2021 Essential Mathematics Subject Assessment Advice

Overview

Subject assessment advice, based on the 2021 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.

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

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. 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.

School and external assessment evidence showed that some students did not have access to approved graphics calculators. This disadvantages students, particularly in the Statistics and Investment and Loans topics. Students are required to show effective use of technology and lack of access to an approved graphics calculator was often 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%).
* 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 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 the opportunity to answer ‘What if’ and ‘reasonableness’ questions in all SAT assessments allowing students to develop their skills in analysing their results and considering assumptions made to find solutions, and how the assumptions impact the reasonableness of the solutions (specific features RC1 and RC2).
* including routine questions that were broken into distinct parts (scaffolding) and often (but not always) used 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 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 all known information.
* providing opportunities for students to use 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.

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).
* not including at least one skills and applications task from each of the non-examined topics as specified in the subject outline.
* 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 and correct units of measurement (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 that’ 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.
* seemed unfamiliar with how to use their graphics calculator or did not have a graphics calculator which made the Financial Models calculations much more difficult.

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 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.

Teachers are requested 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.
* addressing predictions in the Statistics topic where this topic is one of the investigation tasks used (specific feature RC5).
* 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).
* 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:

* 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).
* 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 the 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 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).
* 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’ (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 r 2<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.

External Assessment

Assessment Type 3: Examination

Students undertake one 2-hour examination in which they answer questions on three specified topics from the Subject Outline. The topics that are specified for examination are:

* Topic 2: Measurement
* Topic 4: Statistics
* Topic 5: Investments and loans.

Examination markers aim to award marks for evidence of student understanding in responding 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 their response should be considered by the marker.

If a student crosses out a response and then decides that it was the correct (or the 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 that the student wants to be considered and write ‘please mark this work’. Students do not need to rewrite their answers in this case, unless the crossing out has rendered the response unreadable.

When a question refers students to use a previous answer, students should be encouraged to understand that this is a hint to support them to answer the question successfully.

Students need to be encouraged to be more specific to the actual scenarios in questions requiring explanation and/or discussion.

It is important to understand that the last part of a question is usually designed to allow the highest achieving students to show a greater level of knowledge and understanding. This differentiates the results for these students. However, all students should be encouraged to attempt all questions because often they can earn some marks when they are able to show some knowledge and understanding.

Topic 2: Measurement

Question 1

(a) (i) Some common errors seen in student responses were finding the area of the circle rather than the circumference and using the diameter rather than the radius for the calculation.

(ii) Some common errors seen in student responses were including the top and/or bottom of the cylinder, not halving the surface area and not subtracting the 0.75m from the height of the cylinder. Each of these would be one error, so students still earned marks in this part unless they made more than one error.

(b) It was pleasing to note that students recognised the need to round this answer up to ensure they had adequate paint.

(c) Some students either referred to incorrect previous parts of the question or were unable to respond to the question successfully.

Question 2

Students were generally able to apply Pythagoras Theorem and the Sine or Cosine Rule appropriately. When errors were made, they were due to rearrangement errors or applying the incorrect rearranged formula (e.g. adding or subtracting when the alternative was required).

(c) (ii) Some students attempted to solve this non-right-angled triangle using right-angle triangle formulae.

(e) (ii) Students were asked to explain if the estimation of the area was reasonable. Students needed to focus on the balance of areas included compared to the areas excluded, and to indicate whether they were balanced to achieve the 2 marks for this question.

(f) Despite a number of steps being required (calculation of the volume and mass of sand to be excavated, and hence the number of trips the truck was required to make), a pleasing number of the students were able to complete at least one of the required steps appropriately. Often the mass step was the step that was missed or incorrect.

Question 3

(a) Some common errors seen in students responses were calculations finding the volume of a sphere only instead of the hemisphere, or the use of the diameter rather than the radius.

(b) The calculation was mostly completed successfully, however students often did not include a statement about the significance of the mass of the ice cream calculated compared with the one tonne goal. Students should be encouraged to understand that a question with ‘state’ requires a comment to show understanding of the calculation and ‘justify with calculations’ means a calculation is required. The mark scheme will reflect marks for each requirement.

Topic 4 Statistics

Question 4

(a) Many students were able to accurately calculate the statistical values for females (the first column) but had errors in male values (the second column). This may be due to data entry errors, however an emphasis on correctly ‘setting’ the graphics calculator up for these calculations may also be pertinent to ensure the correct values are being used by the calculator.

(b) Box and whisker plots were generally drawn accurately and included appropriate labelling. Some students did not align their values with the scale.

(c) (ii) When students are asked to explain variability it is imperative that they clearly reference the appropriate statistical values (range, IQR and standard deviation) to show their knowledge and understanding. Commenting generally on all values being higher does not discern their understanding of the statistical values calculated. When discussion of variability is required, this requires students to show understanding of consistency and therefore reference the range, IQR and/or standard deviation in their response. When discussing general trends of data, the mean, median and mode are all appropriate measures to refer to.

Question 5

Students generally showed good understanding of sampling in this question.

(a) The majority of students were able to state at least one concern with the sampling process.

(b) (iii) Many students stated that the sample size would improve the reliability of the results, but this response is not related to a stratified sample method. Appropriate responses for this question included using data for all year levels in the school in the sample or an indication that the proportion of year levels in the population should be reflected in the sample to obtain more reliable results.

Question 6

(c) This common question being asked in a different way appeared to be more challenging for students. Students were challenged to explain why the data for 1980 did not appear to be an outlier. A comment about it following the trend would have addressed the question.

(e) – (g) This set of questions presented a challenge for many students. While many students could calculate the least squares regression line (line of best fit) they were often unable to use it to calculate the predictions and comment on the reasonableness of the predictions. When students did calculate the correct prediction for part f) they often ignored the negative value, misunderstanding that the negative value indicated a negative number of countries attending the Olympic games in that year. Rearranging the least squares regression line (line of best fit) presents a challenge to many students.

Topic 5 Investments and Loans

Students generally demonstrated strong skills when answering Investments and Loans questions with the graphics calculator, however, errors when negative signs are required are still quite prevalent. It may be pertinent to further stress the importance of the correct application of negative signs in the variables used for particular calculations (e.g. when finding ‘i' or ‘n’). There is no penalty for a student not writing the negative signs in their answers because their answers indicate whether they have used them correctly in their calculators.

Students should be encouraged to be more discerning with the language used in reference to loans as compared with savings options. For example, they incorrectly describe reducing interest for investments or increasing interest for loans.

Question 7

(a) Some students only calculated the annual contribution. They did not divide the contribution by 4 to calculate the quarterly contribution as per the instruction given in the question stem.

(d) A common error was for students to indicate the time as 30 years rather than recognising that it was only 10 years because the balance was from the first 20 years.

(e) (ii) While many students were able to recognise that the interest earned was reduced to achieve the two marks for this question, they also needed to include a comment linking the reduction of the superannuation fund balance to the reduction of interest earned because of the withdrawal of the $20000.

Question 8

(a) (i) Some students did not convert 18 months into years before calculating the rate for the simple interest.

(ii) Tax was often incorrectly calculated on the $4000 principal, or on the entire $4275, rather than just on the interest.

(c) Students often did not find ‘how many weeks less’ for part c). In this question they were required to calculate the time *saved* in reaching the goal of $275 in interest earnings Yoko made by contributing $1 each week into the account.

Question 9

(d) Students were generally unable to calculate the interest saved when comparing the two separate situations, however, many were able to calculate the interest for one situation.

(e) This question was an example where students were too general with their discussion of the reasonableness of the situation. A reference about the affordability of the 20% deposit was an appropriate response.