Mathematics Pathways

2013 Chief Assessor's Report

Government of South Australia

SACE Board of SA

MATHEMATICS PATHWAYS

2013 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

In 2013 some improvement was noted in the number of A, B, and C grades achieved by students, with fewer D and E grades. This indicated that improved processes in schools had led to more appropriate placement of students in the Mathematics Pathways course. This course is not an extension of a basic numeracy course and must be assessed at a standard equivalent to Stage 2 Mathematical Applications. There are options in Integrated Studies or Community Studies subjects for students who want to prepare themselves for the workplace with some more practice in basic arithmetic.

The standard of tasks and marking standards were still quite variable across all schools. In addition, marking standards varied at times between different classes in the same school. If schools combine classes with different teachers into one assessment group, they must ensure that the teachers moderate each other's work so that the same standard of assessment is applied to the materials before final moderation. Any moderation impact at a grade level is applied to all students at that level, and inconsistent marking may disadvantage students. If it is difficult to achieve consistency classes should not be combined into one assessment group, allowing for the materials for the class groups to be submitted for moderation separately.

Teachers are encouraged to refer to the subject outline and the topic support sheets on the Mathematics Pathways minisite to ensure that all assessment tasks include enough complexity at the standard of Stage 2 Mathematical Applications.

The most popular topics of study were Applied Geometry, Statistics, Investments and Loans, and Mathematics and Small Business. Other topics included Optimisation, Matrices, Probability, and Formulae.

SCHOOL ASSESSMENT

Assessment Type 1: Skills and Applications Tasks

There was some improvement in the amount of work at the standard of Stage 2 Mathematical Applications in the skills and applications tasks. Students had more than adequate opportunity to achieve at the C level in routine questions. However, it is recommended that at least 30% of each test should consist of complex questions with some complex analysis to give more capable students the opportunity to achieve higher A grades. Topic support notes listing routine and complex subject matter are available for reference on the Mathematics Pathways minisite. The use of technology

is encouraged for statistical and annuity (investment and loan) calculations so that the focus can be on more complex analysis and interpretation. Some discussion of limitations and assumptions should be included in tests when appropriate, and not left to be dealt with only in the investigations. Teachers are encouraged to structure routine questions into clear sequential steps; complex questions may be worded to require students to complete, without scaffolding, several steps in the one problem in an applied context. Tasks that consist mainly of pre-Stage 2 concepts should be replaced with more content of a standard equivalent to that of Stage 2 Mathematical Applications. In statistics, for example, more could be done on normal distribution, analytical comparison of at least two different data sets, and deeper discussion of correlation (such as the meaning of r^2 in relation to its context) and substitution of values into the line of best fit.

Assessment Type 2: Folio

Folio tasks still need further development and will be the focus of clarifying forums in 2014. Folio materials viewed at moderation were often not of sufficient length or depth to be awarded B or A grades. In many cases the mathematics covered in the tasks viewed at moderation did not reach an appropriate level of complexity, and therefore limited the student's ability to achieve beyond the C grade band.

The first task may be directed, but should still give students the opportunity to individualise their responses by choosing their own calculation methods, designs, measurements, or individual data collection. This allows for individuality in worded responses, with students referring to their own figures as evidence, and helps teachers to verify students' work.

The second and any subsequent folio tasks (if more than the minimum number of folio assessments is undertaken as a part of the assessment) should be more open-ended, without a long list of prescriptive questions on the task sheet. However, though brief and general in instructions, it requires each student to develop an individualised, sufficiently complex mathematical model to an adequate depth to solve a 'real-life' problem. All calculations should be displayed with full working, set out in a logical sequence with appropriate labels. For a high grade, an investigation must contain a detailed discussion that goes beyond mere description of results into analysis and interpretation in the context of an applied setting, as well as discussion of reasonableness, possible causation, predictions for future action, assumptions, and limitations of the model. Refer to page 27 of the subject outline for more information about the appropriate presentation of a folio response.

An introduction, a set of detailed calculations with evidence of complex problem-solving, a well-articulated conclusion of the mathematical results, and a discussion showing depth of understanding of the mathematics in context are required for a student to achieve an A grade. For example, an investigation involving statistical correlation may require students to collect or select their own data, to ensure that there is variation in the data used by each student in the class. Students should then display the data with an appropriate computer-generated graph showing the correlation coefficient and the line of best fit (if appropriate) on the printout. This should be supported by discussion and evidence of the effect of outliers, including the removal of outliers, recalculation, and relevant discussion. Interpolation and extrapolation calculations, using the line of best fit, would expand the depth of knowledge of the topic shown by the response; the reasonableness of using any of these calculated values should be discussed in context. Worded discussion of r^2 should be more than a simple statement of its correlation strength from the table of

values. When assumptions and limitations are discussed, students should be encouraged not just to use general statements but to refer to their own data and context to support the general statements.

Applied geometry investigations showed some improvement in the complexity of scale diagrams and, in comparison with previous years, there were more calculations of complex shapes. The inclusion of more trigonometry calculations may lift the level of complexity in investigations on this topic.

Investigations involving loan minimisation strategies were generally satisfactory, with graphics calculators, spreadsheets, or website loan calculators used to compare loans or find the best ways to reduce the interest charges on loans. Conclusions and discussions with reference to figures from student calculations are required, as well as discussion of reasonableness, assumptions, and limitations.

EXTERNAL ASSESSMENT

Assessment Type 3: Investigation

External investigations came from a wide variety of topics. Once again the most popular choices were Mathematics and Small Business, Applied Geometry, Investment and Loans, and Statistics and Working with Data. Most papers covered only one topic. Those that cover a combination of two topics must form a 'series of connected questions', as stated in the subject outline, not two completely different investigations. Most investigations followed guidelines and were presented in a format similar to that of exemplars on the Mathematics Pathways minisite and those used to exemplify appropriate tasks at clarifying forums. A number of investigations seen in the external marking process lacked a connected theme, were short for a 3-hour paper (for a 20-credit subject), and gave students limited opportunities to carry out complex calculations. Issues such as these limited the opportunities for students to demonstrate their abilities to the highest level. Teachers are once again reminded that the work set should be of the same calibre as that of Stage 2 Mathematical Applications. The exemplars on the minisite must not be used by a school as an external assessment task as they are available to the public, and are therefore not considered to be secure.

Mathematical Knowledge and Skills and Their Application

Students were able to clearly display their level of knowledge, skills, and application when the task design allowed for their discernment. However, too many tasks gave credit for repetitious routine calculations or those of a standard lower than Stage 2. This did not give students the opportunity to demonstrate the comprehensive knowledge of content needed to be in the A grade band. It is recommended that teachers access the topic support documents on the minisite to familiarise themselves with the mathematics that is considered routine and that which is considered complex. If the topic being assessed in the investigation has been developed by the teacher, the teacher needs to ensure that the mathematics is of a comparable standard to that covered in Stage 2 Mathematical Applications topics.

In a real-world situation, people always turn to electronic devices to aid accuracy and efficiency (as supported in the A band of the performances standards for the subject), and so should students. Too often students were asked to do calculations (including

standard deviation) manually, when graphics calculators or spreadsheets are available. This also applies to a number of financial problems.

Mathematical Modelling and Problem-solving

Successful students had been explicitly taught how to apply problem-solving methods and analyse with reference to calculations in their mathematical models. In many investigations, tasks had been prepared with heavy scaffolding throughout and thus only gave students the opportunity to apply a mathematical model, not develop one. The investigation should be structured to allow students to show the ability to model, rather than follow a rote model.

It was apparent that many students with reasonable knowledge and skills had little awareness of the appropriate way to respond to questions that required analysis and reflection. Some tasks limited students' opportunity, with questions requiring explanations that drew only on general knowledge (recount of key terms) rather than the interpretation of mathematical results. When students were interpreting or discussing results, their responses often lacked depth or anything other than superficial understanding. Responses were often not even related to the context of the original problem. Teachers need to set questions in the investigation that guide students to analyse the mathematics in terms of the original scenario, and should require discussion of the reasonableness, limitations, or assumptions of the mathematical investigation.

Communication of Mathematical Information

Most students tried to communicate the results of their work and, on the basis of the calculations they had made throughout the investigation, draw a meaningful conclusion to the problem posed. However, many students struggled with reflecting on the significance of their results. Communication is necessary for students to clarify the significance of their result in the context of the question, taking into account reliability of information, limitations of the investigation (e.g. possible errors or outliers), and the reasonableness of the results.

Students often gave basic definitions rather than explaining the significance of a feature. For example, when asked to explain the significance of an outlier, students gave a definition rather than referring to calculations or graphs that showed how they had distorted the results.

Students made a genuine attempt to communicate mathematical ideas in terms of calculations in a logical sequence. Most students used appropriate notation, representations, and terminology. It is still recommended that teachers explicitly encourage the appropriate use of units and rounding of solutions.

General Advice for Submission of External Materials for Marking

It is essential that a set of clear answers is provided with the external materials. Most of the answers provided by teachers were very good, clear and easy to follow. One suggestion that would support the external markers would be to list some common error steps as well as places where students are likely to go wrong. This would make it easier for markers to follow errors through and allocate 'follow-through' marks.

It is also recommended that only a small part of the investigation task should allow for possible variations in students' answers. It is important for possible variations to be at the end of a specific line of mathematical investigation. Questions that follow

the opportunity for variation should bring all the students back to the same starting point for the remaining questions so that markers do not have to follow calculations through in every student's response. In solutions for problems in which variation of responses will occur, teachers are asked to give the marker an example of the expected method of solution for the variable response (or several possible methods of reaching a solution), including appropriate setting out.

OPERATIONAL ADVICE

A teacher folder with a complete set of task sheets and the approved learning and assessment plan (with addendum when applicable) should be included in the materials submitted. 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 folder.

When teachers package materials for the nominated sample that is submitted to the SACE Board for final moderation, each sample folio must include all tasks from Assessment Type 1 and Assessment Type 2. The Variations — Moderation Materials form was also used successfully to provide the moderators with information about special provisions, breaches of rules, and student materials marked but not available for submission.

To help the moderation process, all student materials should be presented with a task sheet. An appropriate performance standards sheet indicating the assessment of the work was very helpful to the moderators, particularly when considering the folio tasks. For a particular task, all students should be assessed against the same specific features unless special provisions are involved.

The inclusion of a completed marks sheet or spreadsheet for the class also helped the moderation process.

Mathematics Pathways
Chief Assessor