Earth & Environmental Science subject report

2021 cohort

February 2022

Queensland Government

QCAA Queensland Curriculum & Assessment Authority

220035

For all Queensland schools

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Introduction

Despite the challenges brought about by the COVID-19 pandemic, Queensland's education community can look back on 2021 with satisfaction at having implemented the first full assessment cycle in the new Queensland Certificate of Education (QCE) system. That meant delivering three internal assessments and one external assessment in each General subject.

This report analyses that cycle — from endorsing summative internal assessment instruments to confirming internal assessment marks, and designing and marking external assessment. It also gives readers information about:

- applying syllabus objectives in the design and marking of internal and external assessments
- patterns of student achievement.

The report promotes continuous improvement by:

- identifying effective practices in the design and marking of valid, accessible and reliable assessments
- recommending where and how to enhance the design and marking of valid, accessible and reliable assessment instruments
- providing 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
- assist in assessment design practice
- assist in making assessment decisions
- help prepare 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 (AS) and Senior External Examination (SEE) subjects, where relevant) and General (Extension) subjects.

Report preparation

The report includes analyses of data and other information from endorsement, confirmation and external assessment processes. It also includes 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 completion

The following data includes students who completed the General subject.

Note: All data is correct as at 17 December 2021. Where percentages are provided, these are rounded to two decimal places and, therefore, may not add up to 100%.

Number of schools that offered the subject: 25.

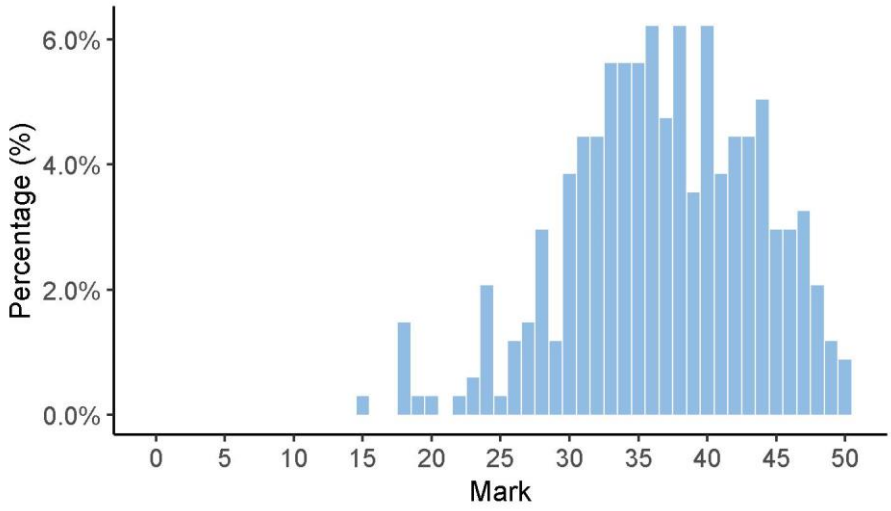
Completion of units	Unit 1	Unit 2	Units 3 and 4
Number of students completed	389	383	334

Units 1 and 2 results

Number of students	Satisfactory	Unsatisfactory
Unit 1	352	37
Unit 2	344	39

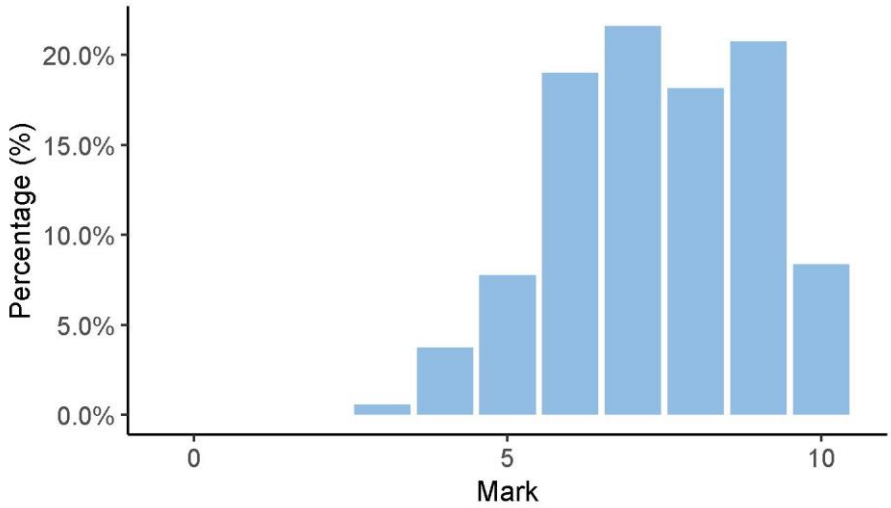
Units 3 and 4 internal assessment (IA) results

Total marks for IA

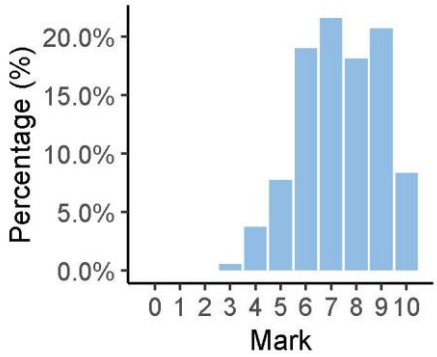


IA1 marks

IA1 total

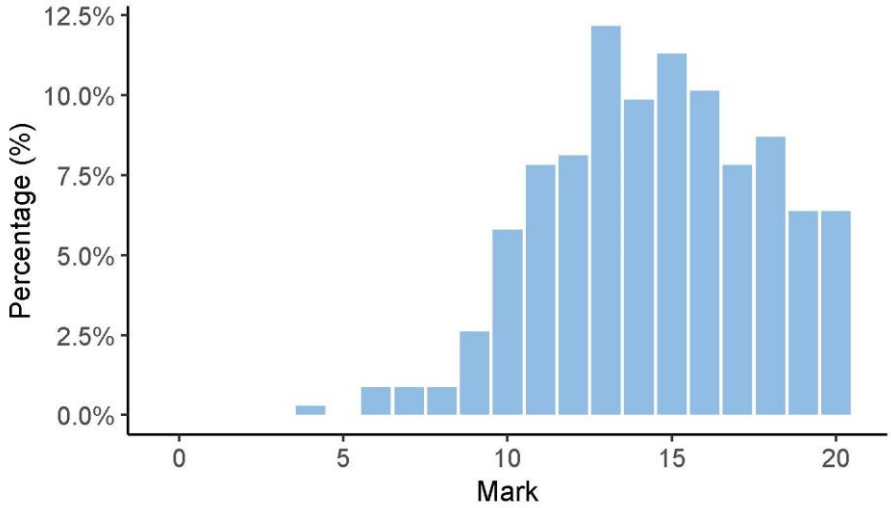


IA1 Criterion: Data test

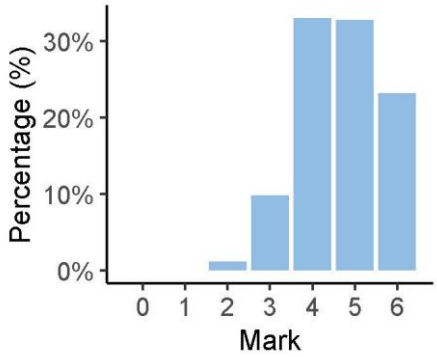


IA2 marks

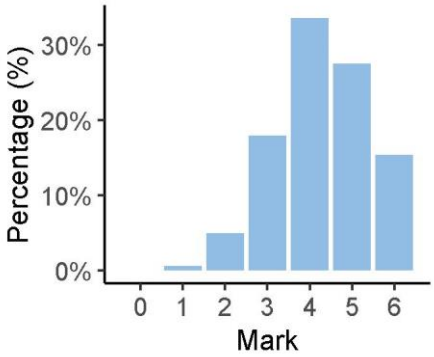
IA2 total



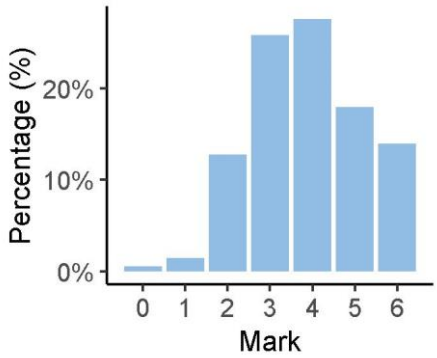
IA2 Criterion: Research and planning



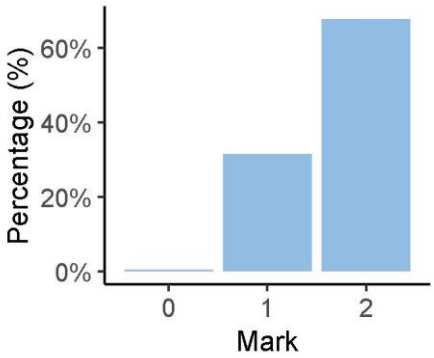
IA2 Criterion: Analysis and evidence



IA2 Criterion: Interpretation and evaluation

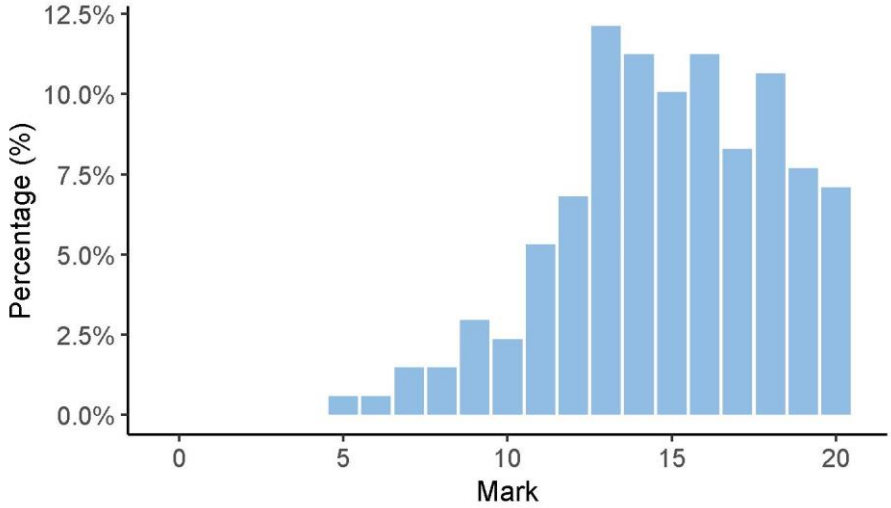


IA2 Criterion: Communication

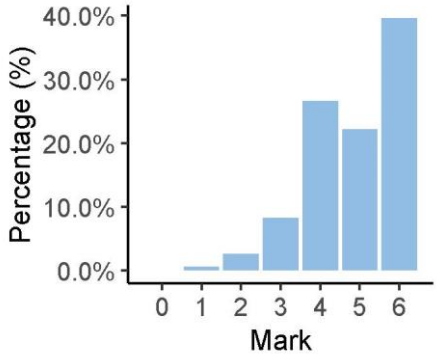


IA3 marks

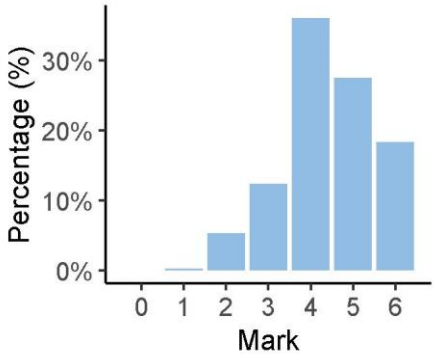
IA3 total



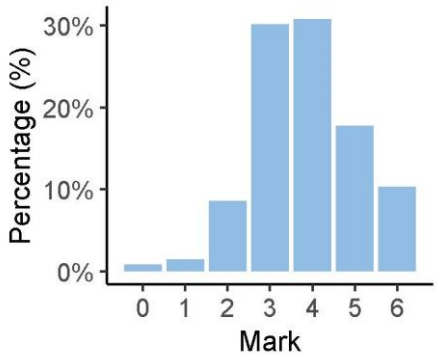
IA3 Criterion: Research and planning



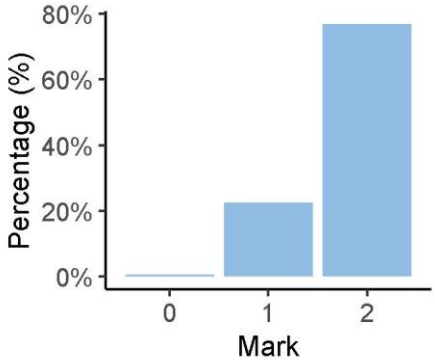
IA3 Criterion: Analysis and interpretation



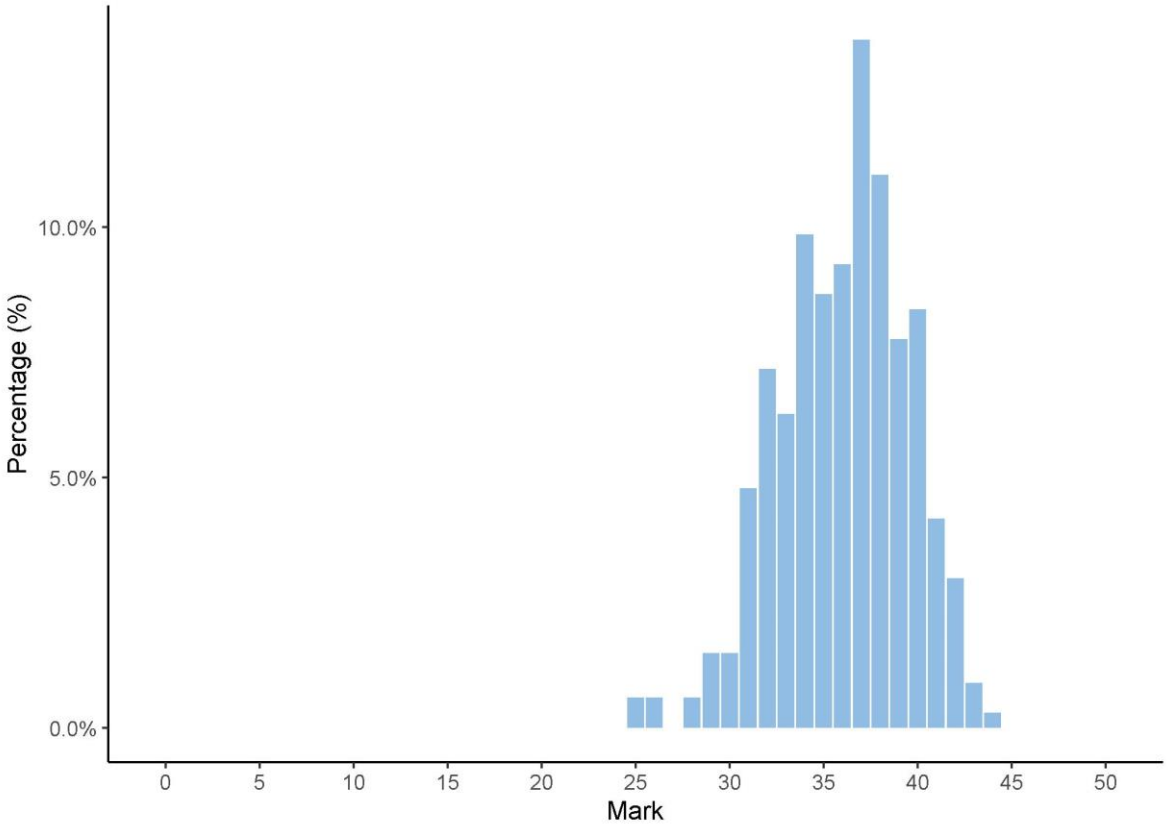
IA3 Criterion: Conclusion and evaluation



IA3 Criterion: Communication

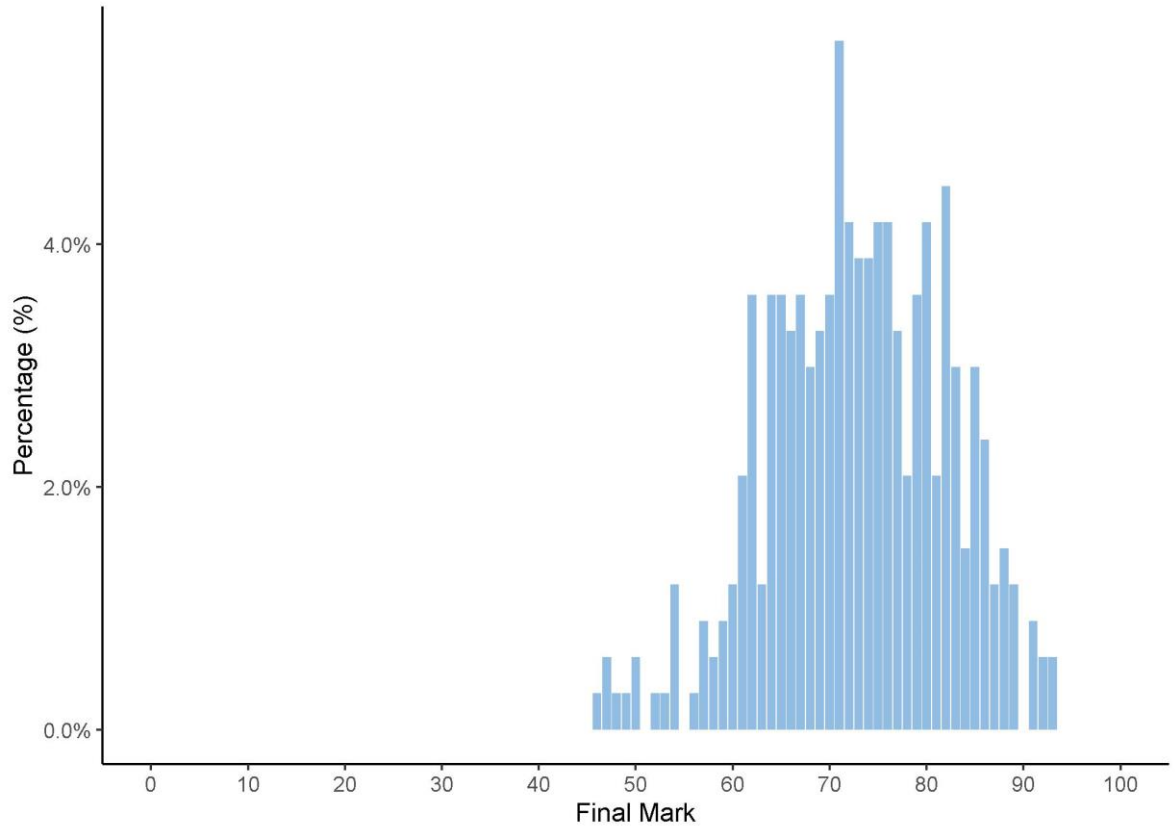


External assessment (EA) marks



Final subject results

Final marks for IA and EA



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	100–82	81–66	65–46	45–18	17–0

Distribution of standards

The number of students who achieved each standard across the state is as follows.

Standard	A	B	C	D	E
Number of students	68	193	73	0	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 section 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 the subject matter and the assessment objective/s.

Refer to the quality assurance tools for detailed information about the assessment practices for each assessment instrument.

Percentage of instruments endorsed in Application 1

Number of instruments submitted	IA1	IA2	IA3
Total number of instruments	25	25	25
Percentage endorsed in Application 1	36%	88%	88%

Confirmation

Confirmation is the quality assurance process based on the attribute of reliability. The QCAA uses provisional criterion marks determined by teachers to identify the samples of student responses that schools are required to submit for confirmation.

Confirmation samples are representative of the school's decisions about the quality of student work in relation to the ISMG and are used to make decisions about the cohort's results. If further information is required about the school's application of the ISMG to finalise a confirmation decision, the QCAA requests additional samples.

Schools may request a review where an individual student's confirmed result is different from the school's provisional mark in one or more criteria and the school considers this result to be an anomaly or exception.

The following table includes the percentage agreement between the provisional marks and confirmed marks by assessment instrument. The Assessment decisions section of this report for each assessment instrument identifies the agreement trends between provisional and confirmed marks by criterion.

Number of samples reviewed and percentage agreement

IA	Number of schools	Number of samples requested	Number of additional samples requested	Percentage agreement with provisional marks
1	25	125	0	100%
2	25	128	13	88%
3	25	129	5	80%

Internal assessment 1 (IA1)

Data test (10%)

The IA1 data test requires students to apply a range of cognitions to multiple provided questions. Students respond to questions using qualitative and/or quantitative data derived from practicals, activities or case studies on topics from Unit 3. The task requires students to identify unknown scientific quantities or features; identify trends, patterns, relationships, limitations or uncertainty in datasets; and draw conclusions based on the analysis of data.

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 priority	Number of times priority was identified in decisions*
Alignment	12
Authentication	0
Authenticity	1
Item construction	2
Scope and scale	1

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- included datasets that were relevant to the topics of Unit 3, i.e. Use of non-renewable Earth resources and Use of renewable Earth resources
- included datasets and a sequence of questions that were appropriately different from QCAA sample assessments
- included datasets and questions that were of appropriate scope and scale for students to respond to within the task conditions e.g. datasets clearly based on data adapted from the mandatory or suggested practicals

Practices to strengthen

It is recommended that assessment instruments:

- contain questions that are clearly aligned with the corresponding objective by using an appropriate cognitive verb and requiring an appropriate nature of response, e.g. in an objective 2 item, '*calculate* unknown scientific quantities'. Teachers should refer to the Mark allocations table in section 4.5.1 of the syllabus for guidance on the appropriate cognitive verbs and responses associated with each objective
- do not use questions that assess objective 1 *describe and explain scientific concepts, theories, models and systems and their limitations*
- do not lead students to a predetermined response by providing too much scaffolding in the question stem.

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 priority	Number of times priority was identified in decisions*
Bias avoidance	3
Language	5
Layout	1
Transparency	4

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- used appropriate language and did not use jargon, specialist language and colloquial language that did not contribute understanding of subject matter
- contained datasets and questions with minimal distractors, i.e. only the data necessary to answer the questions
- maintained consistent language between data sets and related questions see Figure 1 in Dataset 1.

Practices to strengthen

There were no significant issues identified for improvement.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Data test	100%	0%	0%	0%

Effective practices

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

- a marking scheme that clearly and consistently matches each mark to an important feature in the expected response was included, e.g. one mark for working and one mark for calculating the correct value
- datasets included an appropriate amount of data, allowing students to respond to questions within the allocated time
- instruments contained an appropriate number of questions and marks, so students could respond within 60 minutes.

Samples of effective practices

There are no student response excerpts because either the student/s did not provide permission or there were third-party copyright issues in the response/s.

Practices to strengthen

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

- school marking schemes accurately reflect the cognitions being assessed
- schools should label the updated marking scheme for ease of access during the confirmation process
- partial credit (i.e. half marks) should not be awarded for responses that demonstrate incomplete cognition, e.g. working that does not lead to a correct response, contradictory responses to the same item.

Internal assessment 2 (IA2)

Student experiment (20%)

The IA2 student experiment requires students to modify (i.e. refine, extend or redirect) an experiment to address their own hypothesis or question related to topics from Unit 3. Students may use a practical performed in class as the basis for their methodology. They develop a research question, collect and process primary data, analyse and interpret evidence, and evaluate the reliability and validity of their experimental process.

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 priority	Number of times priority was identified in decisions*
Alignment	1
Authentication	3
Authenticity	0
Item construction	0
Scope and scale	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- included mandatory and suggested practicals derived from Unit 3 subject matter, which could be modified by students to address the task specifications
- provide task specifications that match all the specifications in Syllabus section 4.5.2.

Practices to strengthen

It is recommended that assessment instruments:

- clearly identify to students the authentication strategies that are used throughout the task e.g. a declaration of authenticity
- include authentication strategies that identify how individual student work will be assessed for the groupwork components of the task e.g. the teacher will compare the responses of students who have worked together.

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 priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	0
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- featured language that was free from cultural, gender or socio-economic bias
- used appropriate language and avoided jargon, specialist language and colloquial language that did not contribute to the understanding of subject matter.

Practices to strengthen

There were no significant issues identified for improvement.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	92%	8%	0%	0%
2	Analysis of evidence	92%	8%	0%	0%
3	Interpretation and evaluation	92%	8%	0%	0%
4	Communication	100%	0%	0%	0%

Effective practices

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

- in the Research and planning criterion
  - justified modifications to the methodology ensured the experiment collected sufficient data to draw valid conclusions, e.g. include at least five data points to establish a trend
  - a considered rationale clearly connected the research question to Unit 3 subject matter and demonstrated detail in subject matter knowledge
- in the Analysis of evidence criterion
  - *thorough* identification of trends, patterns or relationships was demonstrated using
    - measures of central tendency, e.g. mean
    - measures of dispersion, e.g. standard deviation
    - measures of correlation, e.g. Pearson's correlation coefficient, *r*
  - *thorough and appropriate* identification of uncertainty and limitations of evidence was demonstrated using indicators of uncertainty such as standard error.

Samples of effective practices

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

This student response excerpt has been included:

- to demonstrate *justified* modifications to the methodology that give sound reasons for how the modifications will refine and extend the original experiment and include strategies for achieving these modifications
- to demonstrate a methodology that enables the collection of *sufficient, relevant* data so that informed conclusions to the research question can be derived.

Research and planning (5–6 marks)

- justified modifications to the methodology
- a methodology that enables the collection of sufficient, relevant data

Research Question

Will increasing the surface area of a body of water from 19.63cm^2 to 56.75cm^2, result in a faster evaporation rate of 50ml of water, using temperature to control the experiment?

R&P2a - spec

Methodology

Original Step	Modification	Justification
Two containers with different surface areas.	Three beakers, increasing in surface areas.	By increasing the surface areas and the number of beakers used, the reliability of data collected increased and outliers were established (if there were any present).
150ml of water in each container.	50ml of water in each beaker.	So that the experiment could be completed in the time frame provided.
Left for a week.	Beakers were left on hotplates until the water had been completely evaporated.	This will show how the evaporation rate is affected by temperature, therefore making the results valid and reliable.
Measured the amount of water remaining.	Recorded the time taken for the evaporation to occur.	Increase reliability of experiment, as it will display how long different surface areas take to evaporate.
The beakers remained at room temperature.	Beakers were heated to an average temperature of approximately 98˚C.	This process will be more efficient, as water will reach boiling point, and evaporate faster.

The original Methodology can be found in the appendix on page 9.

R&P2b - suffici

This student response excerpt has been included:

- to demonstrate a *considered* rationale leading to the development of a *specific and relevant* research question.

Research and planning (5–6 marks) • a considered rationale for the experiment • a specific and relevant research question	Rationale Salinity, pH, and turbidity are major factors affecting the health of our waterways. Many organisms require a certain range of salt content and acidity to thrive, which is mainly sourced from soil runoff. For pH, the ideal range is 5.5-8, and the salinity of freshwater should be kept to below 0.5ppt (HORIBA, 2016). Similarly, turbidity is a measure of water clarity due to the presence of suspended particles in Nephelometric Turbidity Units (NTUs) (Diamant, 2013). These particles can include algae, clay, silt, microscopic organisms, or dissolved compounds (USGS, 2019). Managing turbidity is highly important for aquatic life and drinking water, as it reduces sunlight penetration, which significantly hinders photosynthesising plants and the organisms that rely on them (PCA, 2008). The particles also absorb more heat due to the darker colour, reducing the dissolved oxygen in water, an essential factor for organisms. It can also directly kill fish by carrying pathogens and other contaminants that spread waterborne diseases (Cinque, Stevens, Roser, Ashbolt, & Leeming, 2004). Moreover, high turbidity also makes it more difficult to clean, raising the price of water treatment plants. Thus, it is beneficial to lower turbidity in waterways as much as possible. To reduce the particles in water, it is important to address the sources of suspended particles. Turbid water can be caused by a variety of factors, all of which are linked to runoff and soil erosion. Human activities accelerate natural erosion mainly through farming and mining (WWF, 2021). They usually involve deforestation where vegetation is removed to accommodate these practices. Without plants to hold the soil in place, it will begin to erode rapidly. Moreover, the fertilisers and animal wastes provide excess nutrients leading to eutrophication, whilst the constant disturbance of soil adds to the small particles escaping into waterways. After harvest seasons and mining have exhausted the soil, it is important to stabilise the soil to prevent further loss. This can be accomplished in three broad ways: biological, physical, and chemical (Adams, 2015). Biological stabilisation involves growing plants so the roots can hold the soil in place. Physical stabilisation is much broader – involving compacting, wetting, and solid wastes. Compaction removes the air between particles, restricting plant rooting and water drainage (Cotching & Davies, 2021). It can also increase the amount of soil needed, and therefore the cost. The process of wetting is similar, but will use large volumes of water. Solid wastes are ideal because they put materials that would previously be wasted to use. They can be either organic or non-organic, such as old shredded rubber, rock fragments, wood chips and plant debris. Organic mulches can help absorb water and will also slowly decompose to improve soil fertility. Finally, chemical stabilisation encompasses adding agents to the soil. It is both complicated and costly in comparison to other methods. Thus, it has been concluded that vegetation and mulching are the simplest and most cost-efficient erosion prevention methods that will benefit the soil in other ways. This experiment will investigate the effectiveness of mulching and vegetating to stabilise soil to reduce suspended particles in waterways. The pH, salinity and turbidity of the infiltrated water will determine how each has affected the water quality. The volume of excess water will also be collected because once the soil is completely saturated with water, the excess water (or runoff) with travel to waterways, bringing litter, chemicals, and other water polluters. More soil absorption leads to less runoff and thus less water pollution. This leads to the research question... Research question How do soil stabilising methods (grassing, mulching) affect the water quality (turbidity, salinity, pH) from infiltration?

These student response excerpts have been included:

- to show *correct and relevant* processing of data to provide evidence that is applicable to the research question (Excerpt 1)
- to demonstrate identification of uncertainty and limitations of the data that is *thorough and appropriate* enough to determine if the evidence that will be used to draw a conclusion to the research question is reliable and valid (Excerpt 2).

Analysis of evidence (5–6 marks)

- correct and relevant processing of data

Excerpt 1

Quantitative

Table 1: Raw data of different factors of water quality

Soil condition	Bare			Mulch			Grass		
Trial	S1	S2	S3	M1	M2	M3	G1	G2	G3
Mass (±0.01g)	115.14	124.10	214.77	114.70	93.51	88.77	98.41	103.78	99.59
Turbidity (±0.1NTU)	554.4	560.4	933.2	239.4	238.6	331.9	247.1	331.4	281.8
Salinity (±0.1ppt)	1.5	2.4	1.5	2.6	2.5	2.6	5.6	5.7	6.4
pH (±0.01)	6.60	6.40	6.37	6.39	6.35	6.30	6.46	6.81	6.78

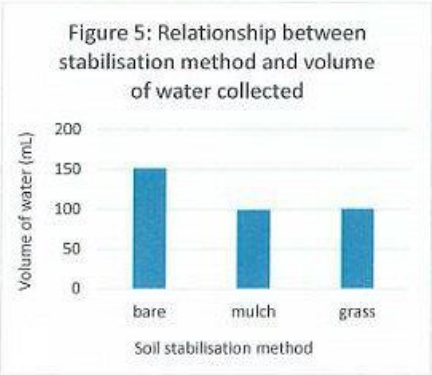
Processed data

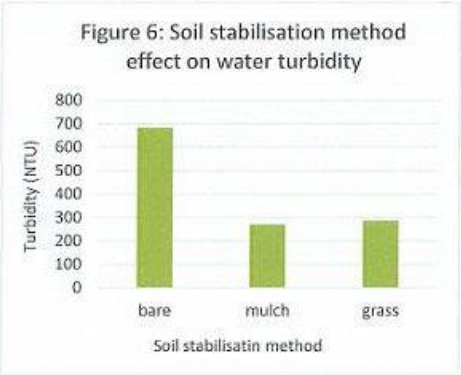
Table 2: Sample calculations for 0.2M of copper nitrate

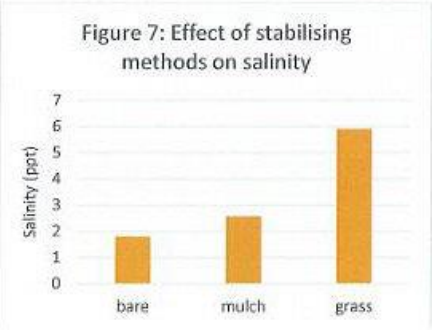
Process	Equation	Calculations for trial 1 of bare soil mass
Average mass	$\bar{x} = \frac{\sum x}{n}$	$\bar{x} = \frac{115.14 + 124.1 + 214.77}{3}$ $\bar{x} = 151.35$
Absolute uncertainty	$\pm \frac{x_{max} - x_{min}}{2}$	$absolute = \pm \frac{214.77 - 115.14}{2} = \pm 49.82$
Percentage uncertainty	$\frac{absolute}{measurement} \times 100$	$\%uncert = \frac{49.82}{151.34} \times 100 = 32.92\%$

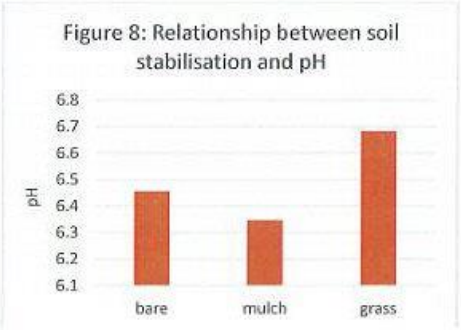
Table 3: Processed Data

Condition	Bare	Bare (no outlier)	Mulch	Grass
Average volume (mL)	151.34±32.92%	119.62±3.75%	98.99±13.10%	100.59±2.67%
Average turbidity (NTU)	682.67±27.74%	557.4±0.54%	269.97±17.28%	286.77±14.70%
Average salinity (ppt)	1.8±25%	1.45±23.08%	2.57±1.95%	5.90±6.78%
pH	6.46±1.78%	6.5±1.54%	6.35±0.71%	6.68±2.62%









• thorough and appropriate identification of the uncertainty and limitations of evidence	**Excerpt 2** Analysis of evidence Figure 2-4 display the experiment set up and each corresponding water sample collected from the bottles. The mulch (M1-3) and grass (G1-3) water appeared approximately the same, except that the grass seemed more yellow. It is likely due to the "lawn food" within the grass seeds. The bare soil (S1-3) appeared the murkiest, and contained more large particles. S3, which was drier than the other trials, produced the dirtiest and largest volume of water. The quantifiable raw data (Tab.1) was processed (Tab.2) in order to analyse its precision and relationships. Table 3 displays the average and percentage uncertainty of the volume, turbidity, salinity and pH of the collected water. It is evident that the bare soil had a large degree of uncertainty within the three trials conducted. Usually, if the uncertainty exceeds 5%, the results are considered unacceptable due to the great degree of random error. All values except pH for bare soil exceeded this standard. This was likely due to S3 not being watered; the other bottles were already somewhat compacted due to previous watering, so when it came to water collection, there were less loose particles. It resulted in more loose soil particles escaping. Since it is so different from the other two trials, it can be omitted as an outlier. Referring to the column in Table 3 highlighted in red, it is clear that eliminating S3 improved the uncertainty dramatically, although salinity uncertainty was still high. The mulch and grass trials also had uncertainties exceeding 5% but were generally somewhat acceptable. Figure 5 shows the volume of water collected after adding 250mL to each bottle. The bare soil (with outlier omitted) held less water in comparison to the mulch and grass, which aligns with the qualitative observation that mulch absorbed much of the water. The water turbidity presented in Figure 6 showed that even with the extremely turbid S3 removed, the turbidity for bare soil was still significantly higher than the mulch and grass. Clean drinking water is generally less than 1NTU, so all the water would need to be treated, but the water from bare soil would be costlier to process (Queensland Health, 2017). For salinity and pH in Figure 7 and 8, the grass was much higher than mulch and bare soil. This was likely also due to the "lawn food" fertiliser salts that affect both salinity and pH. Depending on the location, high salinity water can be very detrimental to aquatic organisms that require a certain salinity range to survive. River water should usually be around 0.12-0.5ppt, in which all water samples exceeded, but acceptable in seawater (35ppt). The bare soil had the lowest salinity, but it does not release as much salt into waterways, it holds in within the soil, which is also harmful to plants (Provin & Pitt, 2018). The water from the grass sample would be the most harmful to freshwater, but it caused by the fertiliser rather than grass. Finally, all pH values lie within the normal and ideal range of 5.5-8, but mulch had the most acidic soil, likely due to the decomposing organic matter. While is it beneficial for plants, fresh water should lie around 7.

Practices to strengthen

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

- in the Interpretation and evaluation criterion, uncertainty and limitations identified through analysis of evidence should be used to
  - *justify* the discussion of the reliability and validity of the experimental process
  - *logically* derive suggested improvements and extensions to the experiment.

Additional advice

- Experimental methodologies should be based on practicals that consider only one dependent variable (e.g. mandatory or suggested practicals from the syllabus) rather than complicated practicals that consider more than one dependent variable or involve complex systems in which external variables are difficult to control.
- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- Through the mandatory and suggested practicals, students should have an opportunity to practise relevant data processing techniques that can be used to identify

trends/patterns/relationships and uncertainty/limitations of data before they use these practicals as the basis for their experiments.

- Strategies outlined in the *QCE and QCIA policy and procedures handbook* are administered to
  - ensure student responses meet the conditions of the syllabus
  - promote academic integrity to ensure student responses clearly demonstrate students' own achievement.

Internal assessment 3 (IA3)

Research investigation (20%)

The IA3 research investigation requires students to gather secondary evidence related to a research question in order to evaluate a claim about topics from Unit 4. Students develop a research question, collect and analyse secondary data, interpret evidence to form a justified conclusion, discuss the quality of the evidence and extrapolate the findings of the research to the claim.

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 priority	Number of times priority was identified in decisions*
Alignment	2
Authentication	0
Authenticity	0
Item construction	0
Scope and scale	1

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Validity priorities were effectively demonstrated in assessment instruments that:

- provided students with claims that could be developed into several unique research questions, e.g. ‘An increase in extreme weather events will increase erosion of top soil’
- featured check points to monitor student progress throughout the task, e.g. specific weeks to develop research question from claim, collect and analyse data, submit draft, submit final response
- included scaffolding that did not lead students to a predetermined response when formulating a research question from a claim.

Practices to strengthen

It is recommended that assessment instruments:

- do not require students to demonstrate experimental skills or collect primary data

- do not use Science as a Human Endeavour (SHE) statements verbatim from the subject matter of the syllabus as claims
- provide task specifications that match all the specifications in Syllabus section 5.5.1.

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 priority	Number of times priority was identified in decisions*
Bias avoidance	0
Language	1
Layout	0
Transparency	0

*Each priority might contain up to four assessment practices.

Total number of submissions: 25.

Effective practices

Accessibility priorities were effectively demonstrated in assessment instruments that:

- featured language that was free from cultural, gender or socio-economic bias
- used appropriate language and avoided jargon, specialist language and colloquial language that did not contribute to the understanding of subject matter

Practices to strengthen

There were no significant issues identified for improvement.

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 confirmed marks

Criterion number	Criterion name	Percentage agreement with provisional	Percentage less than provisional	Percentage greater than provisional	Percentage both less and greater than provisional
1	Research and planning	92%	4%	0%	4%
2	Analysis and interpretation	92%	4%	0%	4%
3	Conclusion and evaluation	80%	16%	4%	0%
4	Communication	96%	0%	4%	0%

Effective practices

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

- in the Analysis and interpretation criterion
  - identification of *sufficient and relevant* evidence drew on qualitative and quantitative data from scientifically credible sources, e.g. peer-reviewed research papers, books by well-credentialed scientists, websites of independent research bodies
  - limitations of evidence were *thoroughly and appropriately* identified with respect to the research question
  - scientific arguments were *justified* using concepts from Unit 4 subject matter
- in the Conclusion and evaluation criterion, the limitations identified in the analysis of the evidence were used as a basis for the *insightful discussion* of the quality of the evidence.

Samples of effective practices

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

This student response excerpt has been included:

- to show the development of a *specific and relevant* research question that is clearly related to subject matter from Unit 4 Topic 1 through a *considered* rationale
- to demonstrate the selection of *sufficient and relevant* sources that are scientific and provide enough evidence for the development of a scientific argument that responds to the research question.

Research and planning (5–6 marks • a considered rationale identifying clear development of the research question from the claim • selection of sufficient and relevant sources • a specific and relevant research question	Rationale The frequency and severity of extreme weather events is expected to increase as the climate changes (Steffen, Hughes, & Karoly, 2013). Coral reefs are already vulnerable due to rising global ocean temperature and ocean acidification, but with the addition of more extreme weather, it is questioned whether it will kill reefs. Thus, it is commonly claimed that an increase in extreme weather events will kill the Great Barrier Reef (GBR) (Matthews, 2013). To effectively investigate this claim, a specific extreme weather event must be identified as it would be more efficient to have a narrower focus. The main extremities are floods, droughts, bushfires and cyclones. Each impact the GBR very differently – floods bring dirt that smother coral, droughts expose sediments that oxidise and create a more acidic environment, and smoke from bushfires contain excess nutrients that lead to eutrophication – but cyclones pose the largest threat due to its direct destruction (NOAA, 2021). Cyclones dislodge or topple corals, or disturb sediments that smother the coral, so it will be the focus of this investigation. Furthermore, the claim does not identify whether the "increase" in extreme weather is referring the frequency or severity. In the case of cyclones, most leading scientific agencies such as the Climate Council, Bureau of Meteorology (BOM), and National Oceanic and Atmospheric Administration (NOAA) predict that there will be a surge in intensity, but not necessarily in frequency (Knutson, et al., 2021; BOM, 2021; Hughes, Steffen, & Rice, 2017). Finally, the GBR refers to the whole ecological community – the coral reef system, seagrasses and other marine organisms. The main concern surrounds the hard corals, which are the primary component of reef structures with a rigid calcium carbonate shell that is easily damaged by cyclones (NOAA, 2019). This leads to the research question... Research question To what extent will the increase in cyclone severity impact the health of hard coral cover in the Great Barrier Reef?

These student response excerpts have been included:

- to show an *insightful* discussion of the quality of evidence used to respond to the research question
- to demonstrate *considered and relevant* improvements and extensions to the investigation, which are identified through careful and deliberate thought about the identified limitations of evidence and claim.

Conclusion and evaluation (5–6 marks) • insightful discussion of the quality of evidence • extrapolation of credible findings of the research to the claim	**Excerpt 1** Conclusion The sourced evidence suggests that, **to a considerable extent**, a sustained increase in seismic activity at the Cotopaxi Volcano from base levels correlated to an imminent eruption in late August 2015. The data supports the presence of a correlation between a sudden jump in the number of long-period and volcanic-tectonic seismic events in the 3 months preceding the eruption, and the eventual explosion. Through evaluation, the claim that volcanic eruptions can be predicted is supported by the data. In the case of many volcanoes, eruption forecasts are critical in preventing large-scale loss of life, such as that caused by the lahars and pyroclastic flows of the 1877 Cotopaxi eruption (eds. Kozák & Čermák 2010). Therefore, formulating an effective evacuation response from the tell-tale signs of an impending eruption, such as prolonged surges in seismic activity (i.e., increases to 160 seismic events per day, Figures 6 and 7) can be crucial in saving hundreds of thousands of lives. Considering the proximity in which many settlements lie to volcanoes, and the danger this places them in, these systems are critical.

• suggested improvements and extensions to the investigation that are considered and relevant to the claim	**Excerpt 2** Evaluation Of Evidence Answering the claim depends on the availability of relevant data, collected using the most up-to-date technology. Though current models of volcanic and seismic activity are reasonably accurate, shortfalls in geographical knowledge and understanding, coupled with underfunded and outdated seismic technology (particularly for figures 2 and 4), increase the number of potential discrepancies in the trend. As such, though most of the data addressed this disparity, the conclusion should still be addressed with a small amount of caution. Additionally, the data has certain unaddressed constraints, such as the role of earthquakes caused by the subduction zone on the amount of magma movement and resulting volcanic seismic activity, and that the evidence is limited to only one volcanic eruption for one volcano. In this way, the investigation could be refined to look solely at how seismic activity caused by the subducting plate affects any volcanic eruptions. Furthermore, the restriction of the seismic data for Cotopaxi Volcano, due to it coming from only one station, could be refined by increasing the number of seismic stations around the volcano, thus providing more variety in data. Also, looking at the application of seismic data to other volcanic eruptions in different circumstances could strengthen the correlation that the Cotopaxi eruption shows. The claim itself is also quite general, offering multiple ways for interpretation. To extend the interpretation of the claim, looking at other factors which precede eruptions, such as gas emissions, the geological structure of volcano, past eruptive history, and changes in visible features. Additionally, investigating how the ability to predict volcanoes depends on their location, such as comparing hotspot volcanoes to volcanic arc volcanoes, could aid in understanding. Considering that seismic activity (though a good indicator) is quite limited and specific in prediction, addressing this with other factors can be crucial in forming a more accurate forecast for volcanic eruptions, saving countless lives.

Practices to strengthen

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

- a *considered* rationale is clearly connected to Unit 4 subject matter and dissects and redefines the claim to demonstrate how the student has created the specific research question.

Additional advice

- Strategies outlined in the *QCE and QCIA policy and procedures handbook* are administered to
  - manage the response length to ensure student responses meet the conditions of the syllabus
  - promote academic integrity to ensure student responses clearly demonstrate students' own achievement.
- Schools should use the ISMG from the syllabus without making any changes to wording or formatting.
- It is not necessary for schools to remove teacher feedback from student responses before uploading them for confirmation, particularly if the feedback is expressed in the language of the ISMG.
- Appropriate teaching/learning strategies reflect the specific requirements of a research investigation (e.g. a rationale that develops the research question from a claim, extrapolation of findings of the research to the claim) rather than the requirements of other genres or assessment techniques, e.g. literature review, extended response task.

External assessment

External assessment (EA) is developed and marked by the QCAA. The external assessment for a subject is common to all schools and administered under the same conditions, at the same time, on the same day.

Summative external assessment (EA) — Examination (50%)

Assessment design

The assessment instrument was designed using the specifications, conditions and assessment objectives described in the summative external assessment section of the syllabus. The examination consisted of two papers:

- Paper 1, Section 1 consisted of multiple choice questions (15 marks)
- Paper 1, Section 2 consisted of short response questions (45 marks)
- Paper 2, Section 1 consisted of short response questions (42 marks)
- Paper 2, Section 2 consisted of an extended response question (11 marks).

The examination assessed subject matter from Units 3 and 4. Questions were derived from the context of:

- use of renewable and non-renewable Earth resources
- the cause and impact of Earth hazards and global climate change.

Assessment decisions

Assessment decisions are made by markers by matching student responses to the external assessment marking guide (EAMG). The external assessment papers and the EAMG are published in the year after they are administered.

Multiple choice item responses

There were 15 multiple choice items in Paper 1.

Percentage of student responses to each option

Note:

- The correct answer is **bold** and in a blue shaded table cell.
- Some students may not have responded to every question.

Questions	A	B	C	D
1	17.17	23.8	**32.23**	25.6
2	25.6	**29.82**	7.53	35.84
3	20.78	10.24	**56.02**	12.35
4	**66.27**	15.06	12.65	5.42
5	7.53	60.54	**26.81**	4.52
6	36.75	17.47	**40.96**	3.61
7	3.01	29.52	38.86	**28.01**
8	14.16	12.05	**54.22**	18.37
9	**68.98**	9.94	13.55	6.93
10	6.63	**62.95**	19.88	9.94
11	60.24	9.34	**20.48**	9.34
12	**30.42**	14.16	22.59	32.23
13	12.65	37.95	**34.64**	14.16
14	30.12	28.01	18.98	**21.69**
15	**27.41**	28.61	7.23	35.54

Effective practices

Overall, students responded well to:

- opportunities to apply their understanding of the use of renewable resources and the cause and impact of earth hazards
- short response questions requiring them to explain concepts relating to mineral extraction, natural and anthropogenic environmental impacts and global climate change.

The following excerpts have been selected to illustrate effective student responses in one or more of the syllabus assessment objectives. The characteristics identified may not be the only time the characteristics have occurred throughout a response.

Samples of effective practices

Short response

Assessment objective: 4

Paper 1

Question 16

This question required students to identify and explain two relevant characteristics of a tropical cyclone observable from meteorological data (stimulus) and determine, with evidence from the stimulus, which of the national parks was the location of Dataset 1 in Stimulus 3. Students were

then required to predict and justify which species was likely to quickly return to pre-cyclone numbers.

Effective student responses:

- identified and explained the required number of characteristics of a tropical cyclone
- determined, with evidence from the stimulus, which of the national parks was the location of Dataset 1
- predicted and justified which species was likely to quickly return to pre-cyclone numbers
- explicitly used evidence from the stimulus to justify their reasoning.

This student response excerpt has been included:

- to exemplify clear alignment with the EAMG
- to demonstrate explicit reference to the stimulus to justify reasoning.

Interpret evidence (11 marks)

QUESTION 16 (11 marks)

a) Explain two characteristics of a tropical cyclone that are observable using meteorological data. *[4 marks]*

One characteristic of a tropical cyclone is ~~to~~ high wind speeds and this can be observed using meteorological data that determines the strength of the wind to categorise a cyclone. A second characteristic would be precipitation levels this would determine the amount of strength and damage a cyclone is likely to cause, this can be observed through an array of measurements.

b) Determine which of the national parks in Stimulus 1 was the location of Dataset 1 in Stimulus 3. Provide evidence from Stimulus 1, 2 and 3 to support your response. *[4 marks]*

The national park which is the location of Data set 1 is National Park B. This is because the majority of National Park B is located within 1 and 4 km away from the ocean making it more susceptible to ~~as~~ cyclone conditions due to ocean proximity which could lead to higher winds, currents and storm surges. The existing damage before the cyclone was higher than dataset 2 and stimulus 1 indicates that National Park B had more percentage habitat loss than National Park A. With the topography also indicating National Park B at a greater height making it more susceptible to higher wind speeds and precipitation.

c) Predict which species is likely to quickly return to pre-cyclone numbers. Justify your response by contrasting two species, using data from Stimulus 3. *[3 marks]*

I predict that the species most likely to return to pre-cyclone numbers is the black wattle. This is because comparatively to all other species except River she oak it didnt suffer as much a percentage lost after existing damage. For example weeping fig had 2% and 0% existing damage and 95% and 72% after damage respectively compared to Black wattle 10%, 7% before and 15% and 9% after. Karkwattle is also a smaller size and easier to recover and grow.

Assessment objective: 4

Paper 1

Question 17

This question required students to identify and justify which years on the Southern Oscillation Index (SOI) graph represented the climatic conditions at a particular location (X) and explain which years from the stimulus were likely to have the largest recharge of natural river systems at that location.

Effective student responses:

- identified and justified which years on the Southern Oscillation Index (SOI) graph represented the climatic conditions at a particular location (X)
- explained which years from the stimulus were likely to have the largest recharge of natural river systems at that location
- explicitly used evidence from the stimulus to justify reasoning.

This student response excerpt has been included:

- to exemplify clear alignment with the EAMG
- to demonstrate explicit reference to the stimulus to justify reasoning.

Interpret evidence (5 marks)	**QUESTION 17 (5 marks)** a) Identify which years on the Southern Oscillation Index (SOI) graph in Stimulus 4 in the stimulus book represent the climatic conditions at X from Stimulus 5 in the stimulus book. Justify your response using evidence from the graph. *[3 marks]* The years in stimulus 4 that represent the climatic condition at X are the years 2015 and 2016. As X represents the lowest rainfall on record it can be seen that on the SOI during those years it ~~reached~~ declining to −25 for a sustained period of time. b) Identify which years in Stimulus 4 were likely to have the largest recharge of natural river systems in the location marked by X in Stimulus 5. Explain your reasoning. *[2 marks]* The years in stimulus 4 that were likely to have the larger recharge of natural river systems is 2011 and 2012 because they have a SOI of around 20 indicating large rainfall and there naturally refilling river systems.

Assessment objective: 4

Paper 1

Question 21

This question required students to determine and justify the depth and thickness of the coal seam/s from provided stimulus.

Effective student responses:

- determined and justified the depth and thickness of the coal seam/s from provided stimulus
- explicitly used evidence from the stimulus to justify their reasoning.

This student response excerpt has been included:

- to exemplify clear alignment with the EAMG
- to demonstrate explicit reference to the stimulus to justify reasoning.

Interpret evidence (3 marks)	**QUESTION 21 (3 marks)** Use Stimulus 7 in the stimulus book to determine the depth and thickness of the coal seam/s. Justify your response using evidence from the stimulus. ~~4 metres~~ 4 metres wide at a depth of roughly 1055 to 109.5 m as stimulus 7 ~~state~~ shows low density rock here as well as a low amount of resistance with a moderate amount of gramma rays ~~as~~ (50) – and coal is inherintully less dense than most rocks. (2) (2) (2)

Extended response

Assessment objectives: 1–4

Paper 2

Question 7

This question required students to engage with stimulus material relating to water availability in the Namoi river catchment and draw conclusions about water management, its impact on the local ecosystem and then propose and justify a solution to the impacts.

Effective student responses:

- drew a conclusion about whether the catchment has been managed effectively
- identified causes for reduced availability and quality of fresh water
- identified impacts on the ecosystem and proposed a justified solution to these impacts
- drew upon information from the stimulus to present a fully synthesised and supported response based on evidence and reasoning.

These student response excerpts have been included:

- to exemplify clear alignment with the EAMG
- to demonstrate explicit reference to the stimulus to justify reasoning.

Describe and explain, Apply understanding, Analyse evidence and Interpret evidence (11 marks)	**QUESTION 7 (11 marks)** This question refers to Stimulus 5–8 in the stimulus book. In January 2020, it was claimed that 'management of the Namoi River catchment has had a negative impact on the availability and quality of fresh water in local ecosystems'. Water restrictions for general use in towns in the catchment area were implemented in December 2019 to increase the availability and quality of fresh water for local ecosystems. a) Draw a conclusion about whether the catchment has been managed effectively. Provide two reasons to support your conclusion. *[3 marks]* Stimulus 6 shows that throughout 2019 and 2020 the turbidity, PH and dissolved oxygen have all been kept at a healthy level. As stimulus 5 shows the average rainfall has dropped by 30mm per decade for the past 50 years. Meaning that to have the same healthy water quality whilst recieving very little rain, it is being managed effectively. Although the turbidity has increased a little from 2019 -2020 it is still regarded as an acceptable water quality.

b) Discuss the claim made about the management of the catchment by using the stimulus to identify three possible causes and associated impacts on the local ecosystem. Propose and justify a solution to address the impacts. *[8 marks]*

It can be seen in stimulus 7 that within the Namoi river catchment. the agricultural cropping has increased roughly 0-10%. These added farms will deplete the natural water from the catchment much faster than when there was less farms. This change happened to come at the same time at which the rainfall was decreasing This would lead people to assume that the catchment is being poorly managed. Stimulus 8 shows Keepit dams water levels reducing rapidly, affecting all vegetation and fish species that occupy it. However the cause for the declining water level is due to the evaporation and farmers. But it is assumed that it is being poorly managed. The lack of rain is affecting all of the natural flora and fauna found in the Namoi river catchment. One possible way of stopping the depletion of water is to stop the farmers from using the water from the catchment. However in this circumstance water restrictions must be introduced to try and reduce this problem and allow Namoi river catchment to re fill.

Practices to strengthen

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

- the multiple choice items where students answered incorrectly to ensure subject matter is sufficiently covered
- ensuring students understand the importance of recording multiple choice responses in the response booklet, rather than responding on the question paper
- regularly reviewing numeracy skills, e.g. calculating percentage change
- the cognitive verb as a guide to determining the expected response, e.g. ‘explain’ is used when students are required to make an idea or situation plain or clear by describing it in more detail or revealing relevant facts
- explicitly using the stimulus in responses to questions, e.g. to justify decisions.