Results of Secondary 3 Mathematics in Territory-wide System Assessment 2016

The percentage of Secondary 3 students achieving Mathematics Basic Competency in 2016 is 80.0%.

Secondary 3 Assessment Design

The design of assessment tasks for S.3 was based on the documents *Mathematics Curriculum: Basic Competency for Key Stage 3 (Tryout Version)* and *Syllabuses for Secondary Schools – Mathematics (Secondary 1 – 5), 1999*. The tasks covered the three dimensions of the mathematics curriculum, namely **Number and Algebra**, **Measures**, **Shape and Space**, and **Data Handling**. They focused on the Foundation Part of the S1 – 3 syllabuses in testing the relevant concepts, knowledge, skills and applications.

The Assessment consisted of various item types including multiple-choice questions, fill in the blanks, answers-only questions and questions involving working steps. The item types varied according to the contexts of the questions. Some test items consisted of sub-items. Besides finding the correct answers, students were also tested in their ability to present solutions to problems. This included writing out the necessary statements, mathematical expressions and explanations.

The Assessment consisted of 147 test items (197 score points), covering all of the 129 Basic Competency Descriptors. These items were organized into four sub-papers, each 65 minutes in duration and covering all three dimensions. Some items appeared in more than one sub-paper to act as inter-paper links. Each student was required to attempt one sub-paper only. The number of items on the various sub-papers is summarized in Table 8.4. These numbers include several overlapping items that appear in more than one sub-paper to enable the equating of test scores.

Table 8.4 Number of Items and Score Points for S.3

Subject	No. of Items (Score Points)				
	Paper 1	Paper 2	Paper 3	Paper 4	Total*
Mathematics					
Written Paper					
Number and Algebra	22 (30)	21 (25)	21 (27)	22 (28)	64 (82)
Measures, Shape and Space	18 (22)	21 (30)	21 (30)	19 (25)	65 (87)
Data Handling	7 (11)	5 (8)	5 (6)	6 (10)	18 (28)
Total	47 (63)	47 (63)	47 (63)	47 (63)	147 (197)

* Items that appear in different sub-papers are counted once only.

The item types of the sub-papers were as follows:

Table 8.5 Item Types of the Sub-papers

Section	Percentage of Score Points	Item Types
A	~ 30%	• Multiple-choice questions: choose the best answer from among four options
B	~ 30%	• Calculate numerical values • Give brief answers
C	~ 40%	• Solve application problems showing working steps • Draw diagrams or graphs • Open-ended questions requiring reasons or explanations

Performance of Secondary 3 Students Achieving Basic Competence in Territory-wide System Assessment 2016

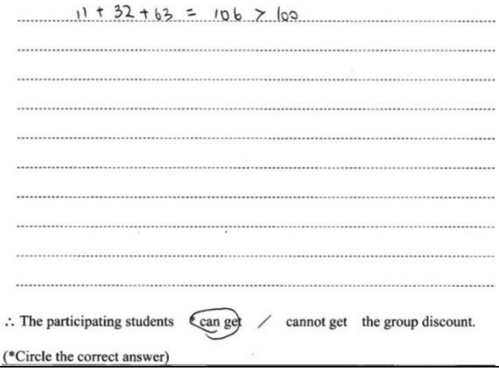
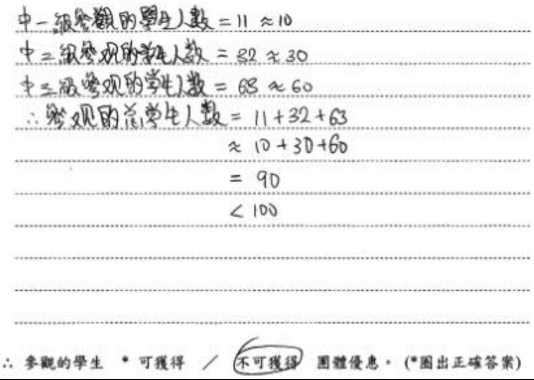
Secondary 3 Number and Algebra Dimension

Satisfactorily S.3 students performed in this dimension. The majority of students demonstrated recognition of the basic concepts of directed numbers, rate and ratio, formulating problems with algebraic language, linear equations in one unknown and linear inequalities in one unknown. Performance was only fair in items related to using identities and formulas. Comments on students' performances are provided with examples cited where appropriate (question number x / sub-paper y quoted as Qx/My). More examples may also be found in the section ***General Comments.***

Number and Number Systems

- Directed Numbers and the Number Line: The performance of students was good. They could use directed numbers to describe the time differences. They could also demonstrate recognition of the ordering of integers on the number line.
- Numerical Estimation: The majority of students were able to determine whether the value mentioned in a simple context was obtained by estimation or by computation of the exact value. More than half of the students could estimate the total number of participants and judge whether they could get the group discount according to the information given in the question. Nevertheless, some students could not judge the reasonability of answers from the computation of division.

Q45/M1
Exemplar Item (Estimate the total number of participants and judge whether they can get the group discount) S1-S3 students of a secondary school are going to visit a museum. The numbers of participating students in S1, S2 and S3 are 11, 32 and 63 respectively. If the total number of participating students of the school is 100 or above, they can be given a group discount. Give **an appropriate approximation** for the number of participating students in each form. Estimate the total number of participating students and judge whether they can get the group discount.

Q45/M1
Example of Student Work (Without giving an approximation for the number of participating students in each form)
 11 + 32 + 63 = 106 > 100 ∴ The participating students *can get* / cannot get the group discount. (*Circle the correct answer)
Example of Student Work (Correct estimation, but errors occurred in the steps and therefore the conclusion is wrong)
 中一級參觀的學生人數 = 11 ≈ 10 中二級參观的学生人数 = 32 ≈ 30 中三級參观的学生人数 = 63 ≈ 60 ∴ 參观的总学生人數 = 11 + 32 + 63 ≈ 10 + 30 + 60 = 90 < 100 ∴ 參觀的學生 * 可獲得 / *不可獲得* 團體優惠。(*圈出正確答案)
Example of Student Work (Good performance)
 若以下措人法表示人數： 中一級參觀的學生人數 = 10 中二級參觀的學生人數 = 30 中三級參觀的學生人數 = 60 ∵ 10 + 30 + 60 = 100，且參觀的學生人數達到 100 或以上，博物館則會提供團體優惠， ∴ 參觀的學生 * *可獲得* / 不可獲得 團體優惠。(*圈出正確答案)

- Approximation and Errors: When students were asked to round a number to 3 decimal places, they might ignore whether it is necessary to add zero after the decimal point. Besides, the majority of students were able to convert numbers in scientific notation to decimals.

- Rational and Irrational Numbers: Many students could represent irrational numbers on a number line. However, some students read the question carelessly and could not select a value which is just greater than the integral part of $\sqrt{123}$.

Comparing Quantities

- Using Percentages: Students did well in solving problems regarding selling prices, compound interest and growths. Nevertheless, they were quite weak in finding simple interest.

Q40/M4

Exemplar Item (Find the selling price)

The cost of a washing machine is \$5 820. It is sold at a loss of 15%. Find the selling price of the washing machine.

Example of Student Work (Correct calculation but the presentation is poor)

\$5820 × 15%　　\$5820 − \$873
= \$873　　= \$4947

Example of Student Work (Correct solution)

該部洗衣机售價:
5820 × (1−15%)
= 4947(元)
∴ 該部洗衣机售價是 4947(元)

Q41/M1

Exemplar Item (Find the new value after the growth)

The value of a ring increases by 10% per year. Kitty bought the ring for \$54 800 two years ago. Find the present value of the ring.

Example of Student Work (Correct solution)

該枚戒指現時的價值 = $54800(1+10\%)^2$
= \$66308

Q40/M2

Exemplar Item (Find the simple interest)

Janet deposits \$6 800 in a bank at a simple interest rate of 2% p.a. Find the interest she will receive after 3 years.

Example of Student Work (Confused compound interest with simple interest)
所得的利息 $= 6800 \times (1+2\%)^3 - 6800$ $= \$416$ (三個有效數字)
Example of Student Work (Mistakenly used the formula for finding the amount by taking compound interest as the formula for finding the simple interest)
$\$6800 \times (1+2\%)^3$ $= \$7216$

- Rate and Ratio: The performance of students was good. They could grasp the basic concepts, and use rate and ratio to solve real-life problems.

Observing Patterns and Expressing Generality

- Formulating Problems with Algebraic Language: Students did well. They could distinguish the difference between $(-2x)^2$ and $-2x^2$; translate word phrases/contexts into algebraic languages and substitute values into formulas and find the value of a variable. They could also write down the next few terms in sequence of square numbers from several consecutive terms that were given. Many students could intuitively find the nth term of a number sequence.

- Manipulations of Simple Polynomials: Students were quite weak in recognizing the terminologies of polynomials. More than half of the students were able to distinguish polynomials from algebraic expressions. They did quite well in dealing with the additions, subtractions and multiplications of simple polynomials.

Q25/M4
Exemplar Item (Terminologies of polynomials) Write down the constant term of the polynomial $5y^2 - 4y + 11$.
Example of Student Work (Could not identify the constant term) $5y^2 - 4y + 11$ 的常數項是 $-4y$ 。

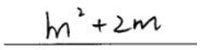
Example of Student Work (Could not identify the constant term)

Q26/M3

Exemplar Item (Manipulations of polynomials)

Expand $m(m+2)$.

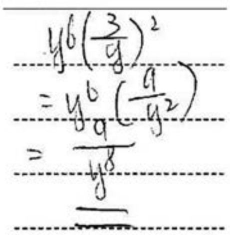
Example of Student Work (Good performance)



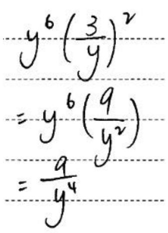
- Laws of Integral Indices: The performance of students was quite good in simplifying algebraic expressions by laws of integral indices.

Q40/M3

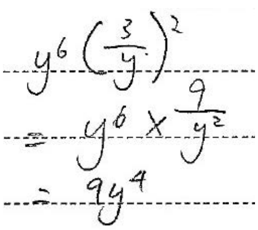
Example of Student Work (Has mistakenly taken $\dfrac{y^m}{y^n} = \dfrac{1}{y^{m+n}}$)



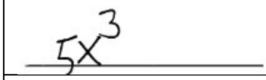
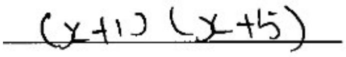
Example of Student Work (Has mistakenly taken $\dfrac{y^m}{y^n} = \dfrac{1}{y^{m-n}}$)

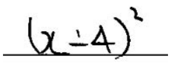
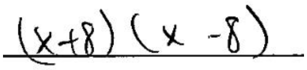


Example of Student Work (Good performance)



- Factorization of Simple Polynomials: Student performed quite well in factorizing simple polynomials by using the cross method. Their performance was fair in using the difference of two squares and by taking out common factors in factorization.

Q26/M2
Exemplar Item (Factorize the expression by taking out common factors) Factorize $x^2 + 5x$.
Example of Student Work (Mistakenly took $x^2 + 5x = x^2(5x)$) 
Example of Student Work (Could not take out the correct common factor) 

Q27/M4
Exemplar Item (Factorize the expression by using the difference of two squares) Factorize $x^2 - 16$.
Example of Student Work (Mistakenly took $(a-b)^2 = a^2 - b^2$) 
Example of Student Work (Mistakenly took $8 \times 8 = 2 \times 8$) 

Algebraic Relations and Functions

- Linear Equations in One Unknown: The majority of students were able to demonstrate understanding of the meaning of roots of equations. They were able to solve simple equations and formulate equations from simple contexts.

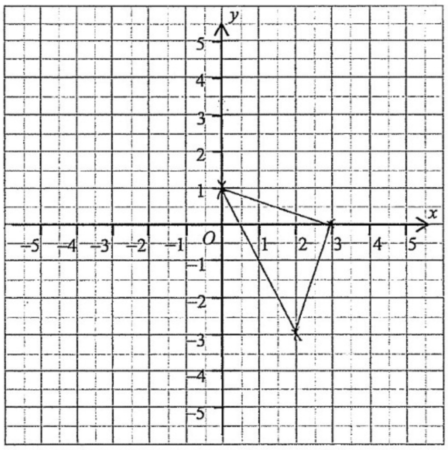
- Linear Equations in Two Unknowns: Students in general could plot graphs of linear equations in 2 unknowns according to the values in the table. They were aware that the root obtained by the graphical method may not be exact. Their performance was only fair when they were asked to solve linear simultaneous equations by algebraic methods.

Q44/M4

Example of Student Work (Has mistakenly marked the point (–3, 2) on the position of (2, –3))

$y = -\frac{x}{3} + 1$

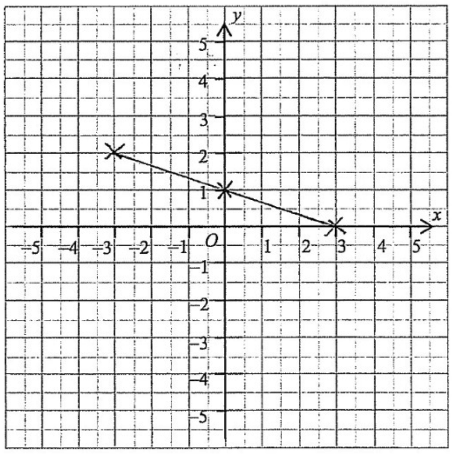
x	–3	0	3
y	2	1	0



Example of Student Work (Did not extend at two ends)

$y = -\frac{x}{3} + 1$

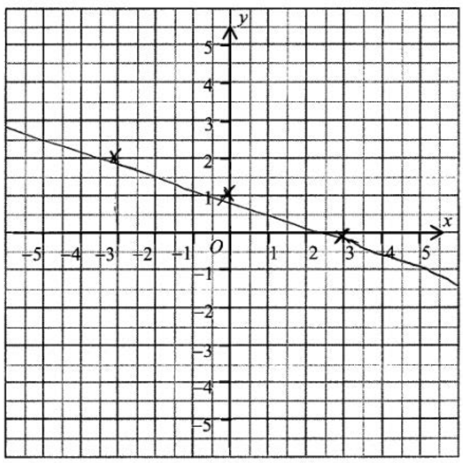
x	–3	0	3
y	2	1	0



Example of Student Work (Without using a ruler to draw the graph)

2 –3
$y = -\frac{x}{3} + 1$

x	–3	0	3
y	2	1	0



Q42/M1
Example of Student Work (Solving simultaneous equations – the student tried to use the method of elimination, but mistakes occurred in the steps and only *x* was solved) $y=4x+9$ …… (1) $y=3x+1$ …… (2) 將(1)代入(2) $4x+9=3x+1$ …… (3) (3): $4x+9=3x+1$ $x=10$
Example of Student Work (Solving simultaneous equations – although the student knew how to use the method of substitution, mistakes occurred in the computation) $\begin{cases} 4x+9=y \text{ ——(1)} \\ 3x+1=y \text{ ——(2)} \end{cases}$ $x=\frac{y-1}{3}$ ——(3) 從(1), $4(\frac{y-1}{3})+9=y$ $\frac{4y-4}{3}+9=y$ $4y+5=3y$ $y=-5$ $x=\frac{(-5)-1}{3}$ $x=-2$ $\therefore x=-2, y=-5$
Example of Student Work (Good performance) $\begin{cases} y=4x+9 \text{ —①} \\ y=3x+1 \text{ —②} \end{cases}$ ①-② $y=4x+9$ $-)\ y=3x+1$ $0=x+8$ $x=-8$ 把 $x=-8$ 代入① $y=4(-8)+9$ $y=-23$ $\therefore x=-8, y=-23$

- Identities: Many students were not able to distinguish equations from identities. There was room for improvement in using the difference of two squares to expand simple algebraic expressions.

Q28/M2
Exemplar Item (Expand algebraic expressions by using the difference of two squares) Expand $(a+10)(a-10)$.
Example of Student Work (The student knew how to expand the expression by using the difference of two squares, but the answer was not simplified) $a^2 - 10^2.$
Example of Student Work (Mistakenly took $10 \times 10 = 2 \times 10$) $a^2 - 20$

- Formulas: Many students could find the value of a specified variable in the formula and perform change of subject in simple formulas. However, their performance was only fair in manipulation of algebraic fractions.

Q28/M3
Exemplar Item (Simplifying algebraic fractions) Simplify $\left(\frac{3}{2x}\right)\left(\frac{2}{3x}\right)$.
Example of Student Work (Mistakenly took $\left(\frac{3}{2x}\right)\left(\frac{2}{3x}\right) = \frac{3}{2x} + \frac{2}{3x}$) $\frac{13}{6x}$
Example of Student Work (Ignored the index of x) $\frac{1}{x}$

- Linear Inequalities in One Unknown: The performance of students was good. They were able to use inequality signs to compare numbers and demonstrate good recognition of the properties of inequalities. They could formulate inequalities from simple contexts and solve simple linear inequalities.

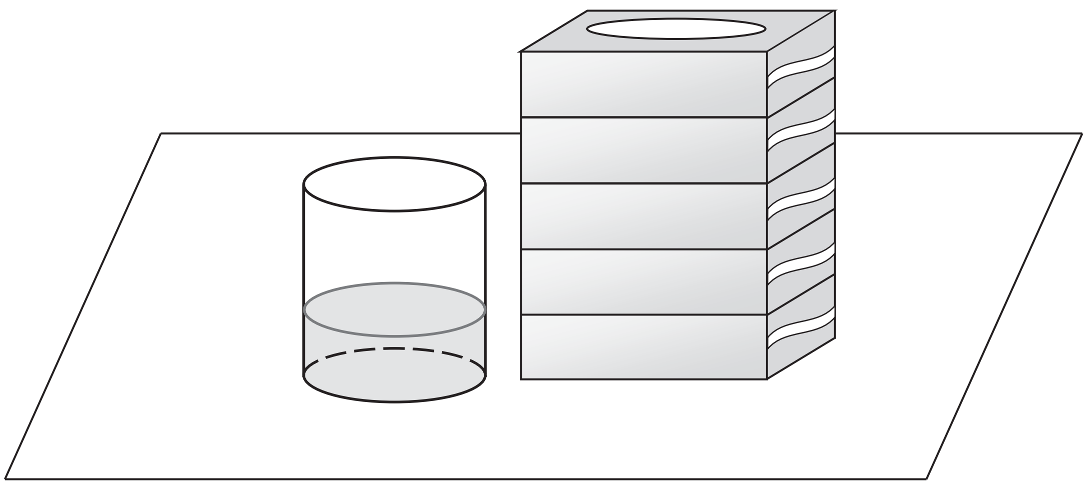
Secondary 3 Measures, Shape and Space Dimension

S.3 students performed steadily in this dimension. They could find areas and volumes of simple plane figures and solids, transformation and symmetry, angles related with lines and rectilinear figures and solve problems regarding 3-D figures. However, more improvement could be shown in items related to definitions of common terms in geometry as well as deductive geometry. Comments on students' performances are provided with examples cited where appropriate (question number *x* /sub-paper *y* quoted as Q*x*/M*y*). More items may also be found in the section ***General Comments***.

Measures in 2-D and 3-D Figures

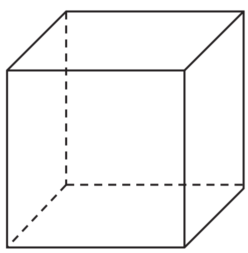
- Estimation in Measurement: The majority of students were able to choose an appropriate unit and the degree of accuracy for real-life measurements. They could select the appropriate ways to reduce errors in measurements. More than half of the students could estimate measures with justification.

Q45/M2
Exemplar Item (Estimate the volume of water in the glass) In the figure, a cylindrical glass filled with some water and a few boxes of tissue paper are placed on a table. The capacity of the glass is 525 mL. Estimate the volume of water in the glass and explain your estimation method.



Example of Student Work (Estimate the volume of water in the glass – with evidence of using estimation strategies, but the explanation contained errors)
水的體積：$525 \times \frac{1}{3}$ $= 175 \text{ cm}^3$ ∵因為杯子是紙巾盒的 $\frac{3}{5}$ 代表杯子是3，而水的是紙巾盒的 $\frac{1}{5}$，即水是1，須變成 $\frac{1}{3}$。
Example of Student Work (Estimated with reasonable justification)
∵ The height of the cylindrical glass ≈ The height of 3 boxes of tissue paper and The height of the water ≈ The height of a box of tissue paper Let x mL be the volume of water ∴ $\frac{x}{525} \approx \frac{1}{3}$ $x \approx 175$ i.e. The estimated volume of water in the glass is 175 mL

- Simple Idea of Areas and Volumes: Many students could use the formulas for circumferences and areas of circles to solve problems. Their performance was quite good in using formulas for the volumes of solids, but they did not do well in surface areas.

Q31/M2
Exemplar Item (Find the side length of a cube) The figure shows a solid cube. Its total surface area is 294 cm^2. Find the side length of the cube. 

Example of Student Work (Has mistakenly taken volume as surface area: $\sqrt[3]{294} \approx 6.65$)

該正方體的邊長是 6.65 cm。

Example of Student Work (Has mistakenly taken the total side lengths of the cube as surface area: $294 \div 12 = 24.5$)

該正方體的邊長是 24.5 cm。

- More about Areas and Volumes: Many students could use formulas to calculate arc lengths, areas of sectors, volumes of cones and surface areas of spheres. Almost half of the students were able to use relationships between the sides and surface areas of similar figures to solve problems and distinguish among formulas for volumes by considering dimensions.

Learning Geometry through an Intuitive Approach

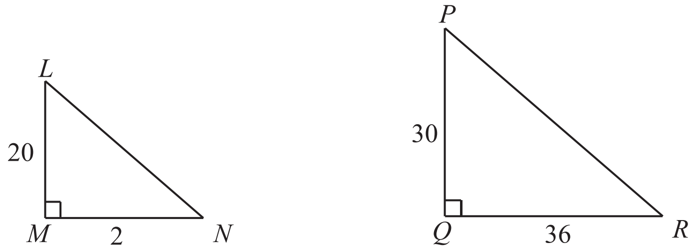
- Introduction to Geometry: Students were able to sketch a diagram of a cube and identify 3-D solids from given nets. More than half of the students could identify straight angles and concave polygons. However, their performance was weak in the recognition of regular polyhedra.

- Transformation and Symmetry: Students were able to grasp the concepts of axes of symmetry and identify the image of a figure after a single transformation. In general, they could identify the effect on the size and shape of a figure under a single transformation and determine the order of rotational symmetry from a figure.

- Congruence and Similarity: Students demonstrated recognition of the conditions for similar triangles. However, some of them confused the reasons for congruent triangles with those for similar triangles. Quite a number of students mistakenly chose SAS and RHS as the reasons for identifying why two triangles are similar.

Q32/M1

Exemplar Item (Identify whether two triangles are congruent or similar)



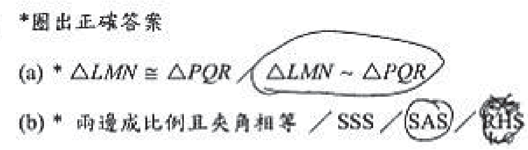
According to the given information in the above figure,

(a) identify whether $\triangle LMN$ and $\triangle PQR$ are congruent or similar triangles, and

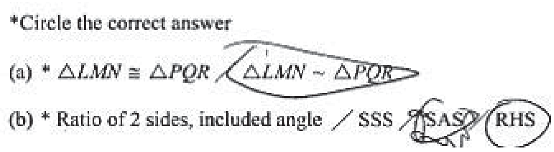
(b) choose the correct reason.

Example of Student Work (Mistakenly identified $\triangle LMN$ and $\triangle PQR$ as congruent triangles)

Example of Student Work (Mistakenly took SAS as the reason for identifying why two triangles are similar)



Example of Student Work (Mistakenly took RHS as the reason for identifying why two triangles are similar)



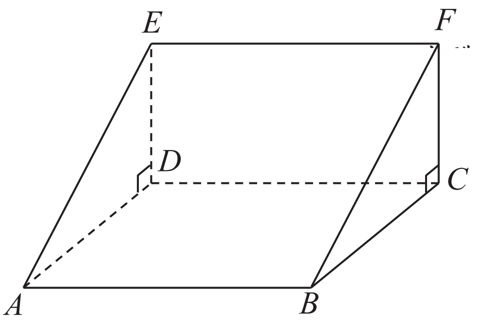
- Angles related with Lines and Rectilinear Figures: Students were able to demonstrate recognition of alternate angles and vertically opposite angles. They could solve simple geometric problems. Nevertheless, some students were weak in applying the formula for exterior angles of convex polygons.

- More about 3-D figures: Students were able to identify axes of rotational symmetries of cubes, the nets of regular tetrahedra and match 3-D objects with various views. More than half of the students could name the projection of an edge on a horizontal plane and the angle between 2 planes.

Q34/M1

Exemplar Item (Name the projection of an edge on a horizontal plane)

The figure shows a triangular prism. *ABCD* and *CFED* are rectangles. *ABCD* is a horizontal plane. Name the projection of *BF* on the plane *ABCD*.



Example of Student Work (Could not identify the correct angle)

(1) FC

(2) AE

(3) ∠BCF

(4) ∠BFC

Learning Geometry through a Deductive Approach

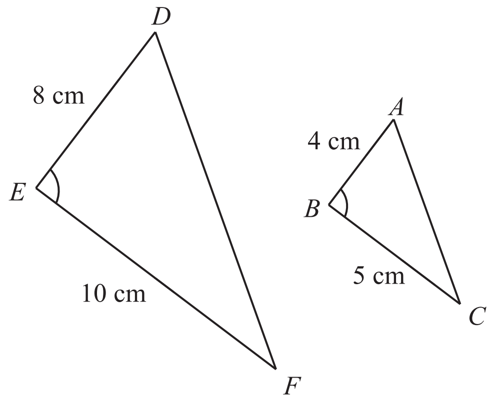
- Simple Introduction to Deductive Geometry: More than half of the students could write the correct steps of a geometric proof, but most could not provide reasons or complete the proof correctly. Besides this, quite a number of students were able to identify altitudes of a triangle.

Q46/M4

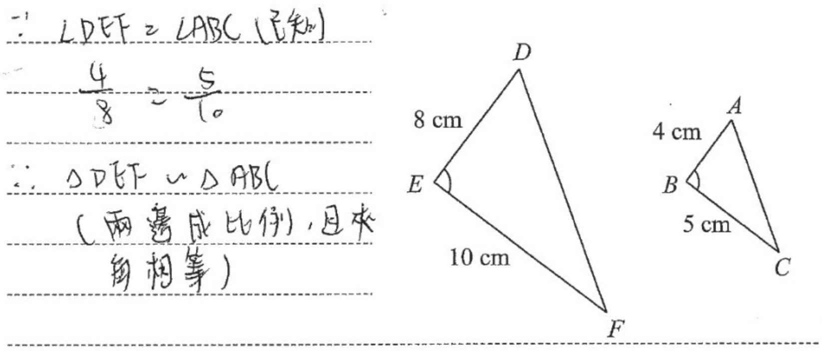
Exemplar Item (Geometric proof)

In the figure, $\angle DEF = \angle ABC$, $DE = 8$ cm, $EF = 10$ cm, $AB = 4$ cm and $BC = 5$ cm.

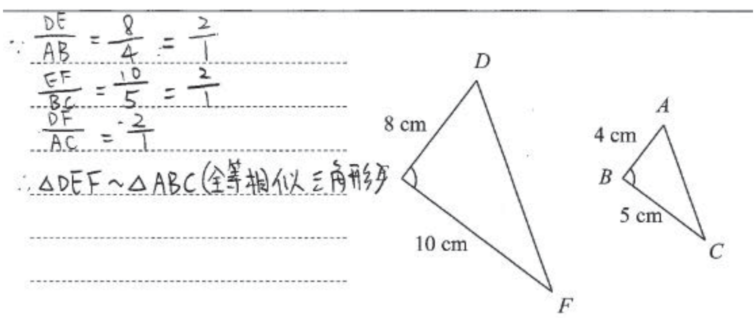
Prove that $\triangle DEF \sim \triangle ABC$.



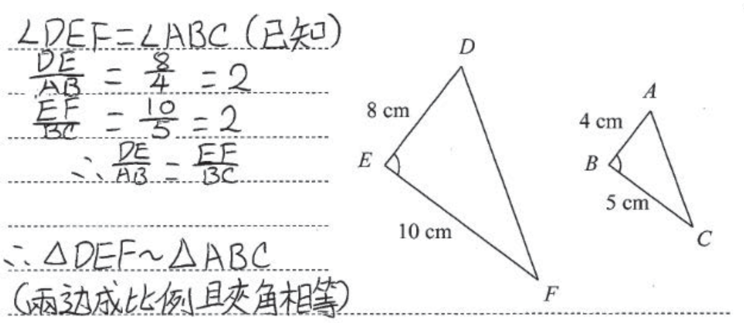
Example of Student Work (Could not explicitly express that the corresponding sides of the two triangles in the figure are proportional)



Example of Student Work (Mistakenly assuming the three pairs of corresponding sides of the two triangles are proportional, and the reasons were incorrect as well)



Example of Student Work (Good performance)



- Pythagoras' Theorem: The performance of students was quite good in using Pythagoras' Theorem and the converse of Pythagoras' Theorem to solve simple problems.
- Quadrilaterals: Students performed well. They could use the properties of trapeziums in numerical calculations.

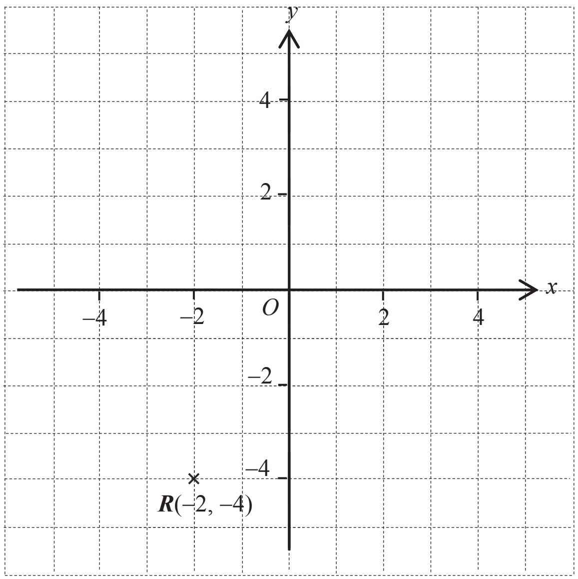
Learning Geometry through an Analytic Approach

- Introduction to Coordinates: Students could grasp the basic concepts of the rectangular coordinate system, but they were quite weak in problems regarding polar coordinates. There was room for improvement in problems related to matching a point under a single transformation including reflection or rotation, and calculating areas of simple figures.

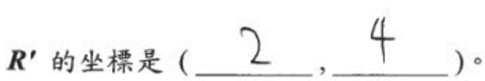
Q35/M4

Exemplar Item (Find the coordinates of a point after reflection)

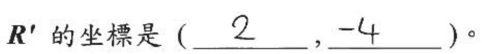
R (–2 ,–4) is reflected along the x-axis to ***R′***. Find the coordinates of ***R′***.



Example of Student Work (Confused reflection with rotation)



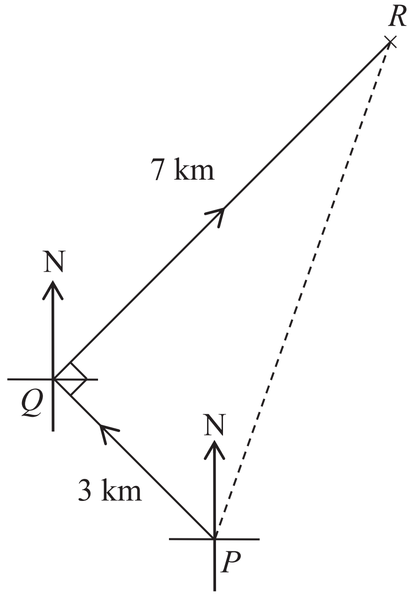
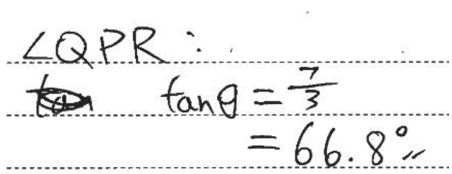
Example of Student Work (Mistakenly reflected ***R*** along the y-axis)



- Coordinate Geometry of Straight Lines: Many students could use the formula of finding slopes and the mid-point formula. Their performance was only fair in applying distance formula and the conditions for parallel lines and perpendicular lines.

Trigonometry

- Trigonometric Ratios and Using Trigonometry: Students could grasp the basic concepts of trigonometric ratios, but they did not do well in recognition of the idea of gradient and solving simple 2-D problems involving one right-angled triangle.

Q47/M3
Exemplar Item (Finding the angle) In the figure, Kitty walks 3 km due northwest from *P* to *Q*. She then turns 90° and walks 7 km due northeast from *Q* to *R*. Find ∠*QPR* and give the answer correct to the nearest 0.1°. 
Example of Student Work (The student knew how to solve the triangle, though the presentation was not satisfactory) 

Secondary 3 Data Handling Dimension

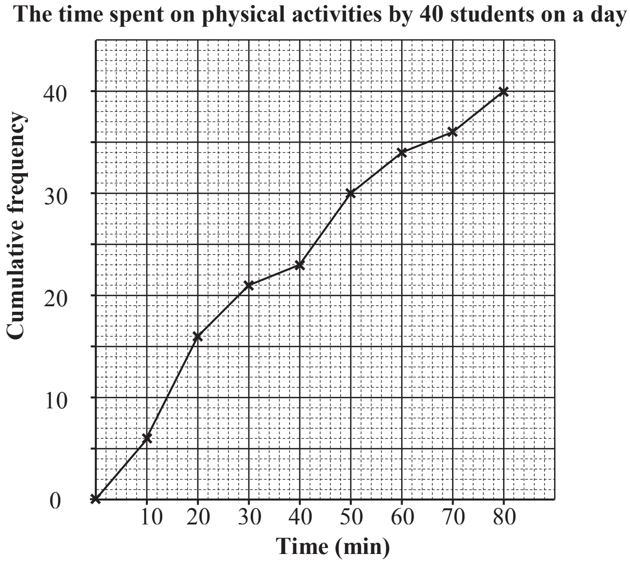
The performances of S.3 students were satisfactory in this dimension. They could use simple methods to collect data, organize the same set of data by different grouping methods, construct simple statistical charts and identify sources of deception in misleading graphs/accompanying statements. However, performance was weak when students were asked to calculate the theoretical probability and read upper quartiles from diagrams. Comments on students' performance are provided below with examples cited where appropriate (question number *x* / sub-paper *y* quoted as Q*x*/M*y*). More examples may also be found in the section ***General Comments***.

Organization and Representation of Data

- Introduction to Various Stages of Statistics: Students were able to use simple methods to collect data and organize the same set of data by using different grouping methods. Quite a number of students could distinguish between discrete and continuous data.

- Construction and Interpretation of Simple Diagrams and Graphs: The majority of students could construct simple statistical charts and compare the presentations of the same set of data by using statistical charts. Nonetheless, many students were not able to read upper quartiles from diagrams.

Q38/M4
Exemplar Item (Read upper quartile from diagram) The cumulative frequency polygon below shows the time spent on physical activities by 40 students on a day.



Find the upper quartile of the time spent on physical activities by the students on a day.

Example of Student Work (Has mistakenly considered 80 ÷ 4)
上四分位數是 20 分鐘。
Example of Student Work (Has mistakenly read the lower quartile)
上四分位數是 14 分鐘。

Analysis and Interpretation of data

- Measures of Central Tendency: The majority of students could find the median from a set of ungrouped data. In the case of grouped data, more than half of the students could find the mean if a table was given with guidance. Likewise, more than half of the students could identify sources of deception in cases of misuse of averages.

Q45/M3
Exemplar Item (Identify sources of deception) A basketball team has 5 players. Their heights (cm) are as follows: 166, 167, 168, 187, 187 It is given that the mode of the heights of the 5 players is 187 cm. Hence the team coach said, 'More than half of the 5 players are 187 cm tall.' Is the coach's statement misleading? Explain your answer.
Example of Student Work (Stating 187 was an extreme value only, without further explanation as to why the coach's statement is misleading) 理由： 187在這5個數中為極端數字，不能以眾數作定決，應以平均數作估計，平均數=168，是最合適。

Example of Student Work (Good performance)

Reason:

Yes, the coach's statement is misleading as there are 3 basketball player in the team is shorter than 187 cm which are 166 cm 167 cm and 168 cm respectively. And there are only 2 basketball player in the team are 187 cm tall. Therefore there aren't more than half of the 5 players are 187 cm tall.

∴ The coach's statement *is / **is not** misleading. (*Circle the correct answer)

Probability

- Simple Idea of Probability: Students were able to find the empirical probability. Their performance was only fair in calculating the theoretical probability.

General Comments on Secondary 3 Student Performances

The overall performance of S.3 students was satisfactory. They did quite well in the Number and Algebra Dimension and in the Data Handling Dimension. Performance was steady in the Measures, Shape and Space Dimension.

The areas in which students demonstrated adequate skills are listed below:

Directed Numbers and the Number Line

- Use positive numbers, negative numbers and zero to describe situations like profit and loss, floor levels relative to the ground level (e.g. Q21/M2).
- Demonstrate recognition of the ordering of integers on the number line (e.g. Q21/M3).

Numerical Estimation

- Determine whether to estimate or to compute the exact value in a simple context (e.g. Q1/M4).

Approximation and Errors

- Round off a number to 3 significant figures (e.g. Q2/M2).
- Convert numbers in scientific notation to integers or decimals (e.g. Q2/M1).

Using Percentages

- Solve simple selling problems (e.g. Q40/M4).

Rate and Ratio

- Represent a ratio in the form $a : b$ (or $\frac{a}{b}$), $a : b : c$ (e.g. Q23/M3).
- Use rate and ratio to solve simple real-life problems (e.g. Q23/M2).

Formulating Problems with Algebraic Language

- Substitute values into some common and simple formulas and find the value of a specified variable (e.g. Q24/M1).

Manipulations of Simple Polynomials

- Multiply a binomial by a monomial (e.g. Q26/M3).

Laws of Integral Indices

- Find the value of a^n, where a and n are integers (e.g. Q5/M4).

Factorization of Simple Polynomials

- Demonstrate recognition of factorization as a reverse process of expansion (e.g. Q6/M3).

Linear Equations in One Unknown

- Formulate linear equations in one unknown from simple contexts (e.g. Q6/M1).

Formulas

- Substitute values of formulas and find the value of a specified variable (e.g. Q29/M2).

Linear Inequalities in One Unknown

- Use inequality signs $\geq$, $>$, $\leq$ and $<$ to compare numbers (e.g. Q30/M4).
- Demonstrate recognition of and apply the properties of inequalities (e.g. Q8/M3).
- Formulate linear inequalities in one unknown from simple contexts (e.g. Q9/M2).
- Represent inequalities, such as $x < -2$, $x \geq 3$, etc., on the number line and vice versa (e.g. Q9/M1).

Estimation in Measurement

- Choose an appropriate unit and the degree of accuracy for real-life measurements (e.g. Q10/M2).
- Reduce errors in measurements (e.g. Q10/M3).

More about Areas and Volumes

- Calculate volumes of pyramids, circular cones and spheres (e.g. Q11/M2).

Introduction to Geometry

- Make 3-D solids from given nets (e.g. Q13/M2).
- Sketch simple solids (e.g. Q34/M2).

Transformation and Symmetry

- Name the single transformation involved in comparing the object and its image (e.g. Q13/M1).

Congruence and Similarity

- Demonstrate recognition of the properties of congruent and similar triangles (e.g. Q33/M4).

Angles related with Lines and Rectilinear Figures

- Demonstrate recognition of the terminologies on angles with respect to their positions relative to lines and polygons (e.g. Q15/M3).
- Use the angle properties associated with intersecting lines/parallel lines to solve simple geometric problems (e.g. Q33/M1).
- use the relations between sides and angles associated with isosceles/equilateral triangles to solve simple geometric problems (e.g. Q33/M3).

More about 3-D Figures

- Name axes of rotational symmetries of cubes (e.g. Q16/M3).
- Match 3-D objects built up of cubes from 2-D representations from various views (e.g. Q16/M4).

Introduction to Coordinates

- Use an ordered pair to describe the position of a point in the rectangular coordinate plane and locate a point of given rectangular coordinates (e.g. Q17/M4 and Q35/M3).

Introduction to Various Stages of Statistics

- Use simple methods to collect data (e.g. Q19/M1).
- Organize the same set of data by different grouping methods (e.g. Q47/M2).

Construction and Interpretation of Simple Diagrams and Graphs

- Construct simple statistical charts (e.g. Q47/M4).
- Interpret simple statistical charts (e.g. Q38/M2).
- Compare the presentations of the same set of data by using statistical charts (e.g. Q20/M4).

Other than items in which students performed well, the Assessment data also provided some entry points to strengthen teaching and learning. Items worthy of attention are discussed below:

Rational and Irrational Numbers

- Demonstrate, without using calculators, recognition of the integral part of $\sqrt{a}$ (e.g. Q3/M2): Quite a number of students chose the correct answer, option C. However, more than 20% of students still chose options B. They might only have considered the integer which is closest to $\sqrt{123}$ rather than the smallest integer greater than it.

Q3/M2
The smallest integer greater than $\sqrt{123}$ is A. 10. B. 11. C. 12. D. 13.

Formulating Problems with Algebraic Language

- Formulate simple equations/inequalities from simple contexts (e.g. Q4/M1 and Q4/M3): Two different items about formulating simple equations were set in the assessment in different sub-papers. The stems and options of these two questions were also the same, except one of the items used the words ‘at most’, while another used the words ‘not more than’. The purpose of the design is to investigate the effect of these two sets of words on students’ understanding of the items and their choices of options.

Q4/M1
The prices of an orange and a mango are \$3 and \$7 respectively. Betty pays at most \$35 to buy x oranges and y mangos. Which of the following inequalities represents the relationship between x and y? A. $3x + 7y > 35$ B. $3x + 7y < 35$ C. $3x + 7y \geq 35$ D. $3x + 7y \leq 35$

Q4/M3
The prices of an orange and a mango are \$3 and \$7 respectively. Betty pays not more than \$35 to buy x oranges and y mangos. Which of the following inequalities represents the relationship between x and y? A. $3x + 7y > 35$ B. $3x + 7y < 35$ C. $3x + 7y \geq 35$ D. $3x + 7y \leq 35$

- According to the result, it was apparent that the performance of students in Q4/M1 was better than the performance of students in Q4/M3. In Q4/M3, option B is a very strong distractor. Students treated 'not more than' as 'less than' in the question.

Manipulations of Simple Polynomials

- Demonstrate recognition of terminologies (e.g. Q5/M1): More than half of the students chose the correct answer, option D. Some students chose option A. They might have confused ascending orders with descending orders.

Q5/M1
Which of the following polynomials is in ascending powers of y? A. $y^2 + 3y + 2$ B. $3y + y^2 + 2$ C. $y^2 + 2 + 3y$ D. $2 + 3y + y^2$

Linear Equations in Two Unknowns

- Plot graphs of linear equations in 2 unknowns (e.g. Q44/M1 and Q44/M2): Two different items about plotting graphs of linear equations in 2 unknowns were set in the assessment in different sub-papers. Two equations are equivalent. One of the equations was expressed in the form $y = \mathrm{m}x + \mathrm{c}$, while the other was expressed in the form $\mathrm{A}x + \mathrm{B}y + \mathrm{C} = 0$.

Q44/M1
Complete the table for the equation $y=-\frac{x}{3}+1$ in the **ANSWER BOOKLET**.

x	-3	0	3
y	2		

According to the table, draw the graph of this equation on the rectangular coordinate plane given in the **ANSWER BOOKLET**.

Q44/M2
Complete the table for the equation $x+3y-3=0$ in the **ANSWER BOOKLET**.

x	-3	0	3
y	2		

According to the table, draw the graph of this equation on the rectangular coordinate plane given in the **ANSWER BOOKLET**.

- The result of finding y in Q44/M1 was higher than that in Q44/M2. However, the results of drawing the graphs of straight lines in these two items were almost the same. This revealed that students found it easier to find the correct values of y if the equation was expressed in the form $y = \mathrm{m}x + \mathrm{c}$, but the advantages disappeared in drawing the graphs. Whether students could draw the correct graphs of the equations still depended on their understanding of the concept.

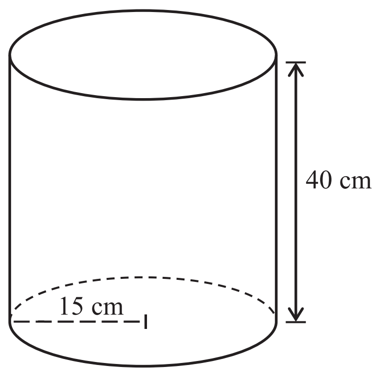
Identities

- Tell whether an equality is an equation or an identity (e.g. Q8/M4): More than half of the students chose the correct answer, option D. Many students still chose option B or C. They mistakenly thought that $\mathrm{a}x + \mathrm{b} = (\mathrm{a} + \mathrm{b})x$ and $2\mathrm{a} + 2\mathrm{b} = (\mathrm{a} + \mathrm{b})^2$ are identities.

Q8/M4
Which of the following is an identity? A. $4x + 10 = 0$ B. $4x + 10 = 14x$ C. $4x + 10 = (2x + 5)^2$ D. $4x + 10 = \frac{8x+20}{2}$

Simple Idea of Areas and Volumes

- Use the formulas for surface areas of cubes, cuboids, prisms and cylinders (e.g. Q10/M4): Almost half of the students chose the correct answer, option C. However, option D was chosen by about 20% of students. They confused total surface areas with volumes. Additionally, more than 10% of students chose option A. They calculated the curved surface area only.

Q10/M4
The figure shows a solid cylinder. Its base radius is 15 cm and its height is 40 cm. Find the total surface area of the cylinder. Express the answer in terms of π . A. $1200\pi \text{ cm}^2$ B. $1425\pi \text{ cm}^2$ C. $1650\pi \text{ cm}^2$ D. $9000\pi \text{ cm}^2$ 

More about Areas and Volumes

- Use the relationships between sides and surface areas/volumes of similar figures to solve related problems (e.g. Q11/M1): More than half of the students chose the correct answer, option B. However, about 30% of students chose options C and 10% of students chose D. Those students tended to choose the options with “square” but they mixed up what exactly the relationship between the surface areas and their corresponding heights is.

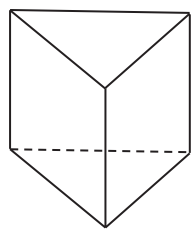
Q11/M1
The ratio of the surface areas of two similar prisms is 1 : 64. Which of the following is the ratio of their corresponding heights?
A. 1 : 4 B. 1 : 8 C. $1^2 : 8^2$ D. $1^2 : 64^2$

Introduction to Geometry

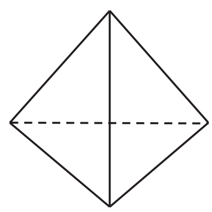
- Demonstrate recognition of common terms in geometry (e.g. Q12/M1): Only some of the students chose the correct answer, option B. However, options A and C were chosen by about 40% and 20% of students respectively. Quite a number of students thought that solid *I* is a regular polyhedron.

Q12/M1

The figure shows two solids *I* and *II*. In each solid, the lengths of **ALL** edges are equal.



Solid *I*



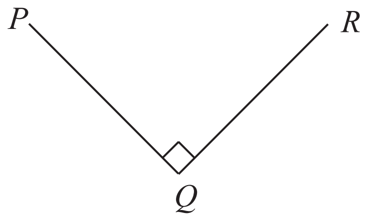
Solid *II*

Which of the following choices is correct?

	Solid *I*	Solid *II*
A.	It is a regular polyhedron.	It is a regular polyhedron.
B.	It is **NOT** a regular polyhedron.	It is a regular polyhedron.
C.	It is a regular polyhedron.	It is **NOT** a regular polyhedron.
D.	It is **NOT** a regular polyhedron.	It is **NOT** a regular polyhedron.

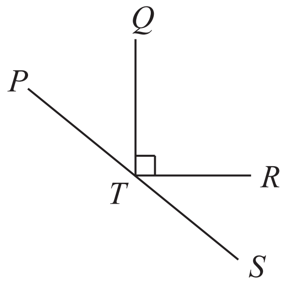
- Use common notations to represent points, line segments, angles and polygons (e.g. Q12/M3): Nearly half of the students chose the correct answer, option B. Some students chose option C or D. They mistakenly thought that *PQR* or $\angle PQR$ are line segments.

Q12/M3
Which of the following represents a line segment shown in the figure? A. *P* B. *PQ* C. *PQR* D. ∠*PQR*



- Identify types of angles with respect to their sizes (e.g. Q12/M4): Nearly half of the students chose the correct answer, option D. However, about 30% of students chose options B. They confused straight angles with right angles.

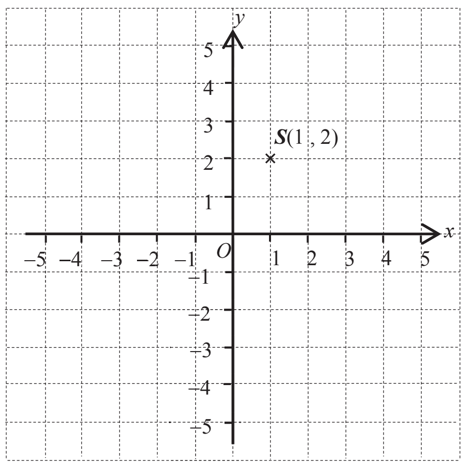
Q12/M4
In the figure, *PTS* is a straight line. Which of the following is a straight angle? A. ∠*PTQ* B. ∠*QTR* C. ∠*QTS* D. ∠*PTS*



Introduction to Coordinates

- Match a point under a single transformation with its image in the rectangular coordinate plane (e.g. Q17/M2): Almost half of the students chose option D. Each of the remaining options was chosen by more than 10% of students. It was revealed that students in general were weak in recognizing the concepts of clockwise and anti-clockwise directions, as well as reflection and rotation.

Q17/M2
In the figure, ***S*** (1 , 2) is rotated about the origin *O* through 90° in an anticlockwise direction to ***S′***. The coordinates of ***S′*** are A. (2 , −1). B. (−1 , −2). C. (1 , −2). D. (−2 , 1).



Good Performance of Secondary 3 Students in Territory-wide System Assessment 2016

Good performing students demonstrated mastery of the concepts and skills assessed by the sub-papers. They were more able in numeracy skills and problem-solving skills, so they could solve various types of problems relating to directed numbers, percentages, rate and ratio, etc. Students had thorough conceptual understanding of algebra and could observe patterns and express generality. They were able to deal with the basic operations, factorization and expansion of simple polynomials. They were capable of solving equations by using algebraic methods and graphical method. They could also plot graphs of linear equations in 2 unknowns.

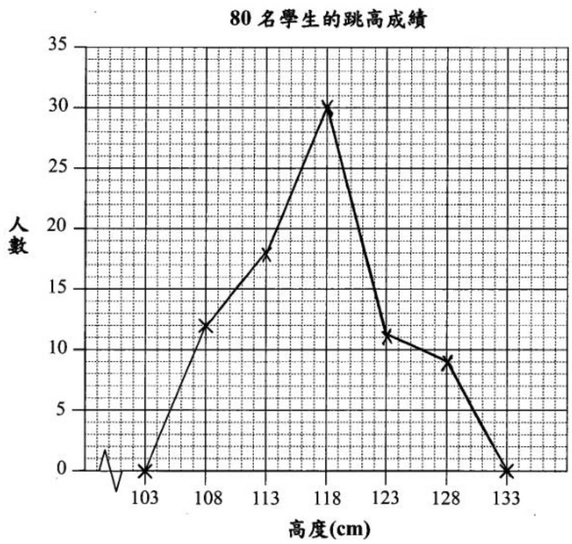
Good performing students were also capable of calculating the areas of simple plane figures and the surface areas and volumes of some solids. They could demonstrate good recognition of the concepts of transformation and symmetry, congruence and similarity, coordinate geometry, quadrilaterals, trigonometry, and Pythagoras' Theorem, etc. In doing geometric proofs, they could write the correct steps and provide sufficient reasons to complete the proofs.

Good performing students had a good knowledge of the various stages of statistics. They were able to construct and interpret simple statistical charts, use statistical charts for presentation of a set of data, and comparison of the presentations of the same set of data. They could find mean, median and mode/modal class, as well as identify sources of deception from a set of data and graphs. They could also grasp the basic concepts of probability.

The examples of work by these students are illustrated as follows:

Students with good performance were able to construct simple statistical charts by using the given data.

Q47/M4
Example of Student Work (Construct simple statistical charts)



Students with good performance could solve the problem correctly with complete and clear presentation.

Q42/M1
Example of Student Work (Solve simultaneous equations)

$\begin{cases} y = 4x+9 & \text{——— ①} \\ y = 3x+1 & \text{——— ②} \end{cases}$

把①代入②

$4x+9 = 3x+1$

$x = -8$

把 $x = -8$ 代入①

$y = 4(-8)+9$

$= -23$

∴方程的解為 $x=-8$, $y=-23$

Students with good performance were able to make good use of the given conditions and solve the problem systematically.

Q45/M2
Example of Student Work (Estimate the volume of water in the glass)

The height of the glass is around 3 boxes of tissue paper high.
The height of the water is around 1 box of tissue paper high.
The volume of water
$= \frac{525}{3} = 175 \text{ cm}^3$

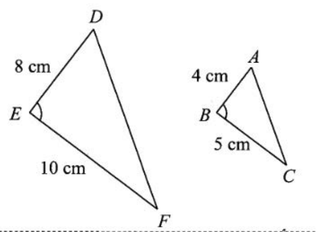
Q46/M3
Example of Student Work (Geometric proof)

在△DEF及△ABC中，
∠DEF=∠ABC (已知)

$\frac{DE}{AB} = \frac{8}{4} = 2$

$\frac{EF}{BC} = \frac{10}{5} = 2$

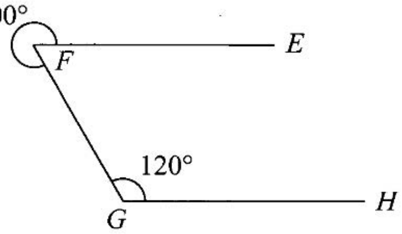
$\therefore \frac{DE}{AB} = \frac{EF}{BC} = 2$



∴△DEF~△ABC (兩邊成比例且夾角相等)

Q46/M2
Example of Student Work (Geometric Proof)

reflex ∠EFG + ∠EFG = 360° (∠s at a pt.)
300° + ∠EFG = 360°
∠EFG = 60°
∵ ∠EFG + ∠FGH = 60° + 120°
= 180°
∴ FE // GH (int. ∠s supp.)



Some common weaknesses of high-achieving students were that:

- Some students could not demonstrate recognition of common terms in geometry such as concave polygons and regular polyhedra.
- Some students tried to explain the sources of deception in cases of misuse of averages, but they could not give sufficient explanations.

Overview of Student Performances in Mathematics at Secondary 3 Territory-wide System Assessment 2014-2016

The percentage of students achieving Basic Competency in the Territory-wide System Assessment this year was 80.0% which was about the same as last year.

The percentages of students achieving Basic Competency from 2014 to 2016 are listed below:

Table 8.6 Percentages of S.3 Students Achieving Mathematics Basic Competency from 2014 to 2016

Year	% of Students Achieving Mathematics Basic Competency
2014	79.9
2015	79.9
2016	80.0

The performances of S.3 students over the past three years in each dimension of Mathematics are summarized in the following table:

Table 8.7 Overview of Student Performances in Mathematics at S.3 Territory-wide System Assessment 2014-2016

Year / Number and Algebra	2014	2015	2016	Remarks
Strengths	• Students did well in the operations of directed numbers. They demonstrated recognition of the number line. • Students could determine whether to estimate or to compute the exact value in a simple context. • Students could convert numbers in scientific notation to decimals. • Students could solve simple problems by using rate. • Students could translate word phrases/contexts into algebraic languages. • Most students were capable of solving simple equations. They could also substitute values into formulas to find the unknown value. • Students could formulate equations from simple contexts. • Students demonstrated recognition of the properties of inequalities.	• Students demonstrated recognition of the number line. They could also use directed numbers to describe real life situations. • Students were able to determine whether to estimate or to compute the exact value in a simple context. • Students were able to round off a number to a certain number of significant figures. They demonstrated recognition of scientific notation. • Students were able to solve simple selling problems and problems on depreciations. • Students were able to solve problems by using ratio. • Students were able to translate word phrases/contexts into algebraic languages. • Students were able to substitute values into formulas to find the unknown value. • Students were able to formulate equations from simple contexts.	• Students could use directed numbers to describe real life situations. They also recognized the ordering of integers on the number line. • Students could determine whether to estimate or to compute the exact value in a simple context. • Students were able to round off a number to a certain number of significant figures. • Students were able to solve simple selling problems by using percentages. • Students were able to solve problems by using rate and ratio. • Students were able to substitute values into formulas to find the unknown value. • Students could formulate equations from simple contexts. • Students demonstrated recognition of inequalities.	• Students were good at answering simple and straightforward questions involving simple calculations. • Many students were not familiar with the concepts of some terminologies (e.g. constant terms of polynomials, loss percent) and so they answered incorrectly. • Many students did not use a ruler to draw straight lines. • Answers were often not corrected to the required degree of accuracy. • Units were often omitted in the answer. • Students were willing to state the working steps and strategies used in solving problems, but sometimes the solutions were incomplete or contained errors.

Year / Number and Algebra	2014	2015	2016	Remarks
Weaknesses	• When students were asked to round off a number to a certain number of decimal places, they mistakenly rounded off the number by considering significant figures. • Many students could not represent a number in scientific notation. • Students were quite weak in recognizing the concepts of percentage change, percentage decrease and loss percentage. They mistakenly substituted the cost price and selling price in the formulas. • Students mixed up the formulas for finding simple interest and compound interest. • Students could not distinguish polynomials from algebraic expressions. • Students were weak in recognizing the terminologies of polynomials. • Students' performance was only fair in factorization of simple polynomials. • Students could not distinguish whether an equality is an equation or an identity.	• Students were quite weak in recognizing the concepts of profit, selling price and so many of them could not find the cost price correctly. • Many students confused compound interest with simple interest, as well as amount with interest. Consequently, they used the incorrect methods in solving problems. • Many students could not distinguish polynomials from algebraic expressions. • Students' performance was only fair in factorization and expansion of simple polynomials. • Without being given a table to assist calculation of coordinates, many students were not able to plot the graph of a linear equation correctly. • Students' performance was weak when they were asked to perform change of subject in simple formulas.	• Students mixed up simple interest and compound interest. Consequently, they used the incorrect methods in solving problems. • Students were weak in recognizing the terminologies of polynomials. • Students could not distinguish whether an equality is an equation or an identity. • Students were weak in manipulating algebraic fractions.	

Year / Measures, Shape and Space	2014	2015	2016	Remarks
Strengths	• Students were able to find the range of measures from a measurement of a given degree of accuracy and choose an appropriate unit and the degree of accuracy for real-life measurements. • Students could choose the method from the given options that gave a more accurate reading. • Students were able to find the areas of sectors and the surface areas of spheres. • Students could demonstrate recognition of common terms in geometry. • Students could identify the relationship between simple 3-D solids and their corresponding 2-D figures. • Students could determine the number of axes of symmetry and locate the centre of rotation from a figure. • When the object and its image were given, students could identify the single transformation involved. • Students could use the angle properties associated with intersecting lines/parallel lines and the properties of triangles to solve simple geometric problems. • Students had good knowledge of the rectangular coordinate system.	• Students were able to find the range of measures from a measurement of a given degree of accuracy and choose an appropriate unit and the degree of accuracy for real-life measurements. • Students were able to find the areas of sectors and the volumes of pyramids. • Students were able to identify the relationship between simple 3-D solids and their corresponding 2-D figures. • Students were able to determine the order of rotational symmetry from a figure. • When the object and its image were given, students were able to identify the single transformation involved. • Students were able to demonstrate recognition of the conditions for congruent and similar triangles. • Students were able to use the angle properties associated with intersecting lines/parallel lines and the properties of triangles to solve simple geometric problems. • Students had good knowledge of the rectangular coordinate system.	• Students were able to choose an appropriate unit and the degree of accuracy for real-life measurements. • Students were able to select the appropriate ways to reduce errors in measurements. • Students were able to find the volumes of cones. • Students could identify the relationship between simple 3-D solids and their corresponding 2-D figures. They could also sketch simple solids. • When the object and its image were given, students could identify the single transformation involved. • Students could demonstrate recognition of terminologies on angles. • Students could use the angle properties associated with intersecting lines/parallel lines and the properties of triangles to solve simple geometric problems. • Students could recognize the axes of rotational symmetries of cubes. • Students had good knowledge of the rectangular coordinate system.	• Students could estimate measures. However, when they had to use their own words to explain the estimation methods, their explanations were very limited and incomplete. • Students were willing to attempt geometric proofs. However, they usually could not use logical reasoning and correct reasons to complete the proofs. • Students could not master abstract concepts (such as distinguishing among formulas for volumes by considering dimensions). • Answers were often not corrected to the required degree of accuracy. • Units were often omitted in the answer. • Many students were not familiar with the formulas.

Year / Measures, Shape and Space	2014	2015	2016	Remarks
Weaknesses	• Students were unable to distinguish among formulas for volumes by considering dimensions. • Students could not determine whether a polygon is regular. • Quite a number of students could not identify the image of a figure after reflection. • Students could not demonstrate recognition of the conditions for congruent and similar triangles. • Students were weak in identifying the planes of reflectional symmetries of cubes. • Many students could not identify the projection of an edge on a plane. • Students' performance was only fair in applying the conditions for perpendicular lines.	• Students were weak in abstract concepts (such as using relationship of similar figures to find measures). • Many students could not determine whether a polygon is equiangular. • Students could not demonstrate recognition of adjacent angles. • Quite a number of students could not identify the angle between a line and a horizontal plane. • Students in general could not complete the proofs of simple geometric problems related with angles and lines. • Quite a number of students could not identify perpendicular bisectors of a triangle.	• Students' performance was quite weak in finding the total surface areas of cylinders. • Students were weak in abstract concepts (such as distinguishing among formulas for volumes by considering dimensions). • Students could not demonstrate recognition of common terms in geometry. • Quite a number of students were not able to recognize straight angles and concave polygons. • Students could not demonstrate recognition of the conditions for congruent and similar triangles. • Students in general could not complete the proofs of simple geometric problems.	

Year / Data Handling	2014	2015	2016	Remarks
Strengths	● Students could use simple methods to collect data. ● Students could interpret simple statistical charts. ● Students' performance was quite good in calculating the empirical probability and the theoretical probability by listing.	● Students could use simple methods to collect data. ● Students could read information from diagrams and interpret the information. ● Students could choose appropriate diagrams/graphs to present a set of data. ● Students were able to calculate the theoretical probability by listing.	● Students could use simple methods to collect data. ● Students could organize the same set of data by different grouping methods. ● Students could construct and interpret simple statistical charts. ● Students were able to compare the presentations of the same set of data by using statistical charts. ● Students could identify sources of deception in misleading graphs/accompanying statements.	● Many students did not draw statistical charts carefully. ● Students were willing to describe the sources of deception in cases of misuse of averages, but in general, they could not give sufficient explanations.
Weaknesses	● Students' performance was only fair in distinguishing discrete and continuous data. ● Students in general could not choose appropriate diagrams /graphs to present a set of data. ● Quite a number of students were not able to find averages from a set of grouped data.	● Students' performance was only fair in distinguishing discrete and continuous data. ● Students in general could not construct stem-and-leaf diagrams correctly. ● Many students could not compare the presentations of the same set of data by using statistical charts. ● Quite a number of students were not able to find averages from a set of grouped data.	● Students could not read upper quartiles from diagrams/graphs. ● Without providing the table or tree diagram for guidance, quite a number of students were not able to calculate the theoretical probability.	