2022 Essential Mathematics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2022 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. In 2022 The following subject outline adjustments have been made: Students provide evidence of their learning through seven to eight assessments, including the external assessment component. Students undertake:

* four or five skills and applications tasks
* two or three folio tasks
* one examination.

It is expected that teachers used their professional judgement in the design of the suite of assessments to suit their cohort, ensuring any specific requirements of the subject outline are met (for example, covering the non-examined topics).

During moderation it was noted that: Some schools chose to take out an SAT for one of the non-examined topics, but went on to include a Folio task that covered that topic instead. Very few schools submitted no tasks at all for either of the non-examined topics. Even with COVID adjustments, most schools submitted a minimum of two Folio tasks. The majority of schools did not choose to remove a task from their LAP at all due to impacts of COVID on their students.

It is a requirement for moderation that student work is marked for both school assessment types. This means clearly indicating the accuracy of mathematical calculations for SATs and Folio tasks, as well as making insightful comments about the written component for investigations. Unmarked samples were returned to schools to be properly marked before moderation could occur.

Before uploading materials, teachers should check the file(s) for reasonable scan quality and that the work has the correct orientation.

Across the Assessment Types for this subject, students can present their responses in oral or multimodal form, where 6 minutes is the equivalent of 1000 words. Students should not speed-up the recording of their videos excessively in an attempt to condense more content into the maximum time limit.

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From 2023, if a video is flagged by moderators as impacted by speed, schools will be requested to provide a transcript and moderators will be advised to moderate based on the evidence in the transcript, only considering evidence up to the maximum word limit.

If the speed of the recording makes the speech incomprehensible, it affects the accuracy of transcriptions and it also impacts the ability of moderators to find evidence of student achievement against the performance standards.

School Assessment

Assessment Type 1: Skills and Applications Tasks

Students complete four or five skills and applications tasks, including at least one skills and applications task from each of the non-examined topics (see COVID adjustments above). Skills and applications tasks are completed under the direct supervision of the teacher. The equivalent of one skills and applications task must be undertaken without the use of either a calculator or notes. In the remaining skills and applications tasks, electronic technology and up to one A4 sheet of handwritten notes (on one side only) may be used at the discretion of the teacher. The school set of assessments as a whole should provide students the opportunity to demonstrate evidence for assessment for each of the specific features at least once.

Teachers are encouraged to access the support material document ‘[Complexity Guide Essential Mathematics](https://www.sace.sa.edu.au/web/essential-mathematics/stage-2/support-materials/subject-advice-and-strategies)’ which is available on the website. The complexity guide has been produced to support teachers to identify key questions and key concepts that provide the opportunity for complexity in questions.

To support student learning, teachers should ensure SATs are marked to clearly indicate how much of each mathematical problem a student has been successful in attempting. This includes identifying where errors have been made to support student learning and checking/marking following parts of a question where the incorrect value may have follow-on implications.

There was little evidence of students not having access to approved graphics calculators. Students are required to show effective use of technology and lack of access to an approved graphics calculator is seen to disadvantage the students.

Teachers can elicit more successful responses by:

* including SATs which have a good balance between routine calculations/analysis (approximately 65%), complex calculations (approximately 30%) and complex interpretive questions (approximately 5%)
* including some routine questions that are broken into distinct parts (scaffolded) and at times (but not always) use prompts such as “show…” and “calculate” to support students to engage initially with questions. Students can be prompted on the method required for solutions sometimes (e.g. “use the Sine rule to”), however this removes complexity and should not be common in a task (specific feature CT2)
* providing students with enough complex problems to enable them to provide evidence of their ability to solve questions of a complex nature. This was particularly evident in Topic 1: Scales, Models and Plans, where limited opportunities for responses to complex calculations limited evidence at the ‘A’ level (specific feature CT2). It should also be noted that excessive scaffolding, breaking too many problems down to 1 or 2 mark sections, can reduce a complex calculation to one that is more routine in nature
* including questions in the Measurement SAT that required a range of simple, compound and irregular shapes to be used in solving problems set within appropriate contexts (specific feature CT2)
* providing students with the opportunity to answer ‘What if’ and ‘reasonableness’ questions in all SAT assessments. This enables students to demonstrate the development of their skills in analysing their results and to consider assumptions made to find solutions, and how the assumptions impact the reasonableness of the solutions (specific features RC1 and RC2)
* expanding questions to include the development of an initial scenario, particularly in Loans and Investments. This increases the complexity particularly where the signs of input values need to be considered (CT2, CT3 and CT4)
* providing diagrams which supported student understanding of contextual information or required students to identify values or add values to the diagram. These supported the students to understand the requirements of the question, and/or to identify and/or interpret all known information
* providing opportunities for students to demonstrate the use of technology, particularly in Statistics and Investments and Loans (specific feature CT4)
* clearly indicating which assessment(s) provided evidence addressing the specification of at least one SAT without technology and notes
* providing clear feedback about errors in SATs and guidance on what needed improvement in following assessments
* provide students with the opportunity to demonstrate the different approaches required for ‘state’, ‘explain’ and ‘describe’ questions.

Teachers limited opportunities of students by:

* using tasks that cover narrow aspects of topic content, limiting student’s ability to demonstrate comprehensive knowledge and understanding of concepts and relationships (specific feature CT1)
* providing limited opportunities for students to display evidence of good interpretation in the context of the question (specific feature RC1)
* providing limited opportunities to effectively communicate mathematical ideas and reasoning to develop logical mathematical arguments (specific feature RC4)
* requiring no or limited evidence of calculations. In multiple mark questions where only final solutions are provided and the result is incorrect, marks for appropriate steps cannot be allocated. Teachers should encourage students to show appropriate steps in their mathematical calculations (specific feature RC4)
* assessing performance standards within a task that did not provide students with multiple opportunities to provide evidence of that particular specific feature. Where only one opportunity was provided students were often disadvantaged
* including tests in the set of assessments straight off of the SACE website. These provide teachers with exemplars of the standard, however as they are available in the public domain they should not be directly used as summative assessment.

The more successful responses commonly:

* displayed clear communication of the steps in solving problems (specific feature RC4), with correctly labelled calculations, correct units of measurement and appropriate rounding (specific feature RC3)
* provided detailed, concise calculations when responding to questions
* stated any formulas used, identified values that had been given in the question stem or provided in diagrams required for the solution, and provided a clear answer for the variable that was required to be found
* displayed an understanding of the impact of assumptions on the answers they calculate, and the ability to explain these in the context of the problem being solved

The less successful responses commonly:

* often did not attempt to answer questions, particularly more complex style questions
* included many arithmetic and algebraic mistakes
* don’t use the prompts given in ‘show’ questions to identify when they have made an error or use that value in following calculations to allow them to continue on through the question successfully
* used incorrect notation and did not communicate a good knowledge of the mathematical techniques and algorithms covered in the course
* attempted to use the compound interest formula in place of the graphics calculator making Financial Models calculations much more difficult and in some cases, impossible
* stated rather than explained or discussed assumptions, limitation and reasonableness
* did not demonstrate the rearrangement of equations to resolve an independent variable sought.

Assessment Type 2: Folio

Students complete two or three folio tasks, where they investigate a mathematical problem based in an everyday or workplace context. Where the option of four SATs for the school assessment is used, the topic not assessed in skills and applications should be assessed within a folio task. The subject of the mathematical problem may be derived from one or more topics. Each folio task, excluding cover page, bibliography and appendices if used, must be a maximum of 8 A4 pages (OR 12 A4 pages for two folio tasks) if written (minimum font size 10), or the equivalent in multimodal form. The folio tasks should provide ample evidence of specific feature CT3.

Again, teachers are encouraged to access the support material document ‘[Complexity Guide Essential Mathematics](https://www.sace.sa.edu.au/web/essential-mathematics/stage-2/support-materials/subject-advice-and-strategies)’ which is available on the website. Teachers need to ensure each Folio task provides opportunity for students to clearly demonstrate complexity in their mathematical calculations.

Teachers are required to ensure that all mathematical solutions produced by the student in the investigations are marked for accuracy and errors are identified. This supports both student understanding and the moderation process.

Teachers can elicit more successful responses by:

* providing students with 12 A4 pages as their maximum page count for each task when the option of two investigations is adopted
* providing students with clear opportunities to format predictions and to go on to test those predictions mathematically and interpret the results of their testing in context of the predictions made
* supporting students to understand where complexity can be found in the mathematical investigations that are undertaken (correlation — removal of outliers, using equation of best fit, investments and loans — explicit use of technology, multiple changes at once, comparisons of investments savings or loan costs, scales, plans and models — ensuring garden designs, for example, include clear, correct dimensions, an appropriate scale and enough complexity (e.g. irregular and/or compound shapes with curves), breakeven — BOTH graphical and algebraic calculations and discussion of breakeven points are demonstrated including relevant and reasonable changes to the original scenario)
* providing students with open-ended tasks that allow students to choose the path of their model development in their investigation and select their own ideas/figures/contexts to follow. This ensures individuality in responses and supports differentiation in assessment of the responses seen (specific feature CT3).

The more successful responses commonly:

* demonstrated a high level of accuracy in their calculations
* had clear communication of the steps undertaken in the investigation — providing connections between the mathematical investigations which were easy to follow and clearly identifiable (specific feature RC4)
* developed a model that addressed “What if….” scenarios/opportunities that were of a complex nature (addressing multiple, simultaneous/sequential changes) (specific feature CT3)
* made links between the results of different “What if….” scenarios and were able to interpret differences within the context of each scenario and the mathematics used (specific feature RC1)
* provided in-depth discussion of reasonableness and limitations that clearly linked to the context of the investigations, not just stating generic reasons (specific feature RC2). The student discussions provided clear explanation of the likely effects of the assumptions/limitations on the model/answers
* showed intuitive modelling and did not repetitively change variables unless it made sense to investigate that particular part of the problem further
* included repetitive calculations in the appendices, with an initial calculation providing evidence of the skill in the main body. The results of the additional calculations that were placed in the appendices were included in a table (or other concise manner of presenting multiple results) in the main body for comparison and discussion

Teachers limited opportunities of students by:

* providing minimal or no feedback to the students, therefore not assisting them to identify areas that they needed to develop further (e.g., communication of the mathematics, including interpretation and analysis), or supporting students to identify which areas of the mathematical calculations had errors. Note: In this instance, teachers should provide students with the drafting feedback to check calculations on page ‘X’, not specifically highlight all calculations with errors
* designing assessment tasks that were too short by providing maximum page limits less than the subject outline allows for the number of assessments undertaken in this assessment type. Providing students with a page maximum less than the subject outline specifies for, limits the students’ ability to demonstrate comprehensive knowledge and understanding of concepts and relationships (specific feature CT1)
* limiting opportunities to provide alternative investigations or changes to scenarios by providing tasks that had obvious scaffolding throughout all parts of the task. This limited the complexity of the overall set of tasks and impeded the student’s ability to show that they could ‘develop’ a model (specific feature CT3)
* designing tasks with very limited scope for further investigation or included mathematical content that did not get beyond basic or routine levels. This was often evident in the Topic 2: Measurement folio tasks where only basic shapes were often seen

The less successful responses commonly:

* provided brief discussions with little or no reference to calculations (specific feature RC4) or provided a description of the mathematical process used rather than a discussion of the assumptions of the mathematical model and its impact on the reasonableness of solutions (specific feature RC2)
* often only addressed the initial routine scenario set up by the task and did not go on to develop “What if….” questions in any depth
* did not provide evidence of using technology when it was identified for assessment in the task. Using technology does not include typing up the folio task response or continually using an ‘online calculator’ or using a calculator for basic arithmetic, often seen in Break Even or Measurement tasks (specific feature CT4)
* provided evidence of students creating and using unreliable models, particularly in Statistics where correlation investigations with a very weak relationship between the variables were used to make predictions. As a guide, an r2<0.7 is not sufficiently large to proceed with. Where students have not got the time to investigate new variables, they need to show a very clear understanding of the limitations of using a least squares regression line to make predictions when the relationship is so weak
* reworded statements from the task sheet slightly rather than discussing findings in their own words with links to their calculations and specifically in the context of their own investigation
* would state an arbitrary prediction, without justification, and then go on to either test the prediction mathematically incorrectly or not at all
* provided limited, if any, interpretation of differences between predicted values and mathematically calculated solutions
* missed the opportunity of exploring the effect of rounding choices
* missed the opportunity to discuss the reasonableness of results or to improve the reasonableness e.g., removal of outliers in correlation or improved techniques in estimation of irregular or compound areas
* missed the opportunity of developing and interpreting the impact of meaningful and reasonable changes to an initial scenario e.g., the impact of making the same lump sum payment at alternative times during the term of a loan or recognising the relationship between different interest minimisation strategies e.g., a first home buyers grant as a lump sum payment made at the start of a loan term is effectively reducing the amount borrowed and not a complex calculation.

External Assessment

Assessment Type 3: Examination

Generally, the students who achieved successfully showed logical and clear solutions. Calculations that required routine substitution in formula were generally completed well. Students were able to convert answers to appropriate units. They interpreted contexts appropriately and responded appropriately by differentiating their responses to ‘state’ and ‘discuss’ questions. Students used correct mathematical terminology in their responses and mathematical reasoning to logically answer questions.

Some students need encouragement to look for parts of questions they can attempt rather than leaving entire questions unattempted.

‘Show’ questions are to ensure students can continue with a question despite not achieving an answer or having an incorrect answer. Some students try to incorporate the ‘show’ answer in their solution suggesting they do not understand or are unfamiliar with this type of question. Teachers should consider including these questions in their SATs if they do not already to support students with their access to follow-on questions so they become familiar with them prior to the examination. Students should be assured that they should just answer a ‘show’ question in the same way they would answer any question and just use the ‘show’ as a check or to continue with if their answer is not similar.

Question 1

(a) Some students did not show an understanding of perimeter by including interior lines in their answer for perimeter.

(b) Students successfully found the area of 1 rhombus but sometimes did not find the area of the pattern by multiplying by 8.

(d) The most common error was caused by students dividing by 100 which would be appropriate if converting linear measure but a conversion for area would require a division of 1000.

(e) Understanding that the quilt had to be a square challenged many students. Many formulated a solution but needed to ensure that 100 square panels were required to make the quilt square.

Question 2

(a) (i) Students often did not recognise they were given the hypotenuse and proceeded to add the given lengths squared rather than subtracting the leg from the hypotenuse.

(ii) As the triangle was right-angled ½ bh was an appropriate method to apply. Some students resorted to the longer methods applicable for non-right-angled triangles. Often their answer was correct but with an expected increase in time.

(b) (ii) While the majority of students successfully applied the Sine Rule to solve this problem some students stated FG = 1km. It was concluded that these students assumed FG = EF. This was not indicated to be the same so was an incorrect assumption. Students must understand lengths that are the same will be clearly indicated and the visual appearance of similar lengths should not be relied on to solve problems. Some students did not substitute the angles correctly.

(iii) Some students were able to apply the given area of a triangle successfully.

(d) (i) Students were challenged by the application of Simpson’s Rule due to requiring zero lengths at both ends of the approximate shape. This affected the pattern of the formula substitution inside the brackets. Some students did not apply the width correctly using 3.2km rather than dividing it by 4.

Question 3

(a) (i) Some students found the area instead of the volume.

(ii) Conversions in this question were generally completed successfully.

(c) (iii) Students generally showed that they understood that the time was dependent on the water flow and gave valid assumptions about the impact on the time calculated.

Question 4

(a) Students often did not refer to the sampling method in their answers. Students regularly referred to the sample size which was not what was required. Teachers are encouraged to explain the necessity of ‘referring to’ as a key indicator as to what to include in their answers to ensure they maximise the marks gained.

(d) (i) Students were generally able to complete the stratified calculation to determine the number of people surveyed but (ii) challenged most students. Pleasingly some did recognise that the number surveyed was double the previous answer to solve it.

Question 5

(a) The stem and leaf plot was competed successfully except for a few students who did not order the leaves.

(b) While most students made the correct selection of words for each statement, some students did indicate (ii) as ‘smaller’ range which was incorrect.

(c) (i) Some students identified the outlier as 79, reading the stem and leaf plot back-to-front.

(ii) Teachers are encouraged to focus students’ understanding that if a question is referring to a general trend, then the statistical measures that are relevant are; mean, median and mode. If a question is referring to consistency or variability the statistical measures that are relevant are; standard deviation, interquartile range and range. This question required students to determine that when an outlier is present the median will be a better measure of general trend because it is a resistant measure.

(e) Some students failed to complete the whiskers on the Boomer’s box plot and some did not include labels. Students are encouraged to use the box plots drawn as examples.

(f) Required students to select an age group and justify their choice. It is important to understand that for this question the age group selection had to be supported by the justification. Either choice could be accepted with an appropriate justification. Students provided detailed and appropriate justifications for both age groups.

Question 6

(c) Some students were not able to state the r2 value.

(e) (ii) Most were able to recognise that the stronger relationship would support a better prediction, but students generally did not recognise this prediction as extrapolation. The best responses included a reference to both the stronger relationship and that it was an extrapolation. A significant number of students incorrectly stated that the prediction would be improved by either an increase in number of data values or the increased spread of the data.

Question 7

(d) Many students missed the additional step required in this calculation to find ‘how much less’ despite it being italicised and bolded. A focus on the number of marks may help students to be aware of these additional requirements in questions.

Question 8

(c) (ii) Similar to Question 7 (d) students missed the additional step required in this calculation to find ‘how much longer’

Question 9

(c) (i) Many students completed a compound interest calculation despite the question stating that it was a simple interest rate and a term-deposit account which, by definition, is a simple interest account. Of those who did recognise it as a simple interest calculation, many did not identify the Interest as $20 not $1020.

(d) (iii) Students are encouraged to answer ‘explain’ questions more specifically and in this case about the impact. They need to discuss the change and the effect of the change. For example: If interest rates increase then she will achieve her saving goal more quickly. If interest rates decrease, then it will take her longer to achieve her saving goal. As compared with if interest rates change it will take longer or shorter for her to achieve her goal. The last statement does not show enough understanding of the relevant impact.

Teachers are encouraged to direct students to focus on the requirement for the negative entries in the Graphics Calculator. Most errors were related to the negative entries. Also 56 weeks in a year was commonly used.

Some students did not attempt or partially attempted the last questions. It is unclear whether they ran out of time or whether they found the finance section most difficult. It is important for students to be encouraged to complete questions and topics in an order that will allow them to maximise their marks.