Mathematical Applications

2011 Assessment Report

Government of South Australia

SACE Board of SA

MATHEMATICAL APPLICATIONS

2011 ASSESSMENT REPORT

OVERVIEW

Assessment 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-BASED 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 and Folio work.

In general it was found that assessment tasks were designed well by many teachers, giving students the 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. Again, there was evidence that attendance at the clarifying forums benefitted teachers in the area of good task design.

Assessment Type 1: Skills and Applications Tasks

It was pleasing to see teachers taking on board the reduction in the number of Skills and Applications Tasks (SATs) by including a single test for some topics. It is important to note that it is no longer a requirement in the Mathematical Applications course to cover *all* key ideas in a topic in the SATs.

In the SATs a lack of complexity in the task design occasionally led to problems with a disparity between the marks awarded and the grade levels achieved in the performance standards. If the tests lack sufficient complexity in the mathematics the higher grade levels could not be achieved no matter how many marks were gained.

At the other end of the spectrum were SATs whose questions lacked enough scaffolding to allow students access to the routine marks. A problem that 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 criteria for Mathematical Communication should be explicitly assessed and clear feedback provided to students. In some of the work seen there was no evident penalty in the marking for students who consistently omitted or used incorrect units, or rounded answers inappropriately. It would be useful preparation for the

examination for the marking of the students SATs throughout the year to model how such penalties are applied.

Occasionally harsh marking was found when an initial error in a multi-step problem was not followed through in the marking to see if subsequent calculations were accurate given the initial error, or if the subsequent reasoning was correct.

In some cases SATs tested mathematical ideas that are not in the Subject Outline, for example; bonds in Investment and Loans; matrix algebra and 2x2 transition matrices; coefficients of skewness and variation, graphs of single data sets (ie no comparison of data sets), cumulative frequency tables in Statistics and Working with Data. It is not appropriate to use these concepts to determine achievement against the performance standards in SATs and students need to be aware that they would not be covered in the examination.

Assessment Type 2: Folio

In the Folio it was found that some tasks were 'over prescribed', giving students too much direction (either in the task sheet or verbally), which reduced the complexity of the task and tended to make the student responses very similar. Doing this makes it difficult for the highest levels of the performance standards to be demonstrated. It is recognised that at the beginning of the year such scaffolding may be needed in folio tasks to support students, but subsequent tasks should be more open and less directed to allow 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 in this case it should be understood that high grades are unlikely to be achieved in these tasks.

Task design in the Folio had implications for students at the A and A+ grade levels. Folio tasks need to allow for discrimination between student responses at the A and A+ grade levels. In classes where the A students' responses 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 hit a 'dead end' and hence be unable to demonstrate the more complex areas of the mathematics. An example of this is in Statistics and Working with Data where a student chooses to investigate prediction using regression between variables which turn out to have little or no correlation in the data. Ways around this are to guide students to use variables which are known to correlate or provide a large data set (with established correlation) from which students can draw a sample to work with.

It is important to note that Folio tasks are more likely to be successful if students focus on one specific area of the topic rather than endeavouring to cover all key ideas of the topic. The topic where this was most likely to be an issue was Mathematics and Small Business.

There is no reason students cannot use mathematical ideas that are not in the Subject Outline (e.g. such as those mentioned in the final paragraph of Assessment Type 1) in a Folio task if it is appropriate to do so. For instance a 2x2 transition matrix could be used as a start to an investigation but the majority of the work in the task would need to employ 3x3 or larger systems to fit the requirements of the Subject

Outline. A student wishing to test the symmetry of the distribution of a set of data in 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 the source is acknowledged and that the material is incorporated meaningfully into the task. Simply including such material without discussing how it is relevant or drawing conclusions from it achieves nothing against the Performance Standards.

Ensuring that the mathematical investigations within the folio tasks are marked for accuracy is a necessity for the moderation process, and supported the process of confirming teacher assessments. Marking of these assessments for accuracy in the calculations is also very important as a tool to assist students in identifying skills that they are applying accurately, and those that they need to review.

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. These questions did allow these students to demonstrate their depth of understanding of the mathematics. Students that had advanced knowledge of and skill with the graphics calculator often completed the questions in the most efficient manner.

Areas of difficulty identified throughout the examinations are listed below by topic:

Topic 1: Applied Geometry

- When using Simpsons or the Trapezoidal rule students did not include zeros to apply the formulae correctly (e.g. for d_0 and d_5).
- Conversion of units challenged students.
- Sudents applied right-angled triangle trigonometry and Pythagoras' Theorem to non right-angled triangles.
- Percentage error was not calculated successfully by many students.
- Calculators that had been reset prior to the examination (perhaps for another subject i.e. Physics) automatically set to radian measure. There was strong evidence that in these cases the students often did not realise that the calculator was set to radians, and this meant that the answers to problems were either incorrect or in some instances did not make sense in the context of the problem. It would be advantageous for students to be made aware of this possible issue, and to have clear instructions on how to reset their calculator to ensure it is ready to be utilised in the Applied Geometry topic.

Topic 2: *Investment and Loans*

- Future value and present value entries were often confused. Students either were unable to identify the type of annuity problem, or were unable to recognise the correct variables on their graphics calculator.
- At times negative signs were not applied correctly in annuity calculator entries, leading to an incorrect answer, or no answer at all.

- Effective rate questions were completed poorly. Students must use the correct effective interest rate methods to compare the options when asked too. Other methods to do not earn marks.
- Interest saved was a challenging calculation for many students, especially when it involved a period of time that had already lapsed. In this case students often omitted the payments that had been made prior to the lump sum payment or did not include the lump sum payment in the calculations.
- Inflation calculations when completed as a compound interest calculation on the graphics calculator were often not calculated with P/Y *and* C/Y = 1.
- Sinking funds were challenging for many students. They showed a lack of understanding about the advantages of a sinking fund, and often did not recognise that the sinking fund was the savings part of the scenario. When calculating the interest on the loan many did not convert to the time frame asked for in the question.
- The transferral of a calculation to a written answer has been an expectation in this topic in previous years. In the limited time available in the examination situation this is no longer necessary. Students should be encouraged to provide 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

- A lack of understanding of the effect of 2 servers on waiting time was often evident in responses.
- Responses tended to focus on the residual value or resale value for choice of depreciation method in Q3 (d) when the tax advantage should be the significant aspect in response to the choice of method.
- Breakeven number of items were often not rounded to a whole number.

Topic 4: Matrices

- The significance of the coefficient in the formula for the matrix (ie the coefficient of 1.5 W^2) implies that second order influence is the most significant (i.e. influence through another group has the greatest impact in this particular scenario)
- Students did not calculate proportions for the steady state (for example in Q3 e) ii)), they automatically tended to calculate customer numbers instead.

Topic 5: Optimisation

- The Linear Programming scenario was specifically chosen because of the acceptability of non-integer solutions. More consideration may need to be given to scenarios that do have non-integer solutions to develop student awareness.
- When students did chose an integer solution many chose one that was outside the feasible region.
- When errors were made with the signs in the Linear Programming model, sometimes the feasible region did not match the signs which made assessing student understanding difficult.
- Paths were often left off solutions for networks even though they were specifically requested in the question to do so (e.g. such as in Q1 c) and d)). When the

question asked for the pathway to be marked on the network there was a mark attached to that step being completed in the marking scheme.

- The minimum spanning tree question was challenging for many students.
- In the maximum flow question students often did not successfully identify the pipe to be upgraded.

Topic 6: *Share Investments*

- Breakeven calculations were completed using a variety of methods. Students who used algebraic methods rather than the doubling of fees had fewer issues with rounding and not reaching a breakeven price. Those students who did check the solution from the doubling fees method sometimes had to recheck multiple times to get the correct answer. This was an inefficient use of their time.
- Calculating percentage changes was not done correctly by many students.
- Application of the imputation credit for franking was poorly applied.
- After tax return (Revenue minus Tax) and profit after tax (Profit minus Tax) were often confused.
- Tax was also commonly calculated on the revenue/total return rather than the capital gain.
- The calculation of a percentage change for All Ords and inflation was poorly done.
- When comparing a portfolio with All Ords and inflation students often did not comment on the significance of both the All Ords *and* inflation. Very few students mentioned a 'real return' when the portfolio exceeded inflation.
- The difference between ordinary and preference shares was not discussed clearly in many cases.

Topic 7: Statistics and Working with Data

- There was a lack of understanding of the significance of extrapolation and interpolation.
- When drawing normal distribution graphs it would be acceptable as a minimum to include half of the percentages on one side the diagram plus one on the other side. This shows what percentages are being used in a calculation if the student completes the calculation this way and that the student understands the symmetrical nature of the distribution.
- A lack of understanding was shown about the appropriate removal of outliers. Few students answered that outliers can only be removed if it is a known error.
- Similarly students showed a lack of understanding of when it was appropriate to apply a linear regression. Few students answered that it was connected to the strength of the relationship or r^2.
- The significance of r (positive or negative correlation) was often left out of students' comments.
- Some students reversed the axis for the correlation question.
- Some students recorded y=ax+b for the equation rather than replacing the coefficients with the appropriate values from the graphics calculator. It would also be advantageous for students to be encouraged to replace x and y with the variables being correlated.

- Students were challenged when the linear regression formula for correlation had to be rearranged to determine a missing variable. The substitution was often incorrect in this situation also.

In preparing students for the examination it is essential that the importance of reading the question carefully is stressed. It is equally important for students to also be aware of the marks allocated for each question as they have implications about the length of the response, particularly where written responses are required. Some students wrote far more that was necessary while others did not address the question appropriately, writing definitions rather than answers that related to the context of the question or not indicating the best solution when a comparison was necessary. Reference to the calculations in written/analysis answers is also an area to focus on with students in their preparation for the examinations.

It is important also to keep in mind that it is assumed that students have knowledge of subtopics from the Stage 1 course, and that key ideas from these topics may be used in parts of questions. Full details of the subtopics that are assumed knowledge are detailed in the Stage 1 Mathematics subject outline on page 10.

Errors with communication that were seen in the marking of the examinations included units not being assigned to answers and poor rounding of answers. Rounding is particularly important when only an integer solution is appropriate, or in breakeven situations where the solution must be rounded up. Labelling the axes of graphs was completed poorly. Students need to include axes labels on all graphs that relate to the question and include units as appropriate.

Analysis

The questions which required students to address the reasonableness, limitations and assumptions were most challenging and students need to be encouraged to use the calculations more readily to support their answers.

OPERATIONAL ADVICE

Organisation of moderation materials

- Overall the moderation panel was pleased with the way teachers organised the student work in the requested samples. Apart from a few instances, work was labelled clearly, SATs and Folio work were separated, and solutions to SATs were provided.

- Of some 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.

Use of the Subject Outline

- There were indications that some teachers are possibly using outdated documents to guide their teaching and learning (old topic names, tasks labelled as ‘D.I.’ or ‘Project’, inclusion of concepts no longer in the course, etc) – the

course must be based on the current Subject Outline and the Performance Standards used for assessment.

GENERAL COMMENTS

This year merits were awarded to 26 students in Mathematical Applications, which was a similar number to previous years.

Moderation

Any grade level change made at moderation based on the sample materials affects *all* students in the assessment group with that grade level. So as not to disadvantage individual students it is important that tasks allow for effective discrimination between responses at the different grade levels.

During the moderation process it was found that when multiple classes were combined into one assessment group it was very important that there was evidence of consistency of marking (through the use of either co-marking or cross-marking techniques). During the moderation process the moderation team have to assume that a consistent understanding and application of the performance standards have been applied in the assessment of student work. Where a consistent application of the performance standards was not evident, a moderation shift may have been the result of only one class within the assessment group having results that could not be confirmed through the moderation process.

Use of Electronic Technology

- In the vast majority of cases students demonstrated the appropriate use of graphic calculator and computer technology to support mathematical calculations. It is important they 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 these calculations in a table.

- Of some concern is the use by some students of outmoded or inefficient methods of calculation. Noted examples of this were: finding standard deviation and/or regression equations by using tables and formulae in Statistics; using formulae to find unknown values for annuities in Investment and Loans; performing matrix multiplication 'by hand', especially for transition matrices; using algebra to find intersection points for constraints in Optimisation.

Any change makes for a challenging year. I would like to acknowledge the efforts of the many teachers involved in the setting, vetting and marking of the two examinations, and those involved in the moderation process at the end of the year. All of these processes occurred at very busy times during the year. Without the valuable input of these dedicated teachers these processes would not be as efficient and effective. All of these teachers have gained experience and knowledge this year by being involved in the process and have acknowledged it as valuable professional development.

Mathematical Applications
Chief Assessor