2020 General Mathematics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2020 assessment cycle, gives an overview of how students performed in their school and external assessments in relation to the learning requirements, assessment design criteria, and performance standards set out in the relevant subject outline. They provide information and advice regarding the assessment types, the application of the performance standards in school and external assessments, and the quality of student performance.

Teachers should refer to the subject outline for specifications on content and learning requirements, and to the subject operational information for operational matters and key dates.

School Assessment

Assessment Type 1: Skills and Applications Tasks

Students undertake five skills and applications tasks, including at least one skills and applications task from each of the non-examined topics. The equivalent of one skills and applications task must be undertaken without the use of either a calculator or notes.

Questions from past examinations or exemplar skills and application tasks can be used as the basis for questions in skills and applications tasks, however they should be amended so they are not easily recognisable and do not form the majority of questions assessed in any individual task.

It assists with moderation if all five skills and applications tasks are scanned into one file. Files also need to be checked for scan quality, and that responses are oriented the right way up before uploading. A variation form also needs to be submitted if a student did not complete one or more skills and applications tasks.

All nine assessment criteria should be assessed at least once in either the skills and applications tasks or in the mathematical investigation. In particular, RC5, ‘forming and testing of predictions’ is easier to assess within Assessment Type 2: Mathematical Investigations. If it is assessed in the skills and applications tasks, then students should have plenty of opportunity to meet the specific feature to an A standard.

The more successful responses commonly:

* included skills and applications tasks that contained an appropriate balance of routine and complex questions to be able to effectively differentiate across the grade bands. A complexity guide has been provided to support teachers to identify key questions and key concepts that provide the opportunity for complexity in responses. The document ‘Complexity Guide General Mathematics’ is available on the website at the following link: [https://www.sace.sa.edu.au/web/general-mathematics/stage-2/support-materials/subject-advice-and-strategies)](https://www.sace.sa.edu.au/web/general-mathematics/stage-2/support-materials/subject-advice-and-strategies%29)
* were seen when students had the opportunity for interpretation of the mathematical results in the context of the problem, including discussion of the assumptions and limitations of the results in all skills and applications tasks
* were seen when skills and applications tasks were marked to clearly indicate how much of each mathematical problem a student had been successful in attempting, identify where errors had been made and parts of a question where an incorrect value may have follow-on implications or marks allocated
* used appropriate notation and rounding in calculations.

The less successful responses commonly:

* were seen in skills and applications tasks that provided limited opportunities for students to respond to questions of a complex nature. Teachers need to ensure that at least 30% of the marks in each task are composed of questions covering complex concepts or requiring complex processes to solve the questions. Please note that where questions requiring complex processes or concepts are heavily scaffolded to support progress through the solution, the complexity is reduced
* were evident when the student was not given opportunity for interpretation of the mathematical results in context of the problem across all five skills and applications tasks
* included content that was outside of the curriculum. Two examples of this were plotting the mean point in statistics and using the incorrect method of calculating the comparison rates by adding all the fees up initially instead of adding them to the payment once calculated. It is important that the teachers reference the subject outline each year to review any changes to the curriculum requirements
* where teachers indicated that they were assessing RC5 (forming and testing of predictions) and CT3 (application of mathematical models), yet the students were not given an opportunity to show these skills at an A level, or at all
* used inappropriate notation and rounding where relevant, specific examples include Topic 5: Discrete Models, where students did not show units when finding the maximum of minimum amount in a Hungarian algorithm and in Topic 3: Statistical Models, when rounding either to an incorrect number of decimal places or not applying basic rounding rules correctly.

Assessment Type 2: Mathematical Investigations

Students undertake two mathematical investigations with a maximum length of 12 pages with a minimum of size 10 font. The evidence present in the two investigations should include key ideas and key concepts from at least two different topics.

Teachers may need to provide support and clear directions for the first investigation. However, the second investigation must be less directed and set within more open-ended contexts.

It is a requirement for moderation that student work is marked, including both clearly indicating the accuracy of mathematical calculations as well as making comments about the written component. Before uploading teachers should check the file for reasonable scan quality and that the work has the correct orientation. It also assists moderators with the moderation process if both tasks are uploaded in the same file.

The more successful responses commonly:

* were in response to tasks designed with enough scaffolding for students to achieve at the C grade band in the initial parts of the task, but also providing an open-ended section which requires students to extend their investigation in a direction of their own choosing. This allowed them to demonstrate their understanding at the higher-grade bands
* included a detailed development and application of a mathematical model beyond the initial model, with enough complexity. A complexity guide has been provided to support teachers to identify key questions and concepts that provide the opportunity for complexity. The document ‘Complexity Guide General Mathematics’ is available on the website at the following link: <https://www.sace.sa.edu.au/web/general-mathematics/stage-2/support-materials/subject-advice-and-strategies>)
* occurred when students demonstrated a comprehensive understanding of the assumptions made in their investigations, the reasonableness of their results, and the limitations of the models they had investigated
* were seen where students made appropriate predictions before they begun calculations, as well as using their calculations to refine future predictions and finally discussing the accuracy of their predictions. An example of this is when students make a prediction of how much money they will save on a home loan if they increase the payment by $100, they undertake this calculation and then use their answer to make a more refined prediction about how much they will save if they were to double the payment to $200
* were presented in an appropriate report format, including relevant headings, tables and graphs to present the key results, tables and graphs labelled for easy reference and a font size of at least 10 making it easier for the students to refer back to key calculations and summarise findings
* clearly marked the mathematical calculations for accuracy and outlined the decisions about the assessed performance standards for each task. This supports the students learning as well as the moderation process.

The less successful responses commonly:

* were in response to tasks that used the same starting parameters or data reducing the individuality of responses
* had evidence of all students following the same modelling processes (with the same changes implemented to their model), which indicated excessive teacher scaffolding. This particularly impacted the students in the higher-grade bands as scaffolding reduces complex mathematical modelling to a more routine level
* did not show enough complexity in calculations and model development at the A level even though the task allowed them to. Examples include in Topic 1: Modelling with Linear Relationships, where students did not cover concepts such as wastage, change of constraints, multiple solutions or non-integer solutions; in Topic 3: Statistical Models, where students only looked at residual plots for the exponential model instead of all models or didn’t look at the impact of removing an outlier; and in Topic 4: Finance Models where students only changed one variable at a time
* occurred where the performance standards were applied appropriately to the individual responses, but the overall grade awarded was inconsistent with the combination of levels achieved in the specific features. For example, a student who achieved assessments against the specific features mostly within the B grade band, with a few specific features in the C grade band across the two assessments should achieve an overall (holistic) B– grade, rather than a B grade
* lacked depth in the analysis of the results in context. Students should be informed that analysis of the mathematical results is what supports evidence rather than a recount what they did and how they did it
* lacked evidence of both drawing conclusions *and* understanding of assumptions and limitations to address RC2 - most commonly providing minimal evidence of explanation of the assumptions and limitations in context
* lacked evidence in either task of predictions being made prior to calculations being completed or a further discussion of the accuracy of the predictions
* when an open topic was covered however the task did not allow the students to show enough complexity to achieve in the higher-grade bands.

External Assessment

Assessment Type 3: Examination

The evidence in the students’ responses to the 2020 exam showed that the students coped well with the changed circumstances in their study due to the COVID 19 pandemic and that this did not appear to impact the overall results adversely, with over 75% of students gaining more than half of the total marks available.

Examination technique and efficiency issues

Many of the exam technique and efficiency issues highlighted in last year’s subject assessment advice remain relevant. Since they continue to have an impact on students’ results some of the notes are reiterated below with additions noted specific to the 2020 student exam responses.

In some cases, students are:

* writing too much in their responses. Students should avoid restating the question or writing sentences in their answers where only a calculation is required. There is also no need to restate the answer once it has been found.
* rewriting arrays unnecessarily in assignment problems (the Hungarian algorithm). They should look for ways to augment existing arrays (without obscuring the values) to indicate their working. An example of this is where students rewrite an array to draw the lines that show whether a solution has been reached
* not rounding answers appropriately for the context and/or not using the correct units of measurement as given in the question
* repeating information already written in the previous part of the question. In financial questions requiring the use of the TVM facility of the calculator follow-up questions often require a change in only one or two values in input for the next calculation. There is no need to repeat the unchanged values in the working for such questions. Only the changed input needs to be shown
* failing to respond to questions which require an addition to an existing graph, diagram or table. Although there is no answer grid below such questions (as the answer needs to be placed elsewhere) the allocation of a mark for the question on the right-hand side of the page shows that a response is required. It would be beneficial for teachers to draw students’ attention to this type of question in past papers during their revision
* not providing enough depth or justification in interpretative questions where more than one mark is awarded for the response
* not providing both answers when two things are required in one question
* not answering in the context of a question but rather copying a ‘standard’ response from their notes sheet when considering the reasonableness of, or limitations to, their solution
* not gaining full marks for a calculation because the calculated value was incorrect even though they gave the correct input values in their working on the paper. Students should be encouraged to take care that all entries written down are entered into the calculator and they are not using a value left over from an earlier calculation
* not appropriately using the fact that the approximate answer is given in a question. To enable students to proceed further through some questions with multiple parts a close approximation to the answer is sometimes given in the question. It is important that students write down the accurate answer from their calculations as the mark cannot be awarded for simply restating the value already provided, even though their answer rounds to this value. They should then proceed in the question using their more accurate value. Students who get a value significantly different from the one expected should indicate with a comment that they realise they must be in error. Such a student should then continue in the question using the given value to avoid further problems.

Examination markers aim to award marks for evidence of student understanding in response to examination questions wherever possible, however students should be advised not to cross out their responses or attempted responses to questions in the examination booklet unless they are confident that no part of what is crossed out should be considered by the marker.

If a student crosses out a response and then decides that it was the correct (or most correct) answer, then the student should indicate clearly to the marker which part of their response should be considered. This could be done by circling or highlighting all or part of the response the student wants to be considered and writing “please mark this work”. Students do not need to rewrite their answers in this case unless the crossing out has rendered the response unreadable.

Feedback on specific questions

Question 1 — Normal distribution

Most students used Ncd calculations correctly to find the answers although the standard proportions could have been used in part (a) with no loss of marks. The most common error in part (b) was the use of the left tail in the inverse normal calculation. The majority of students were aware that an integer answer was required in part (c)(ii).

In part (d) students gained no marks for simply ticking one of the boxes. Appropriate justification involving the comparison of figures from earlier parts of the question was required for a successful response. Many of the less successful responses either resorted to personal opinion or thought the question involved interpolation/extrapolation.

The majority of students correctly identified ‘C’ as the answer in part (e). The most common incorrect answer was ‘D’ which showed that while these students could locate the mean of the distribution, they did not know how to use the standard deviation to get the correct width of the graph. Similar comments apply to part (f).

Most students had no difficulty correctly answering both sections of part (g).

Question 2 – Superannuation

A number of students had difficulty with the straightforward calculation in part (a)(i), whereas they handled subsequent, more complex, calculations better. This may indicate that some students feel less confident doing financial calculations that don’t use the TVM facility of their calculator. One common error was using 9.5% for the calculation instead of 14%.

In part (a)(ii) a significant number of students used the annual salary figure of $32 000 for PV in the calculation instead of zero.

It should be noted that many students are not using the amortisation function to carry out ‘sum of interest’ [part (a)(iii)] and ‘balance’ [part (b)(ii)] calculations. While the longer way to do these calculations is not wrong it is inefficient, and teachers would be well advised to acquaint their students with the use of the amortisation feature.

In part (b)(iii) some of the less successful students gave an explanation that involved loans rather than investment. Others indicated that “interest was earned” but did not recognise the significance of the larger balance at the beginning of the annuity.

A common error in part (c) was using the duration of retirement (20 years) for the inflation calculation instead of years since the age of 23. The most successful students recognised that although the payout figure was sufficient (just) at the beginning of retirement it would not be by the end.

Question 3 – Hungarian algorithm

This question was done very well by most students, with over 50% gaining full marks. Less successful students either treated part (a) as a maximisation problem or did not realise that the better solution in part (b) required the higher score not the lower one (possibly because they thought the score represented ‘time’).

Question 4 – Loans

This question was accessible to most students with about 75% gaining half marks or better. More successful students in part (a)(i) realised that because the nominal and comparison rates were the same there must be no establishment fee. Unsuccessful students thought the answer lay in the fact the charges were zero or because the box was left blank or because the rate was higher than that for option B.

The calculation of the comparison rate in part (a)(ii) was done correctly by many students with working steps set out clearly and logically. The few students who used the ‘old’ method, whereby all the fees are added to the PV at the beginning of the loan, could not gain full marks as this calculation is inaccurate.

In part (b)(i) many students seemed unaware that the most significant disadvantage of the strategy is that the yearly repayment amount will be higher because 26 fortnightly payments is equivalent to 13 months payments, not 12, which raises the issue of affordability. More frequent compounding of the interest has only a very small impact on the amount of interest charged and this is outweighed in the long term by the savings made. Students who simply responded “he pays more interest” showed no understanding that the strategy lowers the amount of interest paid over the term of the loan.

When calculating the number of fortnights in part (b)(ii) quite a few students still seem not to understand the importance of the signs on the values for PV, Pmt, and FV in entering the data into their calculators. They also appear to be unaware that a negative value for the answer indicates they are in error, and the negative sign cannot simply be dropped from the answer.

Question 5 – Hungarian algorithm

This question was tackled well by most students with 80% of students gaining more than half marks, however, some students lost marks answering the question in part (a) because they did not pay careful enough attention to the units on the values, giving answers of 22 or 22,000 instead of 2,200. There were also many who reversed the meaning of the position of the value i.e., they wrote “supporters of Dunedin in South Africa”.

Overall, the calculations involved in the Hungarian algorithm were carried out well by most students. In part (d)(ii), however, many students did not give a complete interpretation of the solution which must include the value of the variable being optimised (in this case the total number of supporters).

In looking for answers to part (e) students had scope to consider the limitations to the existing model by considering factors such as population numbers in each city, the size of the stadiums, etc. which could have an impact on the number of attendees at the matches. Students who said “because Dunedin misses out” did not understand that this is not a problem with the model – with four teams and five cities one city has to miss out no matter how it is done.

Question 6 – Linear regression

The vast majority of students had no trouble answering part (a) although some restated that the relationship was linear (rather than positive) in part (ii). Most could indicate the correct equation in part (b) and recognise that an integer value for the calendar year prediction in part (c)(i) was needed.

In part (c)(ii) the most successful students reasoned that although the correlation was very strong the large amount of elapsed time since the last broken record and/or the unreasonably large increase in the predicted record height (when in the past the record had only been broken by small amounts each time a new record was set) made the assumption of a continuation of the trend (and hence the prediction) unsound. Less successful students simply cited ‘extrapolation’ as the basis for making the prediction unreasonable.

Successful students in part (d) interpreted at least one of the slope values correctly as a rate of increase in the record height per year and knew that these values showed that the trend almost doubled after 1960.

Unsuccessful students focussed only on the slight change in r2 values, despite being directed to the slope and the trend in the question.

Question 7 – Critical path analysis

The majority of students were able to correctly identify the position of the dummy link in the network although some did not gain full marks because they didn’t indicate the direction with an arrow.

In part (b) all three statements are true in certain circumstances but only the third one is always true irrespective of the time taken for tasks H and K. The most common incorrect answer given was the second statement, indicating that those students may not have come across examples where parallel tasks take the same amount of time and both end up on the critical path.

A small but surprising number of students could not identify the ‘finish time’ as the shortest time in which the process could be completed in part (c). Others got the value right but failed to use the correct units of measurement (giving ‘days’ or ‘mins’ instead of ‘hours’) and hence lost the mark.

In part (d) the most common error was to give only the obvious precedents to task R (namely K, L, M and Q) and miss those before the dummy link (A and B).

In part (e) many students could state the two critical paths, however less successful students found only one or else gave a third path along the dummy link.

A great many students are still unable to find slack time correctly from the information in a network diagram. In part (f), instead of subtracting the earliest starting time for task S from its latest finishing time to get the time available (31–12 = 19 hours) and comparing this with the time the task actually takes (10 hours) to get 9 hours slack time, most of the unsuccessful students simply subtracted the two figures at the beginning of task S (18–12 = 6 hours). This calculation only gives the correct answer in certain simple scenarios and it would appear that many students are not familiar with handling more complex cases such as the one presented in this question.

In part (g)(i) most students showed that they could perform a forward scan correctly, however in doing the backward scan many of them ignored the dummy link and made an error at the node between tasks B and C.

Overall, the responses in parts (a), (d), (e), and (g)(i) showed that there are many students who are not comfortable handling dummy links in critical path analysis and more practice with such problems in class might be beneficial for future students.

The next part of the question [(d)(ii)] was left unanswered by a significant number of students even though they had performed the forward and backward scan. It is assumed that the reason for this, in the majority of cases, is covered by the fourth dot point in the comments on exam technique above. It needs to be stressed to students to read carefully and if a mark is awarded then a response is required even if there is no writing grid provided.

Of the students who did mark a critical path there were a significant number who incorrectly included task S. Students need to understand that a task linking two nodes on the critical path does not itself lie on the critical path if the task time < (starting time – finishing time) (i.e., if it has slack time it is not critical).

The last part of question 7 [(d)(iii)(2)] provided quite a challenge. It was not sufficient to simply state that the critical path had changed. A successful response required the student to show depth of understanding of the model by indicating the relevance of the change in the time for task Q as well as that in task D.

Question 8 — Investment

This question presented the widest spread of marks of any of the questions in the paper, however, over three quarters of the students were able to gain half marks or better. Successful responders to part (a) understood the contextual information given in the question and gave the age appropriately (i.e., not as a decimal or rounded up to 22 years old). The comments made at the end of Question 4 about the significance of positive and negative values when calculating ‘n’ also apply here.

In part (b)(ii) quite a few students found the interest earned in the first ten years instead of in the eleventh year of the investment, as required. Others found the interest earned between payments 109 and 120 (which is the tenth year of the investment when Maya is 27 years old, not 28). The question made it clear that the first deposit was made on Maya’s 18th birthday, so all elapsed time needed to be calculated from this point. NOTE: It was far easier and quicker to use the amortisation function of the calculator (Pmt1 = 121, Pmt 2 = 132, **Int = ans) in this part of the question than any other method. Those who found the FV at the end of the eleventh year and subtracted the balance at the end of the tenth year often forgot to take account of the money deposited during the eleventh year.)

In part (b)(iii) there were still a significant number of students calculating tax on a principal value instead of on interest.

Question 9 – Exponential regression

The many students who responded to part (a) by saying “there is a pattern in the data” were unsuccessful as they did not specify what kind of pattern made the linear model inappropriate (a straight line is also a type of pattern and in this case a linear model would be appropriate). It is assumed that many of these students thought they were looking at a residual plot and not a scatterplot of the data. It is important that students understand the difference between these two types of graph.

The italics in part (b)(i) were intended to make sure students understood that they must use the contextual variables in the equation, however many students still used ‘x’ and ‘y’ instead of ‘d’ and ‘M’ and lost the mark.

In (b)(ii) successful responses explained that the value of ‘b’ meant that for each new disc added to the puzzle the minimum number of moves:

* increased 2.135 times or by a factor of 2.135 [not increased by 2.135 which implies addition]

or

* increased by 113.5% [not 213.5% or 13.5%]

or

* “slightly more than doubled” was also acceptable as it showed understanding of the multiplicative nature of the rate of increase and its approximate value.

Unsuccessful responses gave the incorrect answers in the brackets above or else showed a lack of any understanding of this parameter (for instance by saying it was ‘the slope’ or ‘the y-intercept’).

Most students could find the required value of r2 in part (b)(iii) but they needed to state it correct to at least 3 figures (0.995 …) to gain the mark, as rounding to 0.99 is incorrect and rounding to 1 is inappropriate as the correlation is not perfect.

The great majority of students answered part (b)(iv) correctly.

In part (c) quite a few students correctly selected the third statement as being the one which best described the behaviour of the model as evidenced by the residual plot. About the same number of students selected the second statement, showing that they had the right idea but thought that points below the horizontal axis on the residual plot represented an underestimation in the prediction rather than an overestimation. They could have checked this by comparing their answer to the previous part of the question with the data and the point on the residual plot for d=4.

Part (d)(i) was done well by very many students, with the majority being able to state that the r2 value of 1 meant the correlation was ‘perfect’. Only a very few students, however, were able to demonstrate the clear understanding of what this means by making the step required to answer part (d)(ii) correctly. Most students either reiterated the equation found in (b)(i) or left the question blank.

It is possible that most students in this subject only ever deal with ‘noisy’ or ‘statistical’ data in their mathematical modelling, so the models found are always ‘approximate’. It’s important that students realise that situations exist where the relationship between two variables can be modelled exactly by either a linear or an exponential equation and that they have experience of these in their learning.

While the model found in part (d)(ii) was not a standard exponential function like those found by the calculator, the steps were scaffolded in such a way as to lead an able student to the correct conclusion by a simple, logical application of the mathematics taught in the course. It is likely that it was inexperience with this type of situation rather than lack of mathematical ability that prevented more students from being successful in this question.