Mathematical Applications

2012 Chief Assessor's Report

Government of South Australia

SACE Board of SA

MATHEMATICAL APPLICATIONS

2012 CHIEF ASSESSOR'S REPORT

OVERVIEW

Chief Assessors' reports give 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, the quality of student performance, and any relevant statistical information.

SCHOOL ASSESSMENT

There was strong evidence that teachers who had attended the clarifying forums earlier in the year had a good grasp of how to apply the performance standards appropriately in both skills and applications tasks (SATs) and folio work.

In general, assessment tasks were designed well by many teachers, and gave students scope to achieve at all grade levels. These tasks, taken as a whole, addressed all areas of the performance standards in a well-balanced fashion. There was evidence that attendance at the clarifying forums benefited teachers in good task design.

Assessment Type 1: Skills and Applications Tasks

Many teachers responded to the reduction in the number of SATS by including a single test for some topics. It is no longer a requirement of Mathematical Applications that *all* key ideas in a topic are covered in the SATs.

However, it is important to recognise that, if at least one SAT is not included in every topic, there will be a lack of balance in determining the overall grade and students may not be well prepared for the examination. When completed assessment work deviates from the approved learning and assessment plan, particularly for the whole class, this must be clearly indicated on the addendum at the end of the learning and assessment plan submitted in the teacher's folder for moderation.

A lack of complexity in the task design of the SATs occasionally led to a disparity between the marks awarded and the grade levels achieved in the performance standards. If the mathematics in the tests lacked sufficient complexity, students could not achieve the higher-grade levels, no matter how many marks they gained.

At the other extreme were SATs with questions lacking a structure that would allow students access to the routine marks. A problem which requires several steps to solve, but which is posed as a single question, is considered complex even if each of the steps is routine. The same problem posed as a question with several sequential parts makes the routine marks more accessible. A well-designed SAT would contain questions of both types to allow for discrimination between students of different abilities.

In SATs the specific features of the assessment design criterion for communication of mathematical information should be explicitly assessed and clear feedback given to students. In some of the work seen there was no evident penalty in the marking of work in which students consistently omitted units, used incorrect units, or rounded answers inappropriately. It may be useful preparation for the examination for teachers to model how such penalties are applied.

Occasionally harsh marking occurred when teachers had not followed through, after an initial mistake, to see if the subsequent reasoning was correct.

Some SATs tested mathematical ideas that are not in the subject outline: for example, bonds in Topic 2: Investment and Loans; matrix algebra and 2×2 transition matrices; coefficients of skewness and variation, graphs of single data sets (i.e. no comparison of data sets), and cumulative frequency tables in Topic 7: Statistics and Working with Data. It is not appropriate to use these concepts to determine achievement against the performance standards in SATs.

Assessment Type 2: Folio

So as not to disadvantage individual students it is important that teachers set tasks that allow them to effectively discriminate responses at the different grade levels and within grade bands. It is also important for teachers to advise students on the appropriateness of their choices when doing folio tasks or students may restrict their own opportunities to achieve the higher grades. An example of this is a folio task in Topic 1: Applied Geometry which entails setting up the oval for sports day or creating a landscape design. If the student chooses a design that incorporates only simple shapes such as rectangles and right-angled triangles, the resulting task response will lack complexity no matter how well it is done.

In the folio some tasks continued to be ‘over prescribed’, giving students too much direction (either in the task sheet or verbally); this reduced the complexity of the task and tended to produce student responses that were very similar. This makes it difficult for students to demonstrate the highest levels of the performance standards. At the beginning of the year students may need such support in folio tasks, but subsequent tasks should be more open and less directed, to give students the opportunity to demonstrate achievement at the highest levels. For certain cohorts of students more directed tasks may be appropriate throughout the year but it should be understood that students are unlikely to achieve high grades in these tasks.

Task design in the folio had implications for students at the A/A+ level. Folio tasks need to allow for discrimination between student responses at the A/A+ level. In classes where the responses of A students to a folio task showed a high level of similarity, it was deemed that the task was either too directed or not open enough, and hence lacked the complexity required for an A+ grade to be awarded.

In some topics care needs to be taken in designing folio tasks so that students are not likely to reach a ‘dead end’ and hence be unable to demonstrate the more complex areas of the mathematics. An example of this is in Topic 7: Statistics and Working with Data when a student chooses to investigate prediction using regression between variables that turn out to have little or no correlation in the data. Ways around this are to guide students to use variables that are known to correlate, or to provide a large data set (with established correlation) from which students can draw a sample to work with. It is not appropriate for a student to state that there is little

correlation between the variables (based on the r^2 value or the appearance of the scatter plot) and then generate a regression line or equation anyway.

It is important to note that folio tasks have a greater chance of being successful if students focus on one specific area of the topic rather than trying to cover all aspects of it. This was most likely to be an issue in Topic 3: Mathematics and Small Business, although it was also observed occasionally in Topic 7: Statistics and Working with Data.

The concepts mentioned in the final paragraph of the section on Assessment Type 1 earlier in this report can be used by students in a folio task if it is appropriate to do so. For instance, a 2×2 transition matrix could be used at the start of an investigation but, for most of the work in the task, the student would need to use 3×3 or larger systems to fit the requirements of the subject outline. A student who wanted to test the symmetry of the distribution of a set of data in Topic 7: Statistics and Working with Data might choose to calculate the coefficient of skewness but the use of this tool would not form a major part of the investigation.

When students copy graphs or other information from websites for an investigation it is essential that they acknowledge the source, and that they incorporate the material meaningfully in the task. Simply including such material without discussing how it is relevant or drawing conclusions from it achieves nothing against the performance standards.

EXTERNAL ASSESSMENT

Assessment Type 3: Examination

Overall the examinations allowed for a broad distribution of grades. In each paper there were parts of questions designed to differentiate the top students, giving them the opportunity to demonstrate their depth of understanding of the mathematics. Students who had advanced knowledge of, and skill in using, the graphics calculator often completed the questions in the most efficient manner.

Areas of difficulty noted in the examinations are listed below. The 2011 assessment report contains further supporting notes on each examination topic.

Topic 1: Applied Geometry

- It is important for students to have appropriate equipment for this topic. Students should have a ruler and a protractor (or an equivalent device for measuring angles).

Topic 2: Investment and Loans

- Future-value and present-value entries were often confused (reversed), and students' analysis was at times related to an investment annuity when the question was based on a loan annuity.
- Some confusion was evident in the requirement of negative signs in certain calculator entries for annuities. When not applied correctly, either incorrect answers resulted, or no answer was found at all.
- Total interest or interest saved was a difficult calculation for many students.
- Inflation often proved a challenging concept. Many incorrect responses indicated that the amount of money required during retirement decreased.

- When there was an outstanding balance that split the time-frame students often forgot about the initial length of time in the following calculations.
- In most assessments in this topic in the past, students have been expected to transfer a calculation to a written answer; however, this is unnecessary in the examination situation unless a comment is specifically asked for in the question. Students should be encouraged to give very brief and concise written statements, only when required.
- Communication in the form of units on all solutions is a requirement.

Topic 3: Mathematics and Small Business

- In questions involving the determination of the break-even point, the number of items was not always rounded to a whole number.

Topic 4: Matrices

- Communication in the form of units on all solutions is a requirement. Students must also ensure that they describe the answer from the matrix when required.
- Conversions to percentages and rounding to whole numbers when appropriate to the real-life scenario need further attention.
- Students were generally able to identify a position in a matrix; however, they often struggled to explain the significance of the entry in that position.
- The identification and explanation of the significance of second-stage links were challenging for students.
- There was limited understanding of the significance of the coefficient in the formula for a matrix.
- Further attention is needed to ensure that students know what column and row matrices are, and understand the unit matrix and its application.

Topic 5: Optimisation

- Misreading of questions and trivial errors were common in this topic.
- Most students found and rearranged the linear programming constraints but had difficulty in transferring the information onto the graph and/or finding the feasible region. Errors were made with the inequality signs in the linear programming model. The appropriate labelling of graphs (axis and constraints) must be encouraged. Some students did not use all of the vertices identified in a region to determine the optimal solution, as a result of which they incorrectly identified the minimum solution.
- Interpretation of the results of the linear programming investigations was not done well, particularly discussion of the excess vitamin. Students often failed to complete their explanation of the solution.
- Paths were often not clearly indicated on the networks, or only one was indicated when there were two solutions.
- When completing critical path questions, students made many errors with the forward and backward scans. Understanding of the concept of slack time was poor.

Topic 6: Share Investments

- Reading the share table presented problems for some students.
- Interpretation of the price-earnings ratio was not completed with enough depth. Statements about the price-earnings ratio being higher or lower did not show understanding of the value. Some students failed to recognise the significance of

the companies being in the same sector for comparison of the price-earnings ratio.

- Break-even calculations were still completed using a variety of methods. To reduce problems with rounding and not reaching a break-even price, teachers are encouraged to use algebraic methods or accurate formulae rather than the doubling of fees. Students who used the doubling-fees method to check the solution sometimes had to recheck multiple times to get the correct answer. This was an inefficient use of their time.
- Calculating the accurate yield and after-tax return still presented some difficulties for students.
- Contradictory statements were common in the analysis of calculations, and at times students made valid statements about two situations without any indication of which was better.
- Some students reversed the ratio and the price for the rights issue calculation or divided with the wrong total.
- Some students confused after-tax return calculations with calculations for tax on dividends.

Topic 7: Statistics and Working with Data

- Students found it difficult to record the regression line from the graphics calculator.
- Occasionally the outlier was selected incorrectly.
- A lack of understanding of the significance of extrapolation and interpolation was still evident in student responses.
- Students sometimes recorded the standard deviation for the population rather than the standard deviation for the sample.
- Very few students sketched a graph that was narrower and higher when using the same axis for the normal distribution.

General Comments

When teachers are preparing students for the examination it is important that they stress the importance of reading the question carefully. It is also important that students are aware of the marks allocated for questions, especially when written answers are required. Some students wrote far more than was necessary whereas others did not address the question appropriately, often writing definitions rather than answers that related to the question, or did not indicate the best solution when a comparison was necessary. Reference to the calculations in written/analysis answers is another area for teachers to focus on when preparing students for the examinations.

Assumptions, limitations, and reasonableness need further attention. Assumptions are generally aspects of the calculations that are provided as a fixed value, when in reality the value may change or may be a predicted value because the information cannot be obtained yet. Limitations are restrictions that can affect the accuracy of the calculations. Reasonableness addresses whether or not an answer is realistic, given the assumptions made and the limitations considered. Students also need to be encouraged to use the calculations more readily to support these answers.

When students need to use the extra answer page in a question booklet, they must clearly identify the number of the question they are completing and, in the space provided for that question, note that they have continued their answer on the extra answer page (e.g. see page 11 for further calculations).

Communication errors included failing to assign units to answers and poor rounding of answers. Rounding is particularly important when only an integer solution is appropriate or in break-even situations where the solution must be rounded up. Labelling the axes of graphs was completed poorly. Students need to label the axes on all graphs that relate to the question and include units as appropriate.

OPERATIONAL ADVICE

Organisation of Moderation Materials

- Overall the moderators were again pleased with the way teachers organised student work in the requested samples. Nearly all work was labelled clearly, SATs and folio work were separated, and solutions to SATs were provided. The inclusion of task sheets attached to each student's folio task was very helpful to the moderation process. Many teachers included a cover sheet with each set of student materials from the nominated sample for moderation, identifying all completed assessments and the grade level achieved. This was also helpful but teachers need to be careful to transcribe results *accurately* onto these sheets as inconsistencies impede the moderation process.

- A continuing area of concern was work that showed no evidence of how the teacher had reached his or her decision on the assessment grade. All student work submitted must have indications of where that work is correct or incorrect; marks and annotations must be left on student work sent for moderation so that the moderators can confirm the grades. The inclusion of an annotated rubric was very useful. Some work that was submitted had no indication of marking for accuracy. Schools were contacted and teachers were asked to attend the moderation site to provide evidence to support their assessments (e.g. requiring the submitted responses to be re-marked).

- Some student responses to folio tasks contained no feedback apart from the performance standards rubric. To be able to improve their performance in future tasks it is important for students to understand where their work is incorrect and can be improved. If they are to improve their performance, students need to be given feedback on what further evidence is required in order to achieve a better grade.

- The Variations — Moderation Materials form was used successfully by many teachers to provide the moderators with information about special provisions, breaches of rules, and student materials marked but not available for submission. This helped the moderators to identify reasons for missing materials. There was concern, however, at the significant number of cases where there was missing student work and no variations form had been submitted. Without an explanation presented on this form it must be assumed that a student has simply not submitted the required work and has been awarded zero marks, which may have an impact on the grade awarded.

- Taping the clear plastic bags for individual students before placing them in the large white moderation bag is unnecessary and slows the moderation process significantly. Please securely tape only the large white moderation bag in which all the materials are submitted.

Use of Performance Standards

- There was good evidence that teachers are becoming more comfortable with applying the performance standards appropriately in both SATs and folio work. New Mathematical Applications teachers, as well as others who have not yet attended, are strongly encouraged to attend a clarifying forum in 2013; this is an important opportunity for teachers to clarify their assessment decisions and to align them with those determined by the subject experts.

Use of the Subject Outline

- All teachers of Mathematical Applications are strongly advised to refer to the document *Summary of Subject Outline Changes for 2013* on the SACE website to find the most recent changes to the course. From 2013 the specific feature MMP5 (Contribution to group work) has been removed from the performance standards. The learning requirements of the subject still require students to be provided with opportunities to 'work both independently and cooperatively in planning, organising, and carrying out mathematical activities'; however, it will no longer be necessary to explicitly assess the group work in folio assessments. It is sufficient to cross out the reference to working collaboratively (i.e. MMP5), rather than referencing this change in an addendum.

Moderation

- Any change to a grade level that is made at moderation, based on the sample materials, affects all students in the assessment group who are at that grade level. So as not to disadvantage individual students it is important that teachers set tasks that allow them to effectively discriminate responses at the different grade levels. It is important for the same reason that groups of teachers who form a single assessment group take steps to ensure that their assessment of grade levels against the performance standards is consistent, using either co-marking or cross-marking techniques.

GENERAL COMMENTS

Use of Electronic Technology

- Nearly all students demonstrated the appropriate use of graphics calculator and computer technology to support mathematical calculations. It is important for them to realise, however, that evidence for such calculations must be provided in their work in the form of calculator input or spreadsheet formulae. In the case of repetitive calculations in an investigation, it may be appropriate to show only one example of the detailed input and summarise the rest of the calculations in a table.

- Good examples of the use of spreadsheets for 'what if?' investigations in folio tasks were seen in moderation. However, if the spreadsheet used is provided by the teacher and not constructed by the student, the higher grade levels in the performance standards for the mathematical modelling and problem-solving assessment design criterion would not be achieved. Spreadsheets should be supported by appropriately printed formula pages (i.e. including row and column headings).

- It is of continuing concern that a very few students are using outmoded or inefficient methods of calculation rather than appropriate electronic technology as required by the subject outline. Examples of this were: using tables and formulae

to find standard deviation and/or regression equations in Topic 7: Statistics and Working with Data; using formulae to find unknown values for annuities in Topic 2: Investment and Loans; performing matrix multiplication ‘by hand’, especially for transition matrices; using algebra to find intersection points for constraints in Topic 5: Optimisation.

I would like to acknowledge the efforts of the many teachers involved in the setting, vetting, and marking of the examinations and in the moderation process. All of these processes occurred at very busy times of the year and, without the valuable input of these dedicated teachers, would not have been so efficient and effective. All the teachers involved have gained experience and knowledge from these important quality assurance processes, which they have acknowledged as valuable professional development.

Mathematical Applications
Chief Assessor