100%) was used.

Foundational knowledge and problem-solving	**QUESTION 14** A sample of university staff and students was asked whether they preferred catching public transport or driving their own car to university. The data collected is shown in the table. **Public transport** | **Drive own car** **Staff** | 2 | 18 **Students** | 48 | 12 What percentage of university students prefer to drive their own car? (A) 12% (B) 15% (C) 20% (D) 40%

Short response

Item: Question 18 — Paper 1

Assessment objective: 1, 2 and 3 — Simple familiar

This question required students to use arithmetic sequences to model and analyse practical situations involving linear growth.

Effective student responses:

- provided mathematical reasoning to support the answer
- determined the common difference
- substituted into an appropriate rule
- determined an appropriate value.

Student sample of effective response

This excerpt has been included to demonstrate:

- the correct use of an arithmetic sequence to model the given context
- translating the sixth day to meaning substitute $n = 6$ into the rule.

Foundational knowledge and problem-solving	**QUESTION 18 (4 marks)** Exhibition organisers believe that the number of attendees increases each day as an arithmetic sequence. The organisers know that 353 people attended the first day and 439 people attended the third day. a) Determine the common difference. *[2 marks]* $t_n = t_1 + (n-1)d$ $439 = 353 + (3-1)d$ $-353 \quad -353$ $439 = 353 + (2)d$ $\frac{86}{2} = \frac{2d}{2}$ $43 = d$ ∴ The common difference is 43 b) Use the result from 18a) to predict the number of people who will attend the sixth day. *[2 marks]* $t_n = t_1 + (n-1)d$ $t_6 = 353 + (6-1)43$ $t_6 = 353 + (5)43$ $t_6 = 353 + 215$ $t_6 = 568$ ∴ The predicted number of people who will attend the sixth day is 568

Item: Question 24 — Paper 1

Assessment objective: 1, 2, 3 and 4 — Simple familiar

This question required students to distinguish between interpolation and extrapolation when using the fitted line to make predictions, recognising the potential dangers of extrapolation.

Effective student responses:

- estimated the correct value including units
- classified the prediction as interpolation
- commented that the least-squares line supported the statement
- identified potential danger/s of extrapolation.

Student sample of effective response

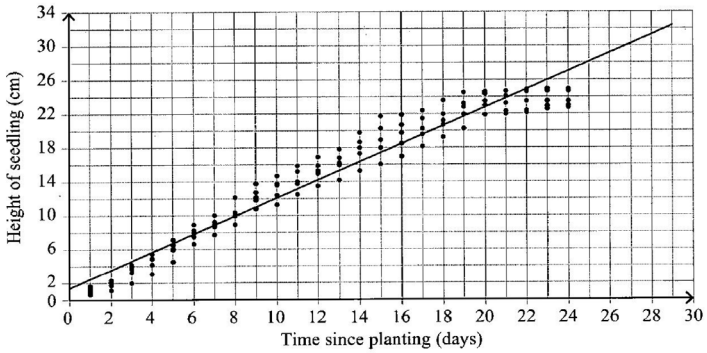
This excerpt has been included to demonstrate:

- accurate estimating skills in reading off a graph
- evaluating the reasonableness of solutions based on certain statements/claims made.

Foundational knowledge and problem-solving

QUESTION 24 (4 marks)

The following data for the height of five seedlings was collected and the least-squares line was developed and graphed.



a) Use the least-squares line to estimate the height of a nine-day-old seedling. *[1 mark]*

A nine-day-old seedling will be approximately 11cm tall.

b) Classify the prediction for 24a) as either interpolation or extrapolation. *[1 mark]*

The prediction for 24a) is interpolation, as the prediction is within the given data set.

c) Based on the graph, the following statement was made:
'A seedling will reach a height of about 32 cm by day 29.'
Comment on the reasonableness and the possible dangers of this statement. *[2 marks]*

This statement is correct based on the least-squares line, but is not a reliable prediction as it is extrapolating, and is therefore outside of the given data set, making the prediction less reliable. The prediction also does not take into account any real-world factors, like weather conditions, type of plant, etc.

Item: Question 4 — Paper 2

Assessment objective: 1, 2 and 3 — Complex familiar

This question required students to calculate seasonal indices using the average percentage method and construct a time series plot by deseasonalising the data.

Effective student responses:

- determined the yearly averages
- calculated the $\frac{\text{profit}}{\text{yearly average}}$ values
- determined the seasonal indices
- calculated the deseasonalised values
- plotted the deseasonalised data on provided graph.

Student sample of effective response

This excerpt has been included to demonstrate:

- understanding the differences between the concepts of yearly averages and $\frac{\text{profit}}{\text{yearly average}}$ values
- recognising that to 'deseasonalise the data' does not mean to calculate the seasonal indices only.

Foundational knowledge and problem-solving

QUESTION 4 (5 marks)

The following data shows the profits per quarter for a company for the last two years.

	Quarter	Profit ($'000s)
2018	1	64
	2	98
	3	116
	4	122
2019	1	87
	2	156
	3	180
	4	177

Deseasonalise the data and plot this on the same set of axes as the original data in the graph on the next page.

2018:

Average Profit ($'000s) $= \frac{64+98+116+122}{4}$

$= 100$

Seasonal Index per Quarter:

$Q_1 = \frac{64}{100} = 0.64$ $\quad Q_2 = \frac{98}{100} = 0.98$ $\quad Q_3 = \frac{116}{100} = 1.16$ $\quad Q_4 = \frac{122}{100} = 1.22$ $\quad$ Sum = 4

2019: Average Profit ($'000s) $= \frac{87+156+180+177}{4}$

$= 150$

Seasonal Index per Quarter:

$Q_1 = \frac{87}{150}$ $Q_2 = \frac{156}{150}$ $Q_3 = \frac{180}{150}$ $Q_4 = \frac{177}{150}$

$= 0.58$ $= 1.04$ $= 1.2$ $= 1.18$ Sum = 4

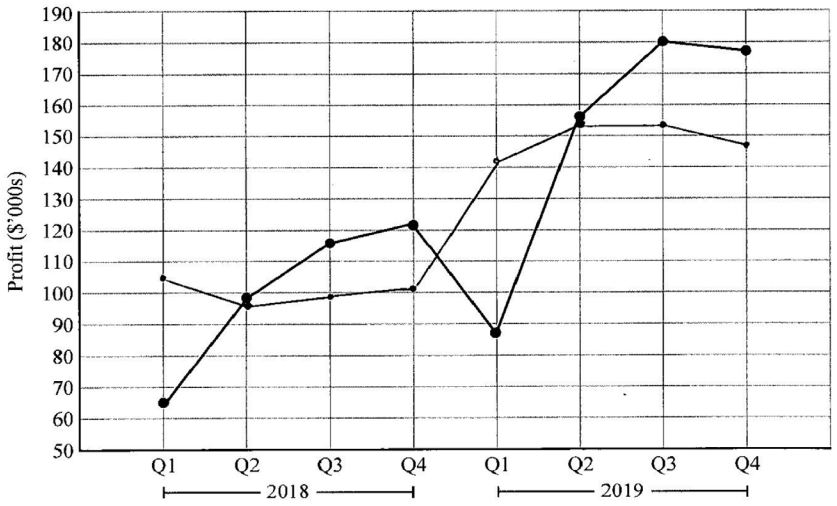
Average Seasonal Index per Quarter:

$Q_1 = \frac{0.64+0.58}{2}$ $Q_2 = \frac{0.98+1.04}{2}$ $Q_3 = \frac{1.16+1.2}{2}$ $Q_4 = \frac{1.22+1.18}{2}$

$= 0.61$ $= 1.01$ $= 1.18$ $= 1.2$ Sum=4

Deseasonalised value = $\frac{\text{actual value}}{\text{seasonal index}}$ and is plotted on the graph below:

see page 12 for calculations



Question 4 Deseasonalised Values

2017:

$Q_1 = \frac{64}{0.61}$ $Q_2 = \frac{98}{1.01}$ $Q_3 = \frac{116}{1.18}$ $Q_4 = \frac{122}{1.2}$

$= 104.92$ $= 97.03$ $= 98.31$ $= 101.67$

2018:

$Q_1 = \frac{87}{0.61}$ $Q_2 = \frac{156}{1.01}$ $Q_3 = \frac{180}{1.18}$ $Q_4 = \frac{177}{1.2}$

$= 142.62$ $= 154.46$ $= 152.54$ $= 147.5$

Item: Question 5 — Paper 2

Assessment objective: 1, 2, 3, 5 and 6 — Complex familiar

This question required students to use a bipartite graph and its matrix form to represent an assignment/allocation problem to determine the minimum cost of hiring contractors for certain tasks.

Effective student responses:

- reduced each row
- reduced each column
- allocated each task to one contractor
- determined the minimum cost
- showed logical organisation, communicating key steps.

Student sample of effective response

This excerpt has been included to demonstrate:

- using a matrix method, as indicated within the question, to develop a response instead of by inspection
- showing adequate logical organisation and communication of key steps.

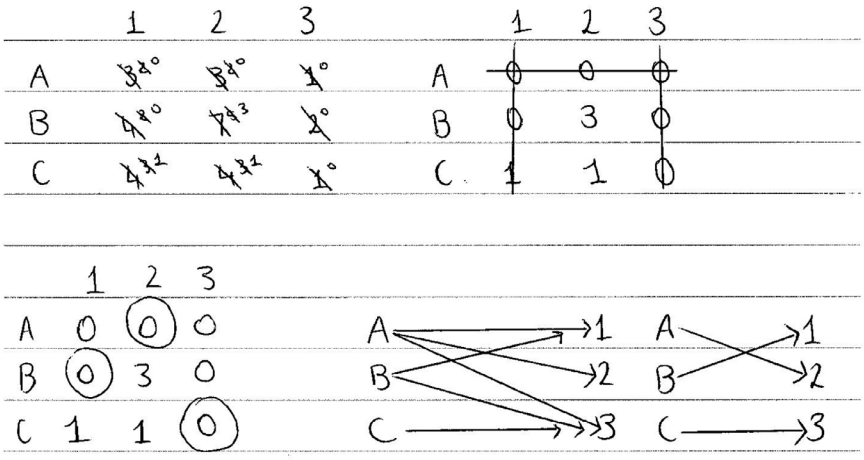
Foundational knowledge and problem-solving

QUESTION 5 (5 marks)

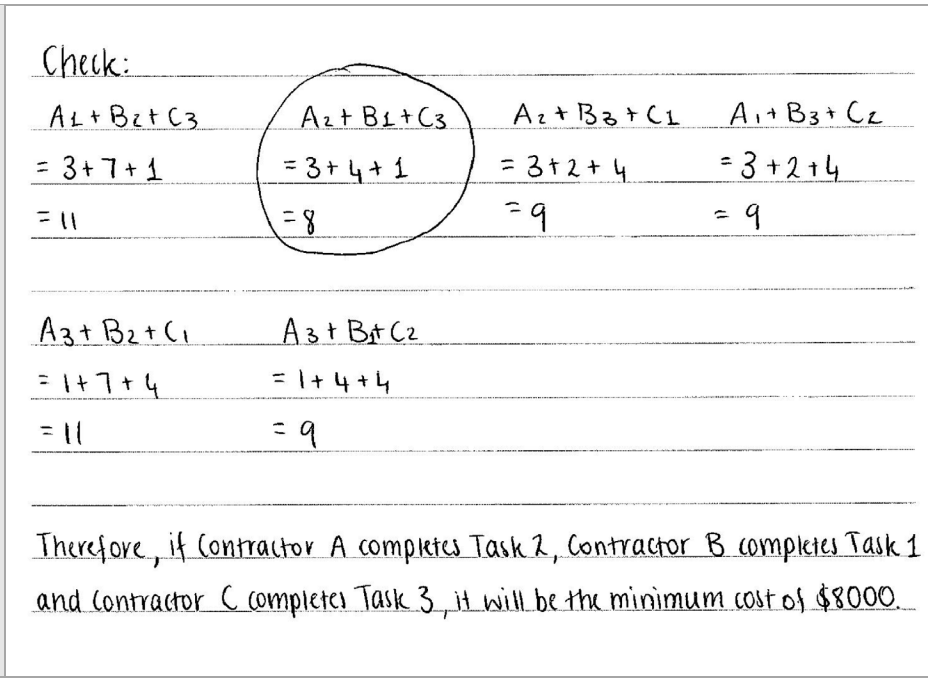
A company has three tasks to allocate to three contractors. Each of the contractors has a quote recorded for each task, shown in the table. The quotes are in thousands of dollars ($'000s).

Contractor	Task 1	Task 2	Task 3
A	3	3	1
B	4	7	2
C	4	4	1

Use a matrix method to determine the minimum cost if each contractor is allocated one task.



Therefore Contractor A should complete Task 2, Contractor B should complete Task 1 and Contractor C should complete Task 3.



Item: Question 6 — Paper 2

Assessment objective: 1, 2, 3, 4, 5 and 6 — Complex unfamiliar

This question required students to use the earliest starting times (ESTs) and latest starting times (LSTs), as well as float times for non-critical activities, to locate the critical path/s for the project and use it to determine the minimum time for the project to be completed.

Effective student responses:

- translated the information into a network
- determined LST for each activity
- determined EST for each activity
- calculated minimum completion time
- determined whether three workers are sufficient
- evaluated reasonableness of the claim
- showed logical organisation, communicating key steps.

Student sample of effective response

This excerpt has been included to demonstrate:

- recognising to use critical path analysis for project planning and scheduling activities
- evaluating the reasonableness of solutions based on certain beliefs/claims made.

Foundational knowledge and problem-solving

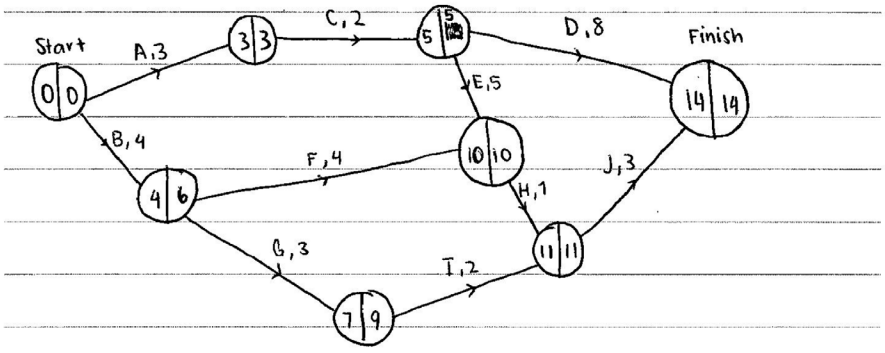
QUESTION 6 (7 marks)

A company needs to complete the following project as quickly as possible. Each task can only be completed by a single employee and must be completed before that employee can start the next task.

Task	Time (days)	Prerequisite
A	3	—
B	4	—
C	2	A
D	8	C
E	5	C
F	4	B
G	3	B
H	1	E, F
I	2	G
J	3	H, I

The owner believes that this project can be completed in minimal time with only three employees.

Evaluate the reasonableness of this belief.



Critical Path = A - C - E - H - J

(Minimum Time = 14 days)

The project could not be completed in the minimal time with only 3 employees. If one employee were to complete the critical path, there would need to be another employee completing task D once C was done, another employee comleting the path B - F and another completing G - I once B is done. This involves 4 employees because the largest float time is 2 for both B and G. None of the tasks that are off the critical path are equal to or less than this float time. This means that the 4 employees would need to be present to complete the project in the minimum time (14 days).

Item: Question 7 — Paper 2

Assessment objective: 1, 2, 3, 5 and 6 — Complex unfamiliar

This question required students to solve problems involving annuities, including perpetuities as a special case involving compound interest loans or investments and reducing balance loans.

Effective student responses:

- determined the i value for the perpetuity
- recalled the perpetuity rule
- determined purchase price of the perpetuity
- determined the i and n values for the annuity
- selected the appropriate annuity rule
- determined the monthly savings
- showed logical organisation, communicating key steps.

Student sample of effective response

This excerpt has been included to demonstrate:

- recognising which interest rate value to use for each of the stated investments
- showing adequate, logical organisation and communication of key steps.

Foundational knowledge and problem-solving

QUESTION 7 (7 marks)

A couple saved for their retirement by making the same monthly payments for 20 years into an account that earned 4.2% p.a. compounded monthly.

At the age of 65, the couple retired and used all their savings to purchase a perpetuity with an interest rate of 5.76% p.a. compounded monthly, paying $3600 each month.

How much did they save each month to prepare for their retirement?

In perpetuity I = monthly payments = 3600

$i = \frac{0.0576}{12}$

$P \times i = I$

$\frac{0.0576}{12} \times P = 3600$

$P = 750\,000$

∴ the perpetuity was $750 000

$A = m\left(\frac{(1+i)^n - 1}{i}\right)$

$i = \frac{0.042}{12} = 0.0035$

$n = 12 \times 20 = 240$

$A = 750\,000$

$750\,000 = m\left(\frac{(1+0.0035)^{240} - 1}{0.0035}\right)$

$750\,000 = 375.135m$

$m = 1999.28$

∴ they needed to save $1999.28 each month

Practices to strengthen

It is recommended that when preparing students for external assessment, teachers consider:

- assessment objective 1 — select, recall and use facts, rules, definitions and procedures drawn from Units 3 and 4, for example, the differences between
  - arithmetic sequence and geometric sequence
  - association and causation
  - closed trail and cycle
  - associated row sums and columns sums in a two-way frequency table
  - interpolation and extrapolation
  - least-squares line and scatterplot
  - minimum cut and maximum flow
  - 12-hour and 24-hour times
  - 'compound interest formula' and 'effective interest formula'
  - angular distance between two places on the same meridian and angular distance between two places on the same parallel of latitude
  - correlation coefficient (r) and coefficient of determination (R^2)
  - earliest start time (EST) and latest start time (LST)
- assessment objective 2 — comprehend concepts and techniques drawn from Units 3 and 4, for example, the understanding of
  - determining percentages from the raw data of a two-way frequency table
  - equivalent decimal forms for angular distances that are measured in degrees and minutes
  - 'maximum-flow minimum-cut' theorem that requires the correct identification of all the possible cuts for a small-scale network flow problem
  - calculating interest rates for different compounding periods for loans, investments and annuities.
- assessment objective 3 — communicate using mathematical, statistical and everyday language and conventions, for example,
  - inclusion of units when stating a quantity, e.g. 11 cm or $8000
  - appropriateness of rounding, e.g. 0.886 ≈ 0.89 (rounded to 2 decimal places) or $2363.225 ≈ $2363.23 (rounded to the nearest cent)
  - identification of parameters and definition of variables for determining mathematical models
  - logical organisation of key steps for complex familiar and complex unfamiliar problems in Paper 2
- assessment objective 4 — evaluate the reasonableness of solutions, for example, the emphasis on
  - supporting or refuting statements/claims/beliefs based on mathematical results or checking calculations in the context of the situation
- assessment objective 5 — justify procedures and decisions by explaining mathematical reasoning, for example, to

  - describe mathematical thinking in detail
  - identify causes and making relationships evident
  - construct mathematical arguments and provide reasons for choices made and conclusions reached
- assessment objective 6 — solve problems by applying mathematical concepts and techniques drawn from Units 3 and 4, e.g. be able to
  - analyse, generalise and translate the given information into a mathematically workable format based on the context of the problem
  - synthesise and refine mathematical models.

Further recommendations for preparing students for external assessment include:

- ensuring students are aware that many simple familiar questions are scaffolded. Students should also be aware that questions worth more than 1 mark require evidence of suitable mathematical reasoning in order to gain full marks
- supporting students in responding to complex familiar and complex unfamiliar questions by presenting logical organisation and communication of their key steps. Students should be encouraged to use explanatory and linking statements, appropriate mathematical vocabulary, symbols and/or conventions of the syllabus, and arrange their responses in a top-to-bottom, left-to-right structure. Units should also be included in the final answer of questions, where appropriate
- enhancing students' abilities in the use of a scientific calculator such as statistical calculations for determining the correlation coefficient and selecting the appropriate mode setting (degree/radian)
- providing students with opportunities to analyse the context of mathematical problems and make decisions about the concepts, techniques and technology that should be used in their solution. This is an important part of the problem-solving process and students should be supported in practising these skills independently
- providing students with opportunities to move beyond practising basic techniques to developing a deeper conceptual understanding of the subject matter to enhance their ability to connect what they already know to new information.

Senior External Examination

The following information relates to the General Mathematics Senior External Examination, a standalone examination offered to eligible Year 12 students and adult learners. For information about Senior External Examination 2 (SEE 2), this commentary should be read in conjunction with the external assessment section of the preceding comments for the General subject.

Summative external examination 1 (SEE 1): Examination (50%)

Assessment design

Assessment specifications and conditions

Summative external examination 1 is developed and marked by the QCAA. In General Mathematics SEE, it contributes 50% to a student's overall subject result. Summative external examination 1 is a problem-solving and modelling task drawing subject matter from Topics 1 and/or 3 in Unit 3. Subject matter from Units 1 and 2 is assumed knowledge and may be drawn on, as applicable, in the development of the examination. The external examination 1 in General Mathematics SEE is common to all schools and administered under the same conditions, at the same time, on the same day.

Conditions

- Time: 3 hours plus 15 minutes planning time
- Length: the task should allow candidates to complete the response in the set time.
- Other: The use of a QCAA-approved handheld scientific calculator is required.

A problem-solving and modelling task is developed in response to a mathematical investigative scenario or context. It requires candidates to respond with a range of understanding and skills, such as using mathematical language, appropriate calculations, tables of data, graphs and diagrams.

Candidates must provide a written response to a specific task or issue set in a context that highlights a real-life application of mathematics. The task requires candidates to use provided stimulus material involving subject matter from the nominated topic/s, which will have sufficient scope to allow candidates to address all the stages of the problem-solving and mathematical modelling approach. 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 Unit 3 Topics 1 and/or 3
2. comprehend mathematical concepts and techniques drawn from Unit 3 Topics 1 and/or 3
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 Unit 3 Topics 1 and/or 3

Number of students completing senior external assessment for the General Mathematics Senior External Examination: 50.

Standards allocation

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

Standard	A	B	C	D	E
Number of students	3	10	15	13	1

Effective practices

Overall, students responded well to the following assessment aspects:

- creating accurate scatterplots
- using technology to generate a linear model
- using a generated function to calculate data values.

Practices to strengthen

It is recommended that when preparing for the assessment for the Senior External Examination consideration be given to:

- defining explanatory and response variables
- evaluating the reasonableness of a model using residual analysis
- adapting other models, such as the geometric model, in complex situations to account for modified situations
- exploring the strengths and limitations of the solution and/or model
- evaluating the reasonableness of using models to make predictions.