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Singapore's Perspective: Highlights of TIMSS 2011

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**Centre for International Comparative Studies • National Institute of Education
Nanyang Technological University • Singapore**

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Singapore

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The objective of the booklet is to provide teachers of students in Singapore who participated in TIMSS 2011 with knowledge about their performance in Mathematics and Science and their attitudes towards the learning of Mathematics and Science.

The booklet explains what TIMSS is and who the participants of the study are. It also introduces the reader to the nature of the TIMSS tests and the performance of students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics and science educators in Singapore, which participated in TIMSS 2011. Test items that relatively more students from Singapore found easy and difficult are also presented. Some data from the student survey related to attitudes towards mathematics and science are also presented. These data would help us better understand the strengths and gaps in our students' learning.

After every cycle of TIMSS about half of the test items are released for use by researchers, educators and others. These items are available at the webpage:

<http://timss.bc.edu/timss2011/international-released-items.html>

The items presented in the booklet are from the pool of released items and some are also in the TIMSS 2011 International Results of Mathematics and Science. The Mathematics Report is available at:

<http://timss.bc.edu/timss2011/international-results-mathematics.html>

The Science Report is available at:

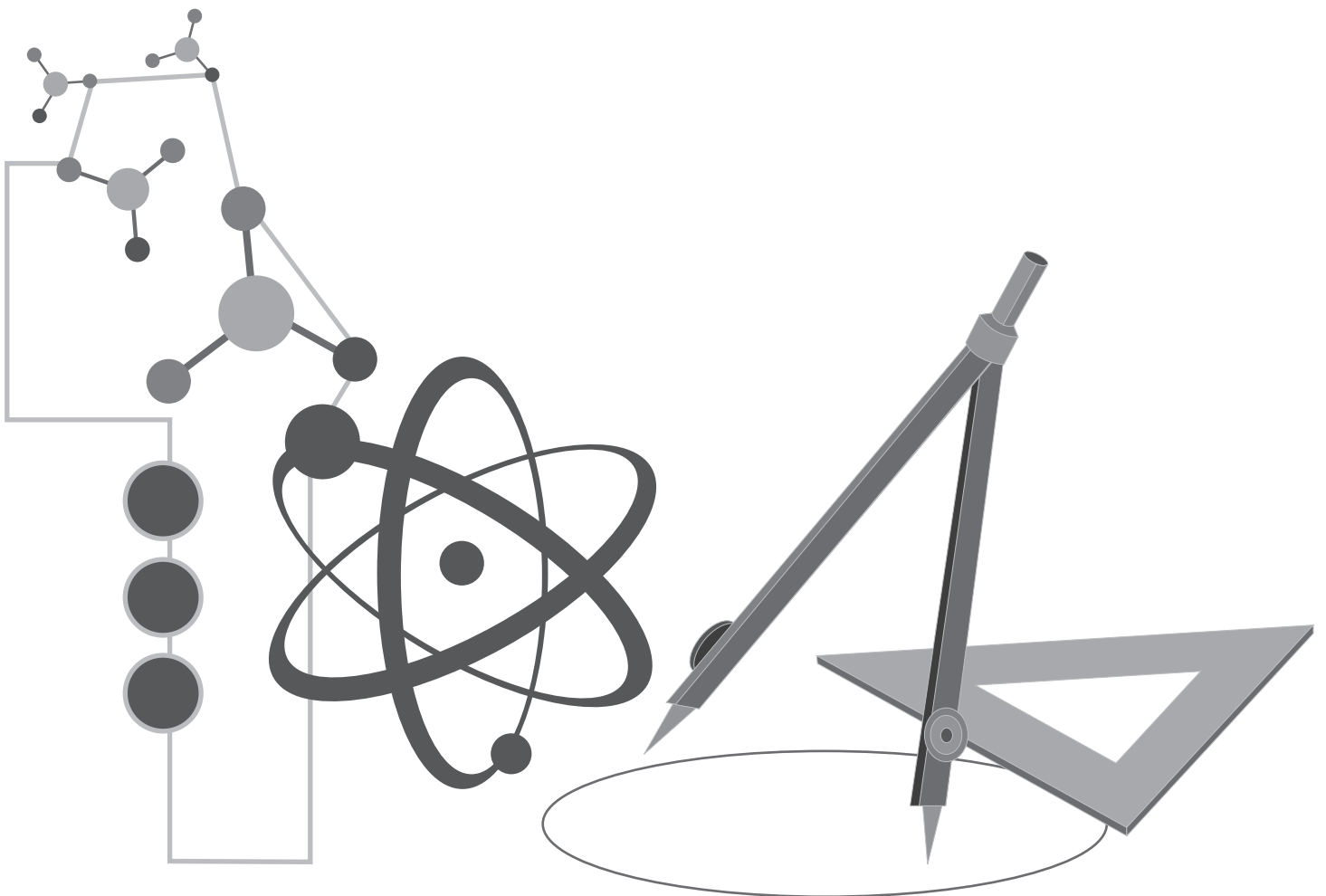
<http://timss.bc.edu/timss2011/international-results-science.html>

The contextual questionnaires used in TIMSS 2011 are also available at:

<http://timss.bc.edu/timss2011/international-contextual-q.html>

The survey data presented are from the international results reports (Mullis, Martin, Foy & Arora, 2012; Martin, Mullis, Foy & Stanco, 2012).

Trends in International Mathematics & Science Study (TIMSS) 2011



What is TIMSS 2011

TIMSS (Trends in International Mathematics and Science Study) 2011 is the fifth cycle of international mathematics and science assessments conducted periodically every four years. TIMSS is designed to provide trends in fourth and eighth grade mathematics and science achievement in an international context. The aim of TIMSS is to provide policy makers with a wealth of information about key instructional, curricular, and resource related variables that are fundamental in understanding the teaching and learning process.

For TIMSS 2011, altogether 52 countries and 7 benchmarking entities participated at the fourth grade level. The East Asian countries that participated at the fourth grade were Chinese Taipei, Hong Kong SAR, Japan, Korea Rep of, Singapore, and Thailand. 45 countries and 14 benchmarking entities participated at the eighth grade level. The East Asian countries that participated in TIMSS 2011 at the eighth grade were Chinese Taipei, Hong Kong SAR, Indonesia, Japan, Korea Rep of, Malaysia, Singapore, and Thailand.

Data were collected from participating students, their teachers and school leaders with the help of assessment tasks and contextual questionnaires. The TIMSS 2011 International Results in Mathematics (Mullis, Martin, Foy, & Arora, 2012) is a comprehensive report of all the data collected and analysed for mathematics assessment of grades four and eight students. The TIMSS 2011 International Results in Science (Martin, Mullis, Foy, & Stanco, 2012) is a comprehensive report of all the data collected and analysed for science assessment of grades four and eight students. This booklet draws data from the reports of international results for grades four and eight students from Singapore and benchmarking entities and countries of interest to mathematics educators in Singapore.

Student Participants and Tests

Representative samples of grades 4 and 8 students from participating countries and benchmarking entities took part in the study. In East Asia the fourth graders were in their fourth year of formal schooling and their average ages ranged from 10.1 to 10.5 years. The eighth graders were in their eighth year of formal schooling and their average ages ranged from 14.2 to 14.5 years.

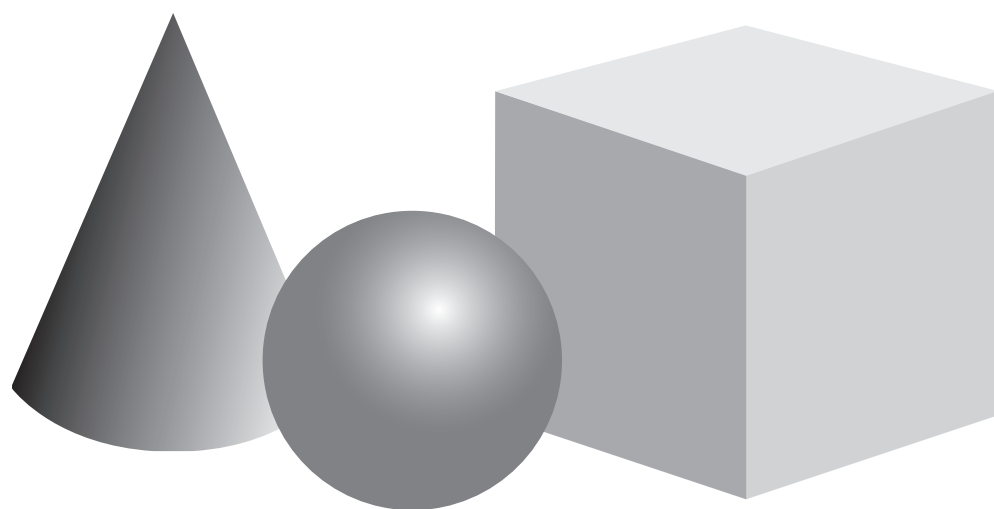
6368 Primary 4 pupils from 176 schools and 5927 Secondary 2 students from 165 schools in Singapore participated in the TIMSS 2011 main study.

The TIMSS 2011 tests (Martin & Mullis, 2008) comprised both mathematics and science items. For grade 4, fourteen different booklets containing a selection of the 175 mathematics items (93 multiple choice and 82 constructed response) and 172 science items (93 multiple choice and 79 constructed response) were administered to the students. Each student completed the test in one booklet. Testing time was 72 minutes.

For grade 8, fourteen different booklets containing a selection of the 217 mathematics items (118 multiple choice and 99 constructed response) and 217 science items (110 multiple choice and 107 constructed response) were administered to the students. Each student completed the test in one booklet. Testing time was 90 minutes.

TIMSS 2011

Mathematics Tests



Content and Cognitive Domains of the Mathematics Test Items

The design of the mathematics test items was guided by the TIMSS 2011 Assessment frameworks (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009). Two dimensions, content and cognitive, were used to organise the items. The content dimension specifies the subject matter to be assessed within mathematics, for e.g., number, algebra, etc. The cognitive dimension specifies the domains or thinking processes to be assessed, for e.g., knowing, applying and reasoning.

Grade 4

Table 1 shows the distribution of the grade 4 mathematics items by item type and content domain. Table 2 shows the distribution of the grade 4 mathematics items by item type and cognitive domain.

Table 1

Grade 4 – Number of mathematics items by item type and content domain

Content Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Number	42 (42)	46 (50)	88 (92)	50%
Geometric Shapes & Measures	38 (38)	23 (27)	61 (65)	35%
Data Display	13 (13)	13 (15)	26 (28)	15%
Total	93 (93)	82 (92)	175 (185)	100%
Percentage of Score Points	50%	50%		

Score points are shown in parentheses.

Table 2

Grade 4 – Number of mathematics items by item type and cognitive domain

Cognitive Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Knowing	43 (43)	27 (30)	70 (73)	39%
Applying	34 (34)	37 (41)	71 (75)	41%
Reasoning	16 (16)	18 (21)	34 (37)	20%
Total	93 (93)	82 (92)	175 (185)	100%
Percentage of Score Points	50%	50%		

Score points are shown in parentheses.

Grade 8

Table 3 shows the distribution of the grade 8 mathematics items by item type and content domain. Table 4 shows the distribution of the grade 8 mathematics items by item type and cognitive domain.

Table 3

Grade 8 – Number of mathematics items by item type and content domain

Content Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Number	31 (31)	30 (36)	61 (67)	29%
Algebra	37 (37)	33 (39)	70 (76)	33%
Geometry	25 (25)	18 (19)	43 (44)	19%
Data and Chance	25 (25)	18 (20)	43 (45)	19%
Total	118 (118)	99 (114)	217 (232)	100%
Percentage of Score Points	51%	49%		

Score points are shown in parentheses.

Table 4

Grade 8 - Distribution of score points by item type and cognitive domain

Cognitive Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Knowing	53 (53)	27 (30)	80 (83)	36%
Applying	47 (47)	38 (44)	85 (91)	39%
Reasoning	18 (18)	34 (40)	52 (58)	25%
Total	118 (118)	99 (114)	217 (232)	100%
Percentage of Score Points	51%	49%		

Score points are shown in parentheses.

Mathematics Achievement - Grade 4

Overall performance of grade 4 students

Table 5 shows the average mathematics achievement of grade 4 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore.

Table 5
 Grade 4 - Average mathematics achievement

Country	Rank	Average Scale Score
Singapore	1	606 (3.2)
Korea, Rep of	2	605 (1.9)
Hong Kong SAR	3	602 (3.4)
Chinese Taipei	4	591 (2.0)
Japan	5	585 (1.7)
Finland	8	545 (2.3)
England	9	542 (3.5)
Russian Federation	10	542 (3.7)
North Carolina, US	--	554 (4.2)
Florida, US	--	545 (2.9)
TIMSS Scale Centerpoint		500

() Standard errors
 -- not available

It is apparent from Table 5 that the top five performing countries for grade 4 are from East Asia. The performance of students from Singapore is commendable as about a quarter of the topics tested in the mathematics tests were not in the Singapore Primary 4 mathematics syllabus.

Table 6 shows the average performance of grade 4 students from top performing East Asian countries (Singapore, Korea, Rep of, Hong Kong SAR, Chinese Taipei, and Japan) in the respective content and cognitive domains.

Table 6

Grade 4 - Average percent correct in respective mathematics content and cognitive domains

Domains		Average percent correct					
		Singapore	Korea, Rep of	Hong Kong SAR	Chinese Taipei	Japan	International Avg
Mathematics content	Number	76 (0.8)	73 (0.4)	73 (0.8)	71 (0.4)	67 (0.4)	47 (0.1)
	Geometric shapes and measures	70 (0.7)	72 (0.4)	74 (0.7)	65 (0.5)	68 (0.4)	49 (0.1)
	Data display	80 (0.6)	84 (0.4)	81 (0.8)	82 (0.5)	82 (0.4)	58 (0.1)
Mathematics cognitive	Knowing	81 (0.6)	79 (0.4)	80 (0.7)	75 (0.4)	74 (0.4)	55 (0.1)
	Applying	75 (0.7)	74 (0.4)	75 (0.9)	72 (0.4)	70 (0.4)	50 (0.1)
	Reasoning	61 (0.9)	65 (0.5)	61 (0.8)	59 (0.6)	63 (0.5)	40 (0.1)

() Standard errors

From Table 6, it is apparent that grade 4 students from Singapore performed well in both the mathematics content and cognitive domains just like their counterparts from East Asia.

International benchmarks of mathematics achievement

The International benchmarks presented as part of the TIMSS 2011 data helps to provide participating countries and benchmarking entities with a distribution of the performance of their students in an international setting. For a country the proportions of students reaching these benchmarks are perhaps telling of certain strengths and weaknesses of the mathematics education programs of the country. The benchmarks delineate performance at four points of the performance scale. Table 7 shows the percentage of grade 4 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore, at each of the four TIMSS 2011 international benchmarks of mathematics achievement.

Table 7
Grade 4 - Percentages of students at the respective international benchmarks of mathematics achievement

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Singapore	43 (2.0)	78 (1.4)	94 (0.7)	99 (0.2)
Korea, Rep of	39 (1.3)	80 (0.8)	97 (0.4)	100 (0.1)
Hong Kong SAR	37 (1.8)	80 (1.6)	96 (1.0)	99 (0.5)
Chinese Taipei	34 (1.2)	74 (1.1)	93 (0.6)	99 (0.2)
Japan	30 (1.0)	70 (1.0)	93 (0.5)	99 (0.2)
England	18 (1.3)	49 (1.7)	78 (1.4)	93 (0.7)
North Carolina, US	16 (1.8)	54 (2.6)	86 (1.7)	98 (0.6)
Florida, US	14 (1.3)	47 (1.7)	83 (1.2)	97 (0.4)
Russian Federation	13 (1.4)	47 (2.0)	82 (1.4)	97 (0.6)
Finland	12 (0.8)	49 (1.3)	85 (1.2)	98 (0.4)
International Median	4	28	69	90

() Standard errors

From Table 7, it is apparent that 99% of the grade 4 students in Singapore had some basic mathematical knowledge and more than 40% were able to apply their knowledge in relatively complex situations and justify their solutions. However, a higher percentage of students from the Republic of Korea compared to Singapore reached the High, Intermediate and Low Benchmarks.

What can students at each of these international benchmarks do?

Characteristics of students at each of these four points are as follows.

Grade 4 - TIMSS 2011 international benchmarks of mathematics achievement

Advanced International Benchmark – 625

Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning. They can solve a variety of multi-step word problems involving whole numbers, including proportions. Students at this level show an increasing understanding of fractions and decimals. Students can apply geometric knowledge of a range of two- and three-dimensional shapes in a variety of situations. They can draw a conclusion from data in a table and justify their conclusion.

High International Benchmark – 550

Students can apply their knowledge and understanding to solve problems. Students can solve word problems involving operations with whole numbers. They can use division in a variety of problem situations. They can use their understanding of place value to solve problems. Students can extend patterns to find a later specified term. Students demonstrate understanding of line symmetry and geometric properties. Students can interpret and use data in tables and graphs to solve problems. They can use information in pictographs and tally charts to complete bar graphs.

Intermediate International Benchmark – 475

Students can apply basic mathematical knowledge in straightforward situations. Students at this level demonstrate an understanding of whole numbers and some understanding of fractions. Students can visualize three-dimensional shapes from two-dimensional representations. They can interpret bar graphs, pictographs, and tables to solve simple problems.

Low International Benchmark – 400

Students have some basic mathematical knowledge. Students can add and subtract whole numbers. They have some recognition of parallel and perpendicular lines, familiar geometric shapes, and coordinate maps. They can read and complete simple bar graphs and tables.

Figures 1, and 2 show items of the advanced international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Reasoning Description: Solves a multi-step numerical reasoning problem	Country	Percent Full Credit
<p>In a soccer tournament, teams get:</p> <p>3 points for a win 1 point for a tie 0 points for a loss</p> <p>Zedland has 11 points.</p> <p>What is the smallest number of games Zedland could have played?</p> <p>Answer: <u> 5 </u></p>	Hong Kong SAR	59 (2.2)
	Japan	56 (2.2)
	Korea, Rep of	52 (2.0)
	Singapore	52 (1.9)
	Chinese Taipei	48 (2.1)
	England	47 (2.3)
	North Carolina, US	39 (3.2)
	Finland	35 (2.2)
	Florida, US	35 (3.1)
	Russian Federation	28 (2.0)
	International Average	27 (0.3)

Figure 1: Advanced international benchmark item – Example grade 4 mathematics item 1

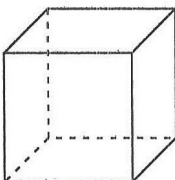
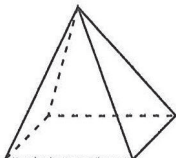
Content domain: Geometrical Shapes and Measures Cognitive domain: Knowing Description: Given the pictures of two common solids, classifies four statements as true or false	Country	Percent Full Credit																		
<p>Figure A  Figure B </p> <p>Here are some statements about Figure A and Figure B. Put an X to show whether each statement is true or false.</p> <table border="1"> <thead> <tr> <th>Statement</th> <th>True</th> <th>False</th> </tr> </thead> <tbody> <tr> <td>A and B both have a square face.</td> <td>X</td> <td></td> </tr> <tr> <td>A and B both have the same number of faces.</td> <td></td> <td>X</td> </tr> <tr> <td>All the angles in A are right angles.</td> <td>X</td> <td></td> </tr> <tr> <td>B has more edges than A.</td> <td></td> <td>X</td> </tr> <tr> <td>Some of the edges in B are curved.</td> <td></td> <td>X</td> </tr> </tbody> </table>	Statement	True	False	A and B both have a square face.	X		A and B both have the same number of faces.		X	All the angles in A are right angles.	X		B has more edges than A.		X	Some of the edges in B are curved.		X	England	58 (2.4)
	Statement	True	False																	
	A and B both have a square face.	X																		
	A and B both have the same number of faces.		X																	
	All the angles in A are right angles.	X																		
	B has more edges than A.		X																	
	Some of the edges in B are curved.		X																	
	Hong Kong SAR	57 (2.3)																		
	Japan	53 (2.0)																		
	Chinese Taipei	53 (2.4)																		
	North Carolina, US	46 (3.2)																		
Korea	44 (2.1)																			
Florida, US	44 (2.7)																			
Singapore	41 (2.2)																			
Finland	33 (2.7)																			
International Average	32 (0.3)																			
Russian Federation	22 (1.8)																			

Figure 2: Advanced international benchmark item – Example grade 4 mathematics item 2

Figures 3, 4, and 5 show items of the high international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Applying Description: Solves a word problem involving addition of time and conversion between hours and minutes	Country	Percent Full Credit
<p>A train left Redville at 8:45 a.m. It arrived in Bedford 2 hours and 18 minutes later. What time did it arrive in Bedford?</p> <p> <input type="radio"/> (A) 11:15 a.m. <input type="radio"/> (B) 11:13 a.m. <input checked="" type="radio"/> (C) 11:03 a.m. <input type="radio"/> (D) 10:53 a.m. </p>	Chinese Taipei	85 (1.5)
	Korea, Rep of	82 (1.8)
	Singapore	82 (1.4)
	Hong Kong SAR	76 (2.0)
	Japan	69 (1.8)
	North Carolina, US	66 (2.8)
	Russian Federation	65 (1.8)
	Finland	65 (2.4)
	England	63 (2.6)
	Florida, US	54 (2.9)
	International Average	52 (0.3)

Figure 3: High international benchmark item – Example grade 4 mathematics item 3

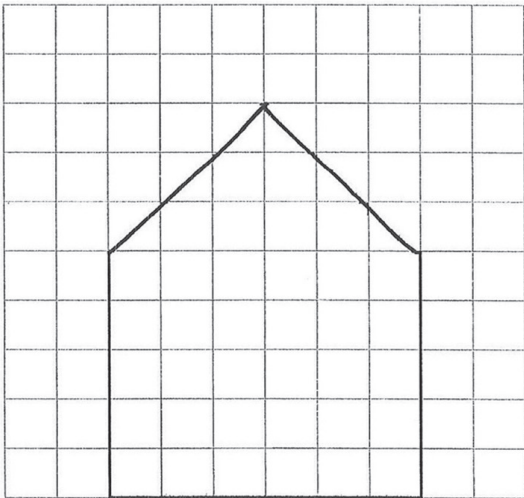
Content domain: Geometric Shapes and Measures Cognitive domain: Applying Description: Completes a shape so that it has line symmetry and a given number of sides	Country	Percent Full Credit
<p>Jay has to draw a shape. It must have 5 sides. It must have one line of symmetry. Jay has started to draw the shape. Complete Jay's shape.</p> 	Hong Kong SAR	84 (2.0)
	Korea, Rep of	67 (1.8)
	England	61 (2.6)
	Singapore	61 (2.0)
	Russian Federation	61 (2.7)
	North Carolina, US	50 (3.0)
	Florida, US	50 (3.4)
	Finland	45 (2.5)
	Chinese Taipei	44 (2.0)
	International Average	42 (0.3)
	Japan	39 (1.9)

Figure 4: High international benchmark item – Example grade 4 mathematics item 4

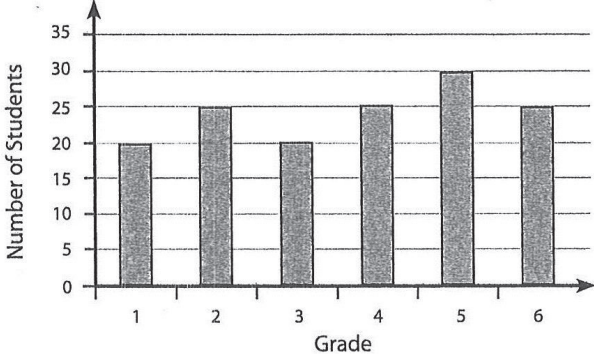
Content domain: Data Display Cognitive domain: Reasoning Description: Solves a multi-step reasoning problem using data from a bar graph	Country	Percent Full Credit
<p>The graph shows the number of students at each grade in the Pine School.</p> <p style="text-align: center;">Pine School</p>  <p>In the Pine School there is room in each grade for 30 students. How many more students could be in the school?</p> <p> <input type="radio"/> (A) 20 <input type="radio"/> (B) 25 <input type="radio"/> (C) 30 <input checked="" type="radio"/> (D) 35 </p>	Chinese Taipei Hong Kong SAR Korea, Rep of Singapore Japan England Finland North Carolina, US Florida, US International Average Russian Federation	79 (1.9) 78 (2.0) 75 (1.3) 73 (1.8) 71 (2.0) 65 (2.5) 63 (2.1) 61 (2.9) 56 (2.4) 54 (0.3) 53 (2.4)

Figure 5: High international benchmark item – Example grade 4 mathematics item 5

Figures 6, 7, and 8 show items of the intermediate international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Applying Description: Solves a word problem involving addition of decimals (one place)	Country	Percent Full Credit
<p>Duncan first traveled 4.8 km in a car and then he traveled 1.5 km in a bus. How far did Duncan travel?</p> <p> <input checked="" type="radio"/> (A) 6.3 km <input type="radio"/> (B) 5.8 km <input type="radio"/> (C) 5.13 km <input type="radio"/> (D) 4.95 km </p>	Korea, Rep of Japan Chinese Taipei Singapore Finland North Carolina, US Hong Kong SAR England Florida, US Russian Federation International Average	97 (0.7) 95 (0.9) 92 (1.1) 92 (1.1) 86 (1.7) 80 (2.8) 74 (1.9) 74 (2.4) 72 (2.5) 67 (1.9) 60 (0.3)

Figure 6: Intermediate international benchmark item – Example grade 4 mathematics item 6

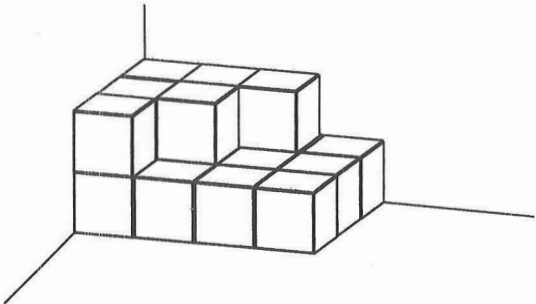
<p>Content domain: Geometric Shapes and Measures Cognitive domain: Applying Description: Determines the number of cubes in a stack with some hidden</p>	Country	Percent Full Credit
 <p>Ann stacks these boxes in the corner of the room. All the boxes are the same size. How many boxes does she use?</p> <p>(A) 25 (B) 19 (C) 18 (D) 13</p>	Chinese Taipei	95 (0.8)
	Korea, Rep of	85 (1.3)
	Japan	84 (1.5)
	Finland	81 (2.0)
	Hong Kong SAR	80 (1.7)
	Singapore	78 (1.4)
	Russian Federation	68 (2.1)
	Florida, US	68 (2.9)
	North Carolina, US	68 (3.0)
	England	67 (2.5)
International Average	63 (0.3)	

Figure 7: Intermediate international benchmark item – Example grade 4 mathematics item 7

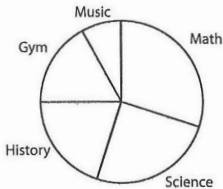
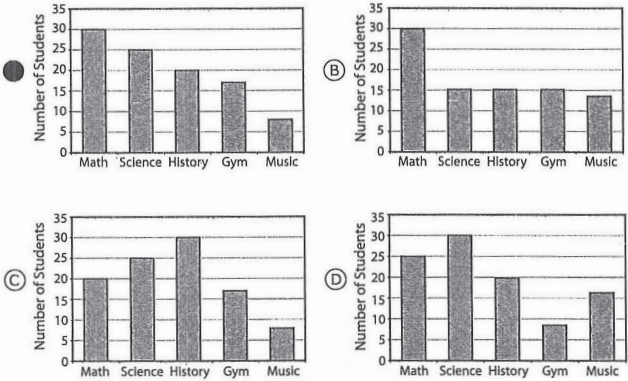
<p>Content domain: Data Display Cognitive domain: Reasoning Description: Identifies the bar graph that matches the information shown in a pie chart</p>	Country	Percent Full Credit
<p>Mr. Johnson asked the students in his school about their favorite subject. This pie chart shows how many students liked each of 5 subjects.</p> <p style="text-align: center;">Favorite Subject</p>  <p>Which graph shows the same information as the pie chart?</p> 	Korea, Rep of	95 (0.9)
	Japan	92 (1.1)
	Singapore	89 (1.0)
	Hong Kong SAR	88 (1.5)
	Chinese Taipei	87 (1.4)
	Russian Federation	86 (1.7)
	Finland	84 (2.1)
	North Carolina, US	82 (2.7)
	Florida, US	81 (2.1)
	England	76 (2.0)
International Average	71 (0.3)	

Figure 8: Intermediate international benchmark item – Example grade 4 mathematics item 8

Figures 9, and 10 show items of the low international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Applying Description: Solves a word problem involving addition of three-digit whole numbers	Country	Percent Full Credit
<p>There are 218 passengers and 191 crew members on a ship. How many people are on the ship altogether?</p> <p>Answer: <u>409</u></p>	Singapore	93 (0.8)
	Korea, Rep of	93 (1.2)
	Japan	91 (1.1)
	Chinese Taipei	89 (1.6)
	North Carolina, US	88 (2.0)
	Florida, US	87 (2.0)
	Russian Federation	86 (1.3)
	Hong Kong SAR	86 (1.8)
	England	78 (2.3)
	International Average	73 (0.3)
	Finland	68 (2.6)

Figure 9: Low international benchmark item – Example grade 4 mathematics item 9

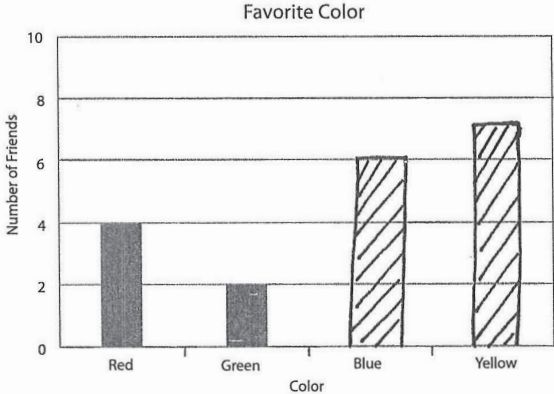
Content domain: Data Display Cognitive domain: Applying Description: Completes a bar graph from data in a table	Country	Percent Full Credit										
<p>Darin asked his friends to name their favorite color. He collected the information in the table shown below.</p> <table border="1" data-bbox="210 1317 596 1509"> <thead> <tr> <th>Favorite Color</th> <th>Number of Friends</th> </tr> </thead> <tbody> <tr> <td>Red</td> <td>4</td> </tr> <tr> <td>Green</td> <td>2</td> </tr> <tr> <td>Blue</td> <td>6</td> </tr> <tr> <td>Yellow</td> <td>7</td> </tr> </tbody> </table> <p>Then Darin started to draw a graph to show the information. Complete Darin's graph.</p> 	Favorite Color	Number of Friends	Red	4	Green	2	Blue	6	Yellow	7	Korea, Rep of	97 (0.7)
	Favorite Color	Number of Friends										
	Red	4										
	Green	2										
	Blue	6										
	Yellow	7										
	Singapore	95 (0.8)										
	Hong Kong SAR	95 (1.1)										
	Japan	93 (1.1)										
	England	89 (1.3)										
	Finland	88 (1.7)										
Chinese Taipei	87 (1.8)											
North Carolina, US	82 (2.2)											
Russian Federation	81 (1.6)											
Florida, US	80 (2.3)											
International Average	73 (0.3)											

Figure 10: Low international benchmark item – Example grade 4 mathematics item 10

Items that relatively more grade 4 students from Singapore found easy

Figures 11, 12, 13, and 14 show four items that relatively more grade 4 students from Singapore found easy.

Content domain: Number Cognitive domain: Applying	Country	Percent Full Credit
<p>If the pattern 3, 6, 9, 12 was continued, which of these numbers would be one of the numbers in the pattern?</p> <p>(A) 26 (B) 27 (C) 28 (D) 29</p> <p>Answer: B</p>	Singapore	93 (0.8)
	North Carolina, US	90 (1.7)
	Korea, Rep of	89 (1.4)
	Florida, US	89 (1.5)
	Chinese Taipei	81 (1.7)
	Finland	80 (2.0)
	Hong Kong SAR	80 (2.2)
	England	80 (2.3)
	Japan	79 (1.9)
	Russian Federation	64 (1.9)
International Average	62 (0.3)	

Figure 11: A relatively easy item for Singapore students – Example grade 4 mathematics item 1

Content domain: Number Cognitive domain: Knowing	Country	Percent Full Credit
<p>Tom ate $\frac{1}{2}$ of a cake, and Jane ate $\frac{1}{4}$ of the cake. How much of the cake did they eat altogether?</p> <p>Answer: _____</p> <p>Answer: $\frac{3}{4}$ or equivalent</p>	Singapore	84 (1.4)
	Chinese Taipei	54 (2.2)
	Hong Kong SAR	53 (2.4)
	England	51 (2.7)
	Finland	46 (2.4)
	North Carolina, US	40 (3.5)
	Korea, Rep of	36 (2.2)
	Florida, US	32 (2.8)
	Japan	28 (1.8)
	International Average	23 (0.3)
	Russian Federation	14 (2.0)

Figure 12: A relatively easy item for Singapore students – Example grade 4 mathematics item 2

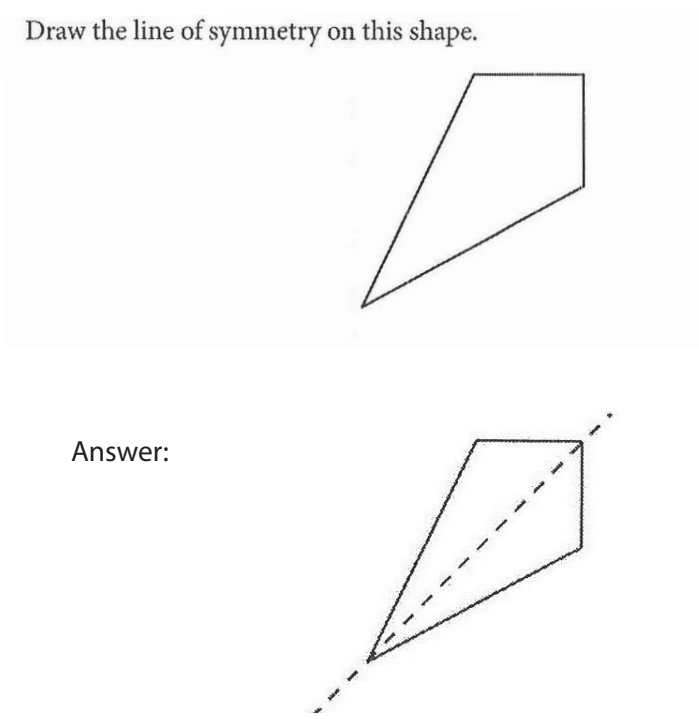
Content domain: Geometric Shapes and Measures Cognitive domain: Applying	Country	Percent Full Credit
<p>Draw the line of symmetry on this shape.</p>  <p>Answer:</p>	Hong Kong, SAR	93 (1.3)
	Singapore	92 (1.1)
	Florida, US	87 (1.8)
	England	82 (1.9)
	North Carolina, US	82 (2.6)
	Russian Federation	61 (2.3)
	Korea, Rep of	57 (2.0)
	International Average	47 (0.3)
	Finland	38 (2.5)
	Japan	31 (2.0)
	Chinese Taipei	22 (1.7)

Figure 13: A relatively difficult item for Singapore students – Example grade 4 mathematics item 1














Content domain: Data Display Cognitive domain: Knowing	Country	Percent Full Credit										
<p>Favorite Ice Cream Flavors</p> <table border="1" data-bbox="159 1411 750 1680"> <thead> <tr> <th>Flavor</th> <th>Number of Children</th> </tr> </thead> <tbody> <tr> <td>Vanilla</td> <td></td> </tr> <tr> <td>Chocolate</td> <td></td> </tr> <tr> <td>Strawberry</td> <td></td> </tr> <tr> <td>Lemon</td> <td></td> </tr> </tbody> </table> <p> stands for 4 children</p> <p>How many children chose vanilla as their favorite flavor?</p> <p>Answer: _____</p> <p>Answer: 12</p>	Flavor	Number of Children	Vanilla		Chocolate		Strawberry		Lemon		Singapore	93 (1.0)
	Flavor	Number of Children										
	Vanilla											
	Chocolate											
	Strawberry											
	Lemon											
	North Carolina, US	93 (2.0)										
	Florida, US	88 (2.0)										
	Korea, Rep of	84 (1.4)										
	Hong Kong SAR	84 (2.1)										
	Chinese Taipei	79 (2.0)										
Japan	78 (1.6)											
England	78 (2.1)											
Finland	71 (2.4)											
Russian Federation	69 (2.4)											
International Average	54 (0.3)											

Figure 14: A relatively easy item for Singapore students – Example grade 4 mathematics item 4

Items that relatively more grade 4 students from Singapore found difficult

Figures 15, 16, 17, and 18 show four items that relatively more grade 4 students from Singapore found difficult.

Content domain: Number Cognitive domain: Reasoning	Country	Percent Full Credit
<p>Three thousand tickets for a basketball game are numbered 1 to 3000. People with ticket numbers ending with 112 receive a prize. Write down all the prize-winning numbers.</p> <p>Prize-winning numbers: _____</p> <p>Answer: 112, 1112, 2112</p>	Korea, Rep of	59 (2.2)
	Hong Kong SAR	47 (2.3)
	Russian Federation	46 (2.0)
	Japan	45 (2.2)
	Singapore	40 (2.2)
	England	39 (2.4)
	Finland	36 (2.4)
	North Carolina, US	33 (2.5)
	Florida, US	32 (2.7)
	International Average	26 (0.3)
	Chinese Taipei	24 (1.7)

Figure 15: A relatively difficult item for Singapore students – Example grade 4 mathematics item 1

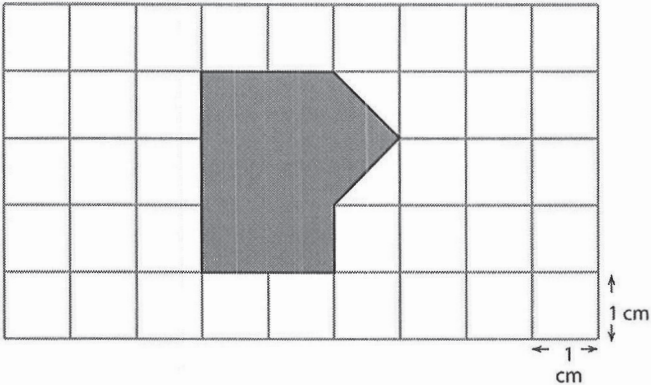
Content domain: Geometric Shapes and Measures Cognitive domain: Applying	Country	Percent Full Credit
 <p>The squares in the grid above are 1 cm by 1 cm. What is the shaded area in square centimeters?</p> <p>Answer: 7 square centimeters</p>	Japan	70 (2.1)
	Hong Kong SAR	67 (3.1)
	Chinese Taipei	63 (2.2)
	Florida, US	57 (3.1)
	Korea, Rep of	48 (2.3)
	Russian Federation	44 (2.4)
	Singapore	39 (2.1)
	North Carolina, US	34 (3.4)
	England	32 (2.7)
	International Average	30 (0.3)
	Finland	26 (2.0)

Figure 16: A relatively difficult item for Singapore students – Example grade 4 mathematics item 2

Content domain: Geometric Shapes and Measures Cognitive domain: Reasoning	Country	Percent Full Credit
<p>Ina found the following patterns to make containers. Which pattern actually makes the container shown beside it?</p>	Japan	80 (1.7)
	Korea, Rep of	75 (1.9)
	Hong Kong SAR	59 (2.3)
	Chinese Taipei	56 (2.2)
	Finland	53 (2.2)
	Russian Federation	51 (2.2)
	Singapore	47 (1.9)
	England	44 (2.5)
	International Average	37 (0.3)
	Florida, US	33 (2.4)
North Carolina, US	24 (3.0)	

Figure 17: A relatively difficult item for Singapore students – Example grade 4 mathematics item 3

Content domain: Geometric Shapes and Measures Cognitive domain: Reasoning	Country	Percent Full Credit													
<p>Sean used the table to sort these shapes. Put the letter of each shape in the space where it belongs. Shape A has been done for you.</p> <table border="1"> <thead> <tr> <th></th> <th>Has 4 Sides</th> <th>Does Not Have 4 Sides</th> </tr> </thead> <tbody> <tr> <td>All sides are the same length</td> <td>A</td> <td></td> </tr> <tr> <td>All sides are NOT the same length</td> <td></td> <td></td> </tr> </tbody> </table> <p>Answer:</p> <table border="1"> <tr> <td>(A) F</td> <td>D</td> </tr> <tr> <td>C E</td> <td>B</td> </tr> </table>		Has 4 Sides	Does Not Have 4 Sides	All sides are the same length	A		All sides are NOT the same length			(A) F	D	C E	B	England	38 (2.5)
		Has 4 Sides	Does Not Have 4 Sides												
	All sides are the same length	A													
	All sides are NOT the same length														
	(A) F	D													
	C E	B													
	Hong Kong SAR	33 (1.9)													
	Japan	32 (2.1)													
	Korea, Rep of	28 (1.8)													
	Chinese Taipei	26 (1.8)													
Finland	22 (2.2)														
Russian Federation	20 (1.8)														
North Carolina, US	16 (2.6)														
International Average	15 (0.2)														
Singapore	12 (1.3)														
Florida, US	8 (1.6)														

Figure 18: A relatively difficult item for Singapore students – Example grade 4 mathematics item 4

Mathematics Achievement - Grade 8

Overall performance of grade 8 students

Table 8 shows the average mathematics achievement of grade 8 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore, which participated in TIMSS 2011.

Table 8
Grade 8 – Average mathematics achievement

Country	Rank	Average Scale Score
Korea, Rep of	1	613 (2.9)
Singapore	2	611 (3.8)
Chinese Taipei	3	609 (3.2)
Hong Kong SAR	4	586 (3.8)
Japan	5	570 (2.6)
Russian Federation	6	539 (3.6)
Finland	8	514 (2.5)
England	10	507 (5.5)
Massachusetts, US	--	561 (5.3)
Minnesota, US	--	545 (4.6)
TIMSS Scale Centerpoint		500

() Standard errors
-- not available

It is apparent from Table 8 that the top five performing countries for grade 8 are from East Asia. Singapore ranked 2nd. The overall performances of grade 8 students from Korea, Rep of, Singapore, and Chinese Taipei were well above all the other participating countries and benchmarking entities.

Table 9 shows the average performance of grade 8 students from top performing East Asian countries (Korea, Rep of, Singapore, Chinese Taipei, Hong Kong SAR, and Japan) in the respective content and cognitive domains.

Table 9

Grade 8 – Average percent correct in respective mathematics content and cognitive domains

Domains		Average percent correct					
		Korea, Rep of	Singapore	Chinese Taipei	Hong Kong SAR	Japan	International Avg
Mathematics content	Number	77 (0.5)	77 (0.9)	72 (0.6)	72 (0.9)	63 (0.7)	43 (0.1)
	Algebra	71 (0.7)	72 (1.1)	72 (0.7)	64 (1.0)	60 (0.7)	37 (0.1)
	Geometry	71 (0.6)	71 (1.0)	73 (0.6)	69 (0.9)	67 (0.7)	39 (0.1)
	Data and Chance	75 (0.5)	72 (0.9)	69 (0.6)	68 (0.8)	68 (0.6)	45 (0.1)
Mathematics cognitive	Knowing	80 (0.5)	82 (0.8)	77 (0.6)	77 (0.8)	70 (0.6)	49 (0.1)
	Applying	73 (0.6)	73 (1.0)	72 (0.6)	67 (0.9)	64 (0.6)	39 (0.1)
	Reasoning	65 (0.6)	62 (1.1)	63 (0.7)	56 (1.0)	56 (0.7)	30 (0.1)

() Standard errors

From Table 9, it is apparent that grade 8 students from Singapore performed well in both the mathematics content and cognitive domains just like their counterparts from East Asia.

International benchmarks of mathematics achievement

The International benchmarks presented as part of the TIMSS 2011 data helps to provide participating countries with a distribution of the performance of their students in an international setting. For a country the proportions of students reaching these benchmarks are perhaps telling of certain strengths and weaknesses of mathematics education programs of the country. The benchmarks delineate performance at four points of the performance scale. Table 10 shows the percentage of grade 8 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore, at each of the four TIMSS 2011 international benchmarks of mathematics achievement.

Table 10

Grade 8 - Percentages of students at the respective international benchmarks of mathematics achievement

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Chinese Taipei	49 (1.5)	73 (1.0)	88 (0.7)	96 (0.4)
Singapore	48 (2.0)	78 (1.8)	92 (1.1)	99 (0.3)
Korea, Rep of	47 (1.6)	77 (0.9)	93 (0.6)	99 (0.2)
Hong Kong SAR	34 (2.0)	71 (1.7)	89 (1.4)	97 (0.8)
Japan	27 (1.3)	61 (1.3)	87 (0.7)	97 (0.3)
Massachusetts, US	19 (3.0)	57 (3.2)	88 (1.4)	98 (0.3)
Russian Federation	14 (1.2)	47 (2.0)	78 (1.4)	95 (0.7)
Minnesota, US	13 (2.3)	49 (2.8)	83 (1.9)	97 (0.7)
England	8 (1.4)	32 (2.9)	65 (2.7)	88 (1.6)
Finland	4 (0.5)	30 (1.5)	73 (1.5)	96 (0.6)
International Median	3	17	46	75

() Standard errors

From Table 10, it is apparent that 99% of the grade 8 students in Singapore had some basic mathematical knowledge and 48% of them were able to apply their knowledge in relatively complex situations and solve non-routine problems. It is noteworthy that although 49% of grade 8 students in Chinese Taipei reached the Advanced benchmark, percentage wise less students made it to the following three benchmarks when compared to Singapore.

What can students at each of these international benchmarks do?

Characteristics of students at each of these four points are as follows.

Grade 8 - TIMSS 2011 international benchmarks of mathematics achievement

Advanced International Benchmark – 625

Students can reason with information, draw conclusions, make generalizations, and solve linear equations. Students can solve a variety of fraction, proportion, and percent problems and justify their conclusions. Students can express generalizations algebraically and model situations. They can solve a variety of problems involving equations, formulas, and functions. Students can reason with geometric figures to solve problems. Students can reason with data from several sources or unfamiliar representations to solve multi-step problems.

High International Benchmark – 550

Students can apply their understanding and knowledge in a variety of relatively complex situations. Students can use information from several sources to solve problems involving different types of numbers and operations. Students can relate fractions, decimals, and percents to each other. Students at this level show basic procedural knowledge related to algebraic expressions. They can use properties of lines, angles, triangles, rectangles, and rectangular prisms to solve problems. They can analyze data in a variety of graphs.

Intermediate International Benchmark – 475

Students can apply basic mathematical knowledge in a variety of situations. Students can solve problems involving decimals, fractions, proportions, and percentages. They understand simple algebraic relationships. Students can relate a two-dimensional drawing to a three-dimensional object. They can read, interpret, and construct graphs and tables. They recognize basic notions of likelihood.

Low International Benchmark – 400

Students have some knowledge of whole numbers and decimals, operations, and basic graphs.

Figures 19, 20, and 21 show items of the advanced international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

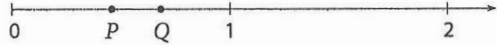
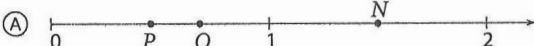
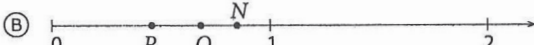
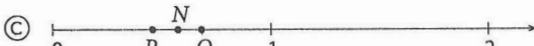
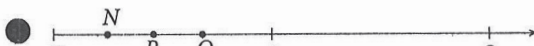
<p>Content domain: Number Cognitive domain: Reasoning Description: Given two points on a number line representing unspecified fractions, identifies the point that represents their product</p>	Country	Percent Full Credit
 <p>P and Q represent two fractions on the number line above. $P \times Q = N$.</p> <p>Which of these shows the location of N on the number line?</p> <p>(A) </p> <p>(B) </p> <p>(C) </p> <p></p>	Chinese Taipei	53 (2.0)
	Hong Kong SAR	47 (2.5)
	Singapore	45 (2.0)
	Korea, Rep of	44 (2.0)
	Massachusetts, US	44 (4.0)
	Japan	43 (2.1)
	Minnesota, US	38 (3.1)
	Russian Federation	31 (2.1)
	Finland	29 (2.0)
	England	29 (3.0)
International Average	23 (0.3)	

Figure 19: Advanced international benchmark item – Example grade 8 mathematics item 1

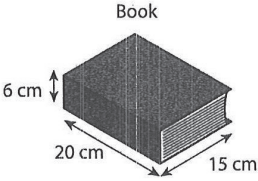
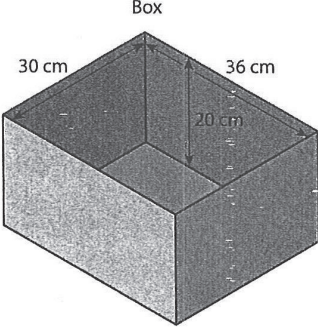
<p>Content domain: Geometry Cognitive domain: Reasoning Description: Solves a word problem involving filling a three-dimensional shape with rectangular solids</p>	Country	Percent Full Credit
<p>Ryan is packing books into a rectangular box. All the books are the same size.</p>   <p>What is the largest number of books that will fit inside the box?</p> <p>Answer: <u>12</u></p>	Chinese Taipei	66 (1.8)
	Hong Kong SAR	65 (2.1)
	Korea, Rep of	62 (2.0)
	Singapore	60 (1.9)
	Japan	58 (1.8)
	Massachusetts, US	49 (3.2)
	Russian Federation	36 (2.6)
	Minnesota, US	36 (3.2)
	Finland	29 (2.3)
	England	26 (2.3)
International Average	25 (0.3)	

Figure 20: Advanced international benchmark item – Example grade 8 mathematics item 2

Content domain: Algebra Cognitive domain: Knowing Description: Solves a linear inequality	Country	Percent Full Credit
<p>Solve this inequality.</p> $9x - 6 < 4x + 4$ <p>Answer: <u>$x < 2$</u></p>	Korea, Rep of	60 (2.3)
	Chinese Taipei	52 (2.0)
	Russian Federation	46 (3.0)
	Singapore	44 (1.9)
	Minnesota, US	33 (3.2)
	Massachusetts, US	33 (4.8)
	International Average	17 (0.3)
	Hong Kong SAR	16 (2.0)
	Japan	9 (1.2)
	Finland	8 (1.4)
	England	5 (1.3)

Figure 21: Advanced international benchmark item – Example grade 8 mathematics item 3

Figures 22, 23, and 24 show items of the high international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Knowing Description: Given the part and the whole, can express the part as a percentage, and given the whole and the percentage, can find the part	Country	Percent Full Credit												
<p>Peter, James, and Andrew each had 20 tries at throwing balls into a basket. Complete the missing boxes below.</p> <table border="1"> <thead> <tr> <th>Name</th> <th>Number of Successful Shots</th> <th>Percentage of Successful Shots</th> </tr> </thead> <tbody> <tr> <td>Peter</td> <td>10 out of 20</td> <td>50 %</td> </tr> <tr> <td>James</td> <td>15 out of 20</td> <td>75%</td> </tr> <tr> <td>Andrew</td> <td>16 out of 20</td> <td>80%</td> </tr> </tbody> </table>	Name	Number of Successful Shots	Percentage of Successful Shots	Peter	10 out of 20	50 %	James	15 out of 20	75%	Andrew	16 out of 20	80%	Singapore	89 (1.2)
	Name	Number of Successful Shots	Percentage of Successful Shots											
	Peter	10 out of 20	50 %											
	James	15 out of 20	75%											
	Andrew	16 out of 20	80%											
	Massachusetts, US	79 (2.5)												
	Minnesota, US	77 (2.7)												
	Korea, Rep of	76 (1.9)												
	Hong Kong SAR	76 (2.4)												
	Chinese Taipei	69 (1.7)												
	Japan	57 (2.2)												
Russian Federation	55 (2.1)													
Finland	50 (2.4)													
England	48 (3.0)													
International Average	37 (0.3)													

Figure 22: High international benchmark item – Example grade 8 mathematics item 4

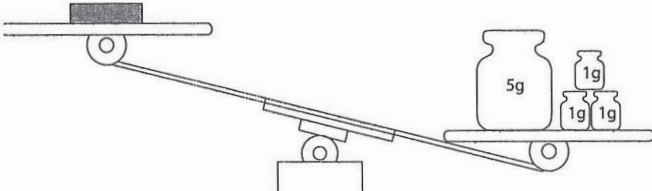
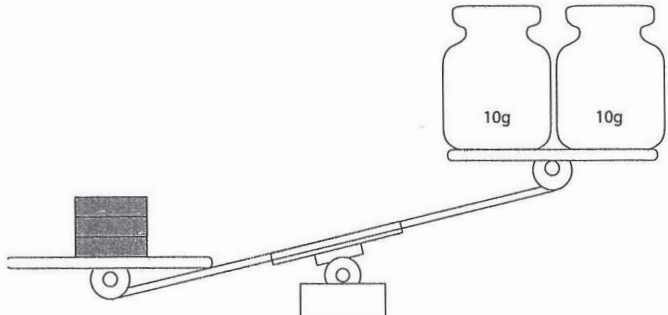
<p>Content domain: Algebra Cognitive domain: Reasoning Description: Identifies the quantity that satisfies two inequalities represented by balances in a problem situation</p>	Country	Percent Full Credit
<p>Jo has three metal blocks. The weight of each block is the same. When she weighed one block against 8 grams, this is what happened.</p>  <p>When she weighed all three blocks against 20 grams, this is what happened.</p>  <p>Which of the following could be the weight of one metal block?</p> <p>(A) 5 g (B) 6 g (C) 7 g (D) 8 g</p>	Korea, Rep of	79 (1.6)
	Japan	76 (2.0)
	Singapore	75 (1.7)
	Chinese Taipei	74 (1.6)
	Finland	74 (1.9)
	Massachusetts, US	69 (2.6)
	Hong Kong SAR	68 (2.1)
	Russian Federation	67 (2.2)
	Minnesota, US	66 (3.2)
	England	62 (2.8)
International Average	47 (0.3)	

Figure 23: High international benchmark item – Example grade 8 mathematics item 5

<p>Content domain: Data and Chance Cognitive domain: Applying Description: Constructs and labels a pie chart representing a given situation</p>	Country	Percent Full Credit										
<p>480 students were asked to name their favorite sport. The results are shown in this table.</p> <table border="1" data-bbox="193 488 735 667"> <thead> <tr> <th>Sport</th> <th>Number of Students</th> </tr> </thead> <tbody> <tr> <td>Hockey</td> <td>60</td> </tr> <tr> <td>Football</td> <td>180</td> </tr> <tr> <td>Tennis</td> <td>120</td> </tr> <tr> <td>Basketball</td> <td>120</td> </tr> </tbody> </table> <p>Use the information in the table to complete and label this pie chart.</p> <p style="text-align: center;">Popularity of Sports</p>	Sport	Number of Students	Hockey	60	Football	180	Tennis	120	Basketball	120	Singapore	85 (1.5)
	Sport	Number of Students										
	Hockey	60										
	Football	180										
	Tennis	120										
	Basketball	120										
	Korea, Rep of	85 (1.4)										
	Chinese Taipei	80 (1.7)										
	Hong Kong SAR	76 (1.8)										
	Japan	75 (1.7)										
	Massachusetts, US	74 (2.7)										
	Minnesota, US	71 (2.6)										
Finland	70 (2.3)											
England	65 (3.0)											
Russian Federation	63 (2.6)											
International Average	47 (0.3)											

Figure 24: High international benchmark item – Example grade 8 mathematics item 6

Figures 25 and 26 show items of the intermediate international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Algebra Cognitive domain: Knowing Description: Knows the meaning of a simple algebraic expression involving multiplication and addition	Country	Percent Full Credit
<p>What does $xy + 1$ mean?</p> <p>(A) Add 1 to y, then multiply by x.</p> <p>(B) Multiply x and y by 1.</p> <p>(C) Add x to y, then add 1.</p> <p><input checked="" type="radio"/> Multiply x by y, then add 1.</p>	Hong Kong SAR	94 (1.3)
	Korea, Rep of	91 (1.3)
	Singapore	91 (1.1)
	Massachusetts, US	91 (1.9)
	Chinese Taipei	90 (1.3)
	Russian Federation	89 (1.2)
	Minnesota, US	88 (2.1)
	Japan	87 (1.5)
	Finland	72 (2.2)
	England	72 (2.8)
	International Average	65 (0.3)

Figure 25: Intermediate international benchmark item – Example grade 8 mathematics item 7

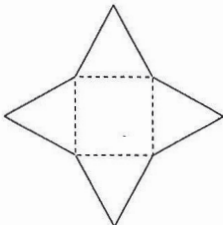

Content domain: Geometry Cognitive domain: Knowing Description: Given a net of a three-dimensional object, completes a two-dimensional drawing of it from a specific viewpoint	Country	Percent Full Credit
 <p>The shape shown above is cut out of cardboard. The triangle flaps are then folded up along the dotted lines until they touch the edges of the flaps next to them.</p> <p>Complete the diagram below to show what the shape would look like when viewed from directly above.</p> 	Massachusetts, US	90 (1.7)
	Finland	89 (1.1)
	Japan	89 (1.2)
	Minnesota, US	89 (1.7)
	Korea, Rep of	85 (1.3)
	Singapore	83 (1.4)
	England	82 (2.1)
	Hong Kong SAR	77 (2.0)
	Russian Federation	75 (1.7)
	Chinese Taipei	74 (1.7)
	International Average	58 (0.3)

Figure 26: Intermediate international benchmark item – Example grade 8 mathematics item 8

Figures 27 and 28 show items of the low international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Number Cognitive domain: Knowing Description: Adds a two-place and a three-place decimal	Country	Percent Full Credit
$42.65 + 5.748 =$ <p>Answer: <u>48.398</u></p>	Massachusetts, US	95 (1.3)
	Singapore	94 (0.8)
	Minnesota, US	93 (1.6)
	Hong Kong SAR	91 (1.5)
	Russian Federation	90 (1.2)
	Chinese Taipei	89 (1.1)
	Korea, Rep of	87 (1.5)
	Japan	81 (1.6)
	Finland	79 (1.8)
	England	79 (2.4)
	International Average	72 (0.3)

Figure 27: Low international benchmark item – Example grade 8 mathematics item 9

Content domain: Algebra Cognitive domain: Knowing Description: Evaluates a simple algebraic expression	Country	Percent Full Credit
$y = \frac{a+b}{c}$ <p>$a = 8, b = 6, \text{ and } c = 2$</p> <p>What is the value of y?</p> <p> <input checked="" type="radio"/> 7 <input type="radio"/> 10 <input type="radio"/> 11 <input type="radio"/> 14 </p>	Massachusetts, US	94 (1.3)
	Korea, Rep of	92 (1.0)
	Minnesota, US	92 (1.5)
	Chinese Taipei	91 (1.0)
	Singapore	91 (1.1)
	Russian Federation	91 (1.6)
	Japan	86 (1.5)
	Hong Kong SAR	83 (1.8)
	Finland	78 (1.8)
	England	73 (2.9)
	International Average	71 (0.3)

Figure 28: Low international benchmark item – Example grade 8 mathematics item 10

Items that relatively more grade 8 students from Singapore found easy

Figures 29, 30, 31 and 32 show four items that relatively more grade 8 students from Singapore found easy.

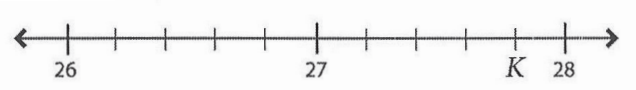
Content domain: Number Cognitive domain: Knowing	Country	Percent Full Credit
 <p>Which number does K represent on this number line?</p> <p>(A) 27.4 (B) 27.8 (C) 27.9 (D) 28.2</p> <p>Answer: B</p>	Singapore	94 (1.0)
	Japan	93 (1.0)
	Hong Kong SAR	92 (1.3)
	Korea, Rep of	90 (1.2)
	Chinese Taipei	86 (1.4)
	Massachusetts, US	82 (2.1)
	England	82 (2.1)
	Minnesota, US	81 (2.3)
	Finland	79 (1.7)
	Russian Federation	68 (2.1)
	International Average	54 (0.3)

Figure 29: A relatively easy item for Singapore students – Example grade 8 mathematics item 1

Content domain: Algebra Cognitive domain: Knowing	Country	Percent Full Credit
<p>$k = 7$ and $l = 10$.</p> <p>What is the value of P when $P = \frac{3kl}{5}$?</p> <p>Answer: 42</p>	Singapore	88 (1.4)
	Hong Kong SAR	87 (1.6)
	Russian Federation	83 (1.6)
	Minnesota, US	83 (2.4)
	Korea, Rep of	81 (1.5)
	Massachusetts, US	81 (2.2)
	Chinese Taipei	77 (1.6)
	Japan	72 (2.1)
	International Average	44 (0.3)
	England	40 (3.0)
	Finland	36 (2.7)

Figure 30: A relatively easy item for Singapore students – Example grade 8 mathematics item 2

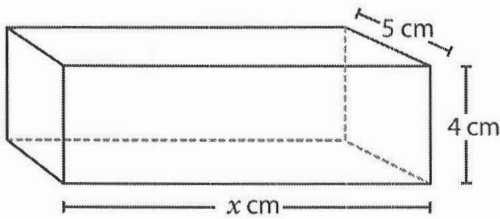
Content domain: Geometry Cognitive domain: Applying	Country	Percent Full Credit
 <p>The volume of the rectangular box is 200 cm^3. What is the value of x?</p> <p>Answer: _____</p> <p>Answer: 10</p>	Singapore	92 (1.2)
	Chinese Taipei	89 (1.1)
	Hong Kong SAR	87 (1.5)
	Massachusetts, US	80 (2.7)
	Japan	79 (1.7)
	Korea, Rep of	78 (1.6)
	Minnesota, US	72 (3.2)
	Russian Federation	65 (2.4)
	Finland	51 (2.3)
	England	49 (3.5)
	International Average	43 (0.3)

Figure 31: A relatively easy item for Singapore students – Example grade 8 mathematics item 3

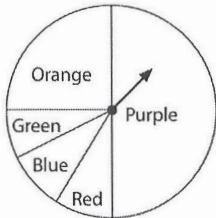
Content domain: Data and Chance Cognitive domain: Applying	Country	Percent Full Credit
 <p>The spinner is for Steve's new game. Out of 600 spins, approximately how many times should he expect the arrow to land on the red sector?</p> <p>(A) 30 (B) 40 (C) 50 (D) 60</p> <p>Answer: C</p>	Singapore	70 (1.8)
	Korea, Rep of	68 (1.6)
	Japan	60 (1.9)
	Minnesota, US	56 (2.2)
	Chinese Taipei	55 (2.2)
	Hong Kong SAR	55 (2.3)
	Massachusetts, US	53 (4.1)
	England	50 (2.9)
	Finland	39 (1.9)
	Russian Federation	32 (1.7)
International Average	31 (0.3)	

Figure 32: A relatively easy item for Singapore students – Example grade 8 mathematics item 4

Items that relatively more grade 8 students from Singapore found difficult

Figures 33, 34, 35, and 36 show four items that relatively more grade 8 students from Singapore found difficult.

Content domain: Number Cognitive domain: Applying	Country	Percent Full Credit
<p>Kim is packing eggs into boxes. Each box holds 6 eggs. She has 94 eggs. What is the smallest number of boxes she needs to pack all the eggs?</p> <p>Answer: 16 boxes</p>	Hong Kong SAR	89 (1.3)
	Chinese Taipei	86 (1.4)
	Massachusetts, US	76 (2.8)
	Minnesota, US	76 (3.2)
	Japan	75 (1.9)
	Korea, Rep of	74 (1.9)
	Finland	66 (2.2)
	Singapore	64 (2.0)
	England	61 (2.9)
	Russian Federation	54 (2.3)
	International Average	41 (0.3)

Figure 33: A relatively difficult item for Singapore students – Example grade 8 mathematics item 1

Content domain: Algebra Cognitive domain: Applying	Country	Percent Full Credit
<p>What is the sum of the three consecutive whole numbers with $2n$ as the middle number?</p> <p>(A) $6n + 3$ (B) $6n$ (C) $6n - 1$ (D) $6n - 3$</p> <p>Answer: B</p>	Korea, Rep of	78 (1.8)
	Chinese Taipei	76 (1.9)
	Finland	70 (2.0)
	Hong Kong SAR	69 (2.0)
	Japan	68 (1.7)
	Singapore	64 (1.7)
	Massachusetts, US	54 (3.0)
	Russian Federation	53 (2.6)
	International Average	52 (0.3)
	England	46 (2.4)
	Minnesota, US	40 (3.4)

Figure 34: A relatively difficult item for Singapore students – Example grade 8 mathematics item 2

Content domain: Geometry Cognitive domain: Knowing	Country	Percent Full Credit
<p>Which of these shows the result of a half-turn clockwise around point O?</p> <p>Answer: D</p>	Korea, Rep of	79 (1.7)
	Japan	73 (1.8)
	Hong Kong SAR	71 (2.0)
	Finland	66 (2.2)
	Chinese Taipei	64 (1.6)
	Singapore	62 (1.6)
	England	56 (2.2)
	Minnesota, US	50 (2.8)
	Russian Federation	48 (1.8)
	International Average	45 (0.3)
	Massachusetts, US	44 (2.9)

Figure 35: A relatively difficult item for Singapore students – Example grade 8 mathematics item 3

Content domain: Data and Chance Cognitive domain: Knowing	Country	Percent Full Credit
<p>Pat and Chris were candidates for school president. Here are the election results:</p> <p style="padding-left: 40px;">Pat 80%</p> <p style="padding-left: 40px;">Chris 20%</p> <p>How likely would it be for a student asked at random to have voted for Pat?</p> <p>(A) It is certain that the student voted for Pat. (B) It is likely that the student voted for Pat. (C) It is unlikely that the student voted for Pat. (D) It is certain that the student did not vote for Pat.</p> <p>Answer: B</p>	Korea, Rep of	95 (0.8)
	Chinese Taipei	89 (1.3)
	Finland	89 (1.5)
	Japan	88 (1.3)
	England	87 (1.6)
	Hong Kong SAR	87 (1.7)
	Minnesota, US	84 (1.9)
	Massachusetts, US	84 (2.6)
	Singapore	77 (1.4)
	Russian Federation	65 (2.3)
	International Average	64 (0.3)

Figure 36: A relatively difficult item for Singapore students – Example grade 8 mathematics item 4

TIMSS 2011

Science Tests



Content and Cognitive Domains of the Science Test Items

The design of the science test items was guided by the TIMSS 2011 Assessment frameworks (Mullis, Martin, Ruddock, O’Sullivan, & Preuschoff, 2009). Just like mathematics, the science items are also organised around two dimensions, a content dimension specifying the subject matter to be assessed within science (for e.g., life science, physical science and earth science at the fourth grade and biology, chemistry, physics, and earth science at the eighth grade) and a cognitive dimension specifying the domains or thinking processes to be assessed (i.e., knowing, applying, and reasoning).

Grade 4

Table 11 shows the distribution of the grade 4 science items by item type and content domain. Table 12 shows the distribution of the grade 4 science items by item type and cognitive domain.

Table 11

Grade 4 – Number of science items by item type and content domain

Content Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Life Science	36 (36)	39 (46)	75 (82)	45%
Physical Science	37 (37)	26 (27)	63 (64)	35%
Earth Science	20 (20)	14 (18)	34 (38)	20%
Total	93 (93)	79 (91)	172 (184)	100%
Percentage of Score Points	51%	49%		

Score points are shown in parentheses.

Table 12

Grade 4 – Distribution of score points by item type and cognitive domain

Cognitive Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Knowing	42 (42)	27 (34)	69 (76)	41%
Applying	38 (38)	33 (37)	71 (75)	41%
Reasoning	13 (13)	19 (20)	32 (33)	18%
Total	93 (93)	79 (91)	172 (184)	100%
Percentage of Score Points	51%	49%		

Score points are shown in parentheses.

Grade 8

Table 13 shows the distribution of the grade 8 science items by item type and content domain. Table 14 shows the distribution of the grade 8 science items by item types and cognitive domain.

Table 13

Grade 8 – Number of science items by item type and content domain

Content Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Biology	38 (38)	41 (49)	79 (87)	37%
Chemistry	22 (22)	22 (25)	44 (47)	20%
Physics	29 (29)	26 (29)	55 (58)	25%
Earth Science	21 (21)	18 (21)	39 (42)	18%
Total	110 (110)	107 (124)	217 (234)	100%
Percentage of Score Points	47%	53%		

Score points are shown in parentheses.

Table 14

Grade 8 – Distribution of score points by item type and cognitive domain

Cognitive Domain	Multiple-choice Items	Constructed-response Items	Total Items	Percentage of Score Points
Knowing	58 (58)	15 (18)	73 (76)	32%
Applying	40 (40)	52 (63)	92 (103)	44%
Reasoning	12 (12)	40 (43)	52 (55)	24%
Total	110 (110)	107 (124)	217 (234)	100%
Percentage of Score Points	47%	53%		

Score points are shown in parentheses.

Science Achievement – Grade 4

Overall performance of grade 4 students

Table 15 shows the average science achievement of grade 4 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore, which participated in TIMSS 2011.

Table 15

Grade 4 – Average science achievement

Country	Rank	Average Scale Score
Korea, Rep of	1	587 (2.0)
Singapore	2	583 (3.4)
Finland	3	570 (2.6)
Japan	4	559 (1.9)
Russian Federation	5	552 (3.5)
Chinese Taipei	6	552 (2.2)
United States	7	544 (2.1)
Hong Kong SAR	9	535 (3.8)
Florida, US	--	545 (3.7)
North Carolina, US	--	538 (4.6)
TIMSS Scale Centerpoint		500

() Standard errors

From Table 15, it is apparent that grade 4 students from the Republic of Korea and Singapore performed very well in science.

Table 16 shows the average performance of grade 4 students from top performing countries (Rep of Korea, Singapore, Finland, Japan, and Chinese Taipei) in the respective content and cognitive domains.

Table 16

Grade 4 - Average percent correct in respective science content and cognitive domains

Domains		Average percent correct					International Avg
		Korea, Rep of	Singapore	Finland	Japan	Chinese Taipei	
Science content	Life Science	61 (0.3)	68 (0.7)	63 (0.5)	55 (0.3)	56 (0.4)	48 (0.1)
	Physical Science	69 (0.3)	69 (0.6)	63 (0.4)	68 (0.4)	64 (0.4)	49 (0.1)
	Earth Science	68 (0.4)	56 (0.7)	61 (0.6)	58 (0.4)	58 (0.5)	46 (0.1)
Science cognitive	Knowing	67 (0.4)	67 (0.6)	68 (0.5)	60 (0.4)	62 (0.4)	53 (0.1)
	Applying	64 (0.3)	65 (0.7)	60 (0.4)	59 (0.3)	58 (0.4)	46 (0.1)
	Reasoning	66 (0.5)	64 (0.8)	55 (0.6)	63 (0.5)	57 (0.5)	41 (0.1)

() Standard errors

From Table 16, it is apparent that grade 4 students from Singapore generally performed well in both the science content and cognitive domains. Of concern is their achievement in Earth Science when compared with fourth graders from the Republic of Korea and Finland. This certainly has contributed to the rank position for Singapore in TIMSS 2011 grade 4 Science. It is worthy to note that the curriculum for science at grade 4 in Singapore schools does not have any explicit instruction in Earth Science.

International Benchmarks of science achievement

The International benchmarks presented as part of the TIMSS 2011 data helps to provide participating countries with a distribution of the performance of their students in an international setting. For a country the proportions of students reaching these benchmarks are perhaps telling of certain strengths and weaknesses of science education programs of the country. The benchmarks delineate performance at four points of the performance scale. Table 17 shows the percentage of grade 4 students from Singapore and selected education systems, mainly those ranked within the top 5, countries and benchmarking entities of interest to science educators, at each of the four TIMSS 2011 international benchmarks of science achievement.

Table 17

Grade 4 - Percentages of students at the respective international benchmarks of science achievement

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Singapore	33 (1.7)	68 (1.7)	89 (0.9)	97 (0.4)
Korea, Rep of	29 (1.5)	73 (1.0)	95 (0.4)	99 (0.1)
Finland	20 (1.1)	65 (1.7)	92 (0.8)	99 (0.3)
Russian Federation	16 (1.4)	52 (2.0)	86 (1.2)	98 (0.4)
United States	15 (0.8)	49 (1.1)	81 (0.8)	96 (0.4)
Chinese Taipei	15 (0.9)	53 (1.3)	85 (1.1)	97 (0.4)
Japan	14 (1.0)	58 (1.3)	90 (0.7)	99 (0.2)
Florida, US, US	14 (1.5)	48 (2.3)	82 (1.3)	97 (0.5)
North Carolina, US	12 (1.5)	46 (2.6)	80 (1.9)	95 (0.9)
Hong Kong SAR	9 (0.9)	45 (2.1)	82 (1.5)	96 (1.2)
International median	5	32	72	92

() Standard errors

From Table 17, it is apparent that 97% of the grade 4 students in Singapore had some elementary knowledge of life science, physical science, and earth science. It is noteworthy that although a higher percentage, i.e., 33% of grade 4 students from Singapore reached the advanced benchmark when compared with the Republic of Korea, higher percentages of students from Korea reached the remaining three benchmarks. Similarly when we compare with Finland higher percentages of students in Finland than in Singapore reached the Intermediate and low benchmark levels.

What can students at each of these international benchmarks do?

Characteristics of students at each of these four points are as follows.

Grade 4 - TIMSS 2011 international benchmarks of science achievement

Advance International Benchmark – 625

Students apply knowledge and understanding of scientific processes and relationships and show some knowledge of the process of scientific inquiry. Students communicate their understanding of characteristics and life processes of organisms, reproduction and development, ecosystems and organisms' interactions with the environment, and factors relating to human health. They demonstrate understanding of properties of light and relationships among physical properties of materials, apply and communicate their understanding of electricity and energy in practical contexts, and demonstrate an understanding of magnetic and gravitational forces and motion. Students communicate their understanding of the solar system and of Earth's structure, physical characteristics, resources, processes, cycles, and history. They have a beginning ability to interpret results in the context of a simple experiment, reason and draw conclusions from descriptions and diagrams, and evaluate and support an argument.

High International Benchmark – 550

Students apply their knowledge and understanding of the sciences to explain phenomena in everyday and abstract contexts. Students demonstrate some understanding of plant and animal structure, life processes, life cycles, and reproduction. They also demonstrate some understanding of ecosystems and organisms' interactions with their environment, including understanding of human responses to outside conditions and activities. Students demonstrate understanding of some properties of matter, electricity and energy, and magnetic and gravitational forces and motion. They show some knowledge of the solar system, and of Earth's physical characteristics, processes, and resources. Students demonstrate elementary knowledge and skills related to scientific inquiry. They compare, contrast, and make simple inferences, and provide brief descriptive responses combining knowledge of science concepts with information from both everyday and abstract contexts.

Intermediate International Benchmark – 475

Students have basic knowledge and understanding of practical situations in the sciences. Students recognize some basic information related to characteristics of living things, their reproduction and life cycles, and their interactions with the environment, and show some understanding of human biology and health. They also show some knowledge of properties of matter and light, electricity and energy, and forces and motion. Students know some basic facts about the solar system and show an initial understanding of Earth's physical characteristics and resources. They demonstrate ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

Low International Benchmark – 400

Students show some elementary knowledge of life, physical, and earth sciences. Students demonstrate knowledge of some simple facts related to human health, ecosystems, and the behavioral and physical characteristics of animals. They also demonstrate some basic knowledge of energy and the physical properties of matter. Students interpret simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

Figures 37, 38, and 39 show items of the advanced international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

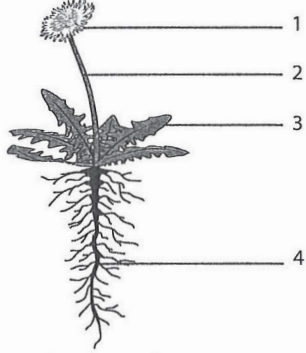
Content domain: Life Science Cognitive domain: Knowing Description: From a diagram of a flowering plant, identifies numbered parts and states a function of most of these parts	Country	Percent Full Credit															
<p>The diagram shows a flowering plant. Four of its parts are numbered.</p>  <p>In the table below, write the name of each part, and state its function.</p> <table border="1" data-bbox="193 931 903 1406"> <thead> <tr> <th>Part Number</th> <th>Name of Part</th> <th>Function of Part</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>flower</td> <td>produces seeds</td> </tr> <tr> <td>2</td> <td>stem</td> <td>transports water and food</td> </tr> <tr> <td>3</td> <td>leaf</td> <td>makes food for the plant</td> </tr> <tr> <td>4</td> <td>root</td> <td>absorbs water, minerals, and nutrients into the plant</td> </tr> </tbody> </table>	Part Number	Name of Part	Function of Part	1	flower	produces seeds	2	stem	transports water and food	3	leaf	makes food for the plant	4	root	absorbs water, minerals, and nutrients into the plant	Singapore	80 (1.6)
	Part Number	Name of Part	Function of Part														
	1	flower	produces seeds														
	2	stem	transports water and food														
	3	leaf	makes food for the plant														
	4	root	absorbs water, minerals, and nutrients into the plant														
	Korea, Rep of	42 (2.2)															
	Finland	32 (2.3)															
	Chinese Taipei	26 (1.8)															
	United States	24 (1.0)															
Florida, US	24 (2.8)																
International Average	21 (0.3)																
Japan	20 (1.6)																
Russian Federation	20 (1.8)																
Hong Kong SAR	16 (1.5)																
North Carolina, US	13 (2.3)																

Figure 37: Advanced international benchmark item – Example grade 4 science item 1

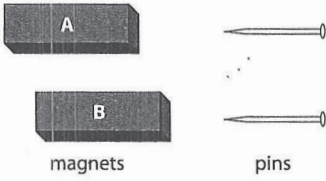
Content domain: Physical Science Cognitive domain: Reasoning Description: Infers that magnets have different strengths from an observation of magnets attracting pins from two different distances	Country	Percent Full Credit
<p>Betty has two magnets (A and B) and two metal pins that are the same.</p> <p>She slides Magnet A along a table until a pin is attracted to the magnet.</p> <p>She slides Magnet B along a table until a pin is attracted to the magnet.</p> <div style="text-align: center;">  <p>magnets pins</p> </div> <p>She finds that Magnet A attracts the pin from 15cm and Magnet B attracts the pin from 10cm.</p> <p>Steven says that both magnets are equally strong.</p> <p>Do you agree?</p> <p>(Check one box.)</p> <p><input type="checkbox"/> Yes</p> <p><input checked="" type="checkbox"/> No</p> <p>Explain your answer.</p> <p>magnet A is stronger because it attracted the pin from farther away than magnet B did.</p>	Singapore	66 (2.0)
	Japan	50 (1.8)
	Chinese Taipei	47 (2.3)
	Finland	41 (2.6)
	Florida, US	38 (2.6)
	United States	37 (1.4)
	North Carolina, US	34 (3.5)
	Hong Kong SAR	31 (2.3)
	Korea, Rep of	27 (1.6)
	Russian Federation	27 (1.9)
	International Average	26 (0.3)

Figure 38: Advanced international benchmark item – Example grade 4 science item 2

Content domain: Earth Science Cognitive domain: Knowing Description: Recognizes a soil change due to natural causes	Country	Percent Full Credit
<p>Which of these soil changes is due only to natural causes?</p> <p>(A) Loss of minerals due to farming.</p> <p>(B) Deserts forming due to tree cutting.</p> <p>(C) Flooding due to dam construction.</p> <p><input checked="" type="radio"/> Minerals washing out due to heavy rain.</p>	Korea, Rep of	63 (2.3)
	Finland	61 (2.2)
	Russian Federation	60 (2.0)
	Japan	55 (2.1)
	United States	54 (1.6)
	North Carolina, US	51 (3.3)
	Chinese Taipei	48 (2.3)
	Florida, US	48 (3.3)
	Hong Kong SAR	44 (2.1)
	Singapore	40 (1.7)
International Average	39 (0.3)	

Figure 39: Advanced international benchmark item – Example grade 4 science item 3

Figures 40, and 41 show items of the high international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

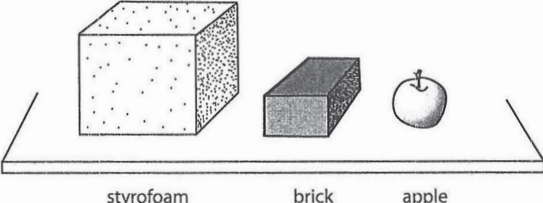
Content domain: Physical Science Cognitive domain: Reasoning Description: Justifies that objects with more volume do not necessarily weigh more using a diagram of three objects of different materials ordered by volume	Country	Percent Full Credit
<p>Jack's teacher places three objects on a table, as shown below. She puts them in order according to their volume.</p>  <p style="text-align: center;">styrofoam brick apple</p> <p>Jack thinks that objects with more volume weigh more. Do you agree with him?</p> <p>(Check one box.)</p> <p><input type="checkbox"/> Yes</p> <p><input checked="" type="checkbox"/> No</p> <p>Explain your answer.</p> <p><i>It depends on what the object is made of. The brick is smaller than the styrofoam block but it is more dense so it probably weighs more.</i></p>	Chinese Taipei	74 (2.2)
	Russian Federation	71 (1.9)
	Finland	71 (2.3)
	Korea, Rep of	68 (1.9)
	Singapore	52 (2.0)
	Hong Kong SAR	49 (2.2)
	North Carolina, US	49 (3.2)
	United States	46 (1.5)
	Japan	45 (2.3)
	International Average	42 (0.3)
Florida, US	40 (2.4)	

Figure 40: High international benchmark item – Example grade 4 science item 4

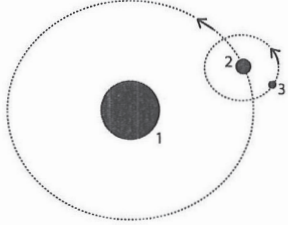
Content domain: Earth Science Cognitive domain: Reasoning Description: Identifies the Earth, Moon, and Sun from a diagram of their orbits	Country	Percent Full Credit
<p>The figure below shows Earth, the Moon, and the Sun. Each body is labeled by a number. The arrows show the direction each body is moving.</p>  <p>Fill in the correct number next to each body (1, 2 or 3).</p> <p>Earth is body number: <u> 2 </u></p> <p>The Moon is body number: <u> 3 </u></p> <p>The Sun is body number: <u> 1 </u></p>	Russian Federation	74 (2.5)
	Korea, Rep of	73 (1.6)
	Florida, US	68 (3.7)
	United States	65 (1.6)
	Finland	65 (2.2)
	North Carolina, US	63 (3.4)
	Hong Kong SAR	58 (1.8)
	Japan	53 (2.1)
	Chinese Taipei	52 (2.2)
	International Average	49 (0.3)
Singapore	48 (1.8)	

Figure 41: High international benchmark item – Example grade 4 science item 5

Figures 42 and 43 show the items of the intermediate benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

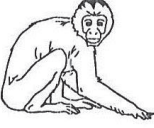
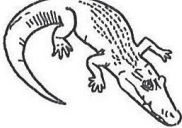

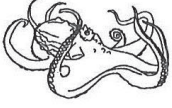
Content domain: Life Science Cognitive domain: Applying Description: Pairs pictures of three animals with their distinguishing biological characteristics (skeleton, milk production, number of legs)	Country	Percent Full Credit
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Monkey </div> <div style="text-align: center;">  Crocodile </div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 20px;"> <div style="text-align: center;">  Grasshopper </div> <div style="text-align: center;">  Octopus </div> </div> <p style="margin-top: 20px;">Answer the following questions using the animals shown above. Write the name for the correct animal in the spaces below.</p> <p>Which animal has an internal skeleton and produces milk for its young? <u>monkey</u></p> <p>Which animal has an external skeleton and three pairs of legs? <u>grasshopper</u></p> <p>Which animal has a soft body and no skeleton? <u>octopus</u></p>	Korea, Rep of	88 (1.4)
	Singapore	83 (1.4)
	North Carolina, US	74 (3.6)
	Russian Federation	72 (2.5)
	Florida, US	72 (2.8)
	Japan	70 (1.8)
	United States	69 (1.3)
	Chinese Taipei	69 (2.0)
	Hong Kong SAR	69 (2.1)
	Finland	64 (2.4)
	International Average	58 (0.3)

Figure 42: Intermediate international benchmark item – Example grade 4 science item 6

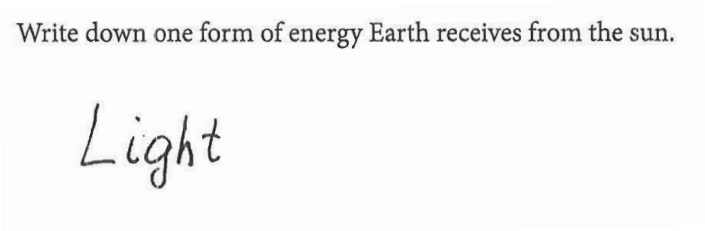
Content domain: Earth Science Cognitive domain: Knowing Description: States one form of energy Earth receives from the sun	Country	Percent Full Credit
<p>Write down one form of energy Earth receives from the sun.</p> 	Singapore	82 (1.5)
	Korea, Rep of	79 (1.7)
	Hong Kong SAR	73 (1.9)
	Russian Federation	73 (2.0)
	Florida, US	67 (2.6)
	United States	63 (1.4)
	North Carolina, US	62 (3.0)
	Chinese Taipei	61 (2.1)
	Japan	59 (2.0)
	Finland	55 (2.5)
	International Average	54 (0.3)

Figure 43: Intermediate international benchmark item – Example grade 4 science item 7

Figures 44, and 45 show items of the low international benchmark that grade 4 students reaching the benchmark are likely to answer correctly.

Content domain: Life Science Cognitive domain: Applying Description: Recognizes that wings are common to birds, bats, and butterflies	Country	Percent Full Credit
<p>What do birds, bats and butterflies have in common?</p> <p> <input type="radio"/> (A) feathers <input type="radio"/> (B) hair <input type="radio"/> (C) internal skeleton <input checked="" type="radio"/> wings </p>	Korea, Rep of	99 (0.3)
	Florida, US	97 (1.0)
	United States	96 (0.5)
	Singapore	95 (0.7)
	Finland	95 (0.9)
	North Carolina, US	95 (1.2)
	Russian Federation	92 (1.0)
	Japan	87 (1.5)
	International Average	83 (0.2)
	Chinese Taipei	83 (1.5)
	Hong Kong SAR	79 (2.1)

Figure 44: Low international benchmark item – Example grade 4 science item 8

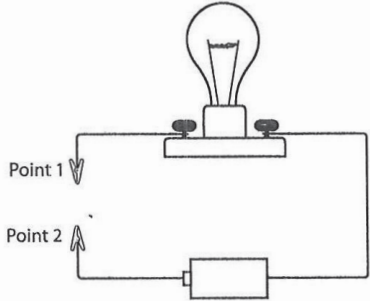
Content domain: Physical Science Cognitive domain: Applying Description: From a simple circuit diagram, recognizes that an iron nail can complete an electrical circuit	Country	Percent Full Credit
<p>The following picture shows a lightbulb connected to a battery in an electrical circuit. Which of the following objects connected to Points 1 and 2 will allow the bulb to glow?</p>  <p>● iron nail Ⓑ plastic spoon Ⓒ rubber band Ⓓ wooden stick</p>	Japan	94 (1.1)
	Chinese Taipei	94 (1.1)
	Singapore	94 (1.0)
	North Carolina, US	91 (1.8)
	Finland	86 (1.8)
	United States	84 (1.2)
	Hong Kong SAR	84 (1.6)
	Korea, Rep of	83 (1.6)
	Florida, US	80 (2.0)
	Russian Federation	72 (2.2)
	International Average	71 (0.3)

Figure 45: Low international benchmark item – Example grade 4 science item 9

Items that relatively more grade 4 students from Singapore found easy

Figures 46, 47, 48, and 49 show four items that relatively more grade 4 students from Singapore found easy.

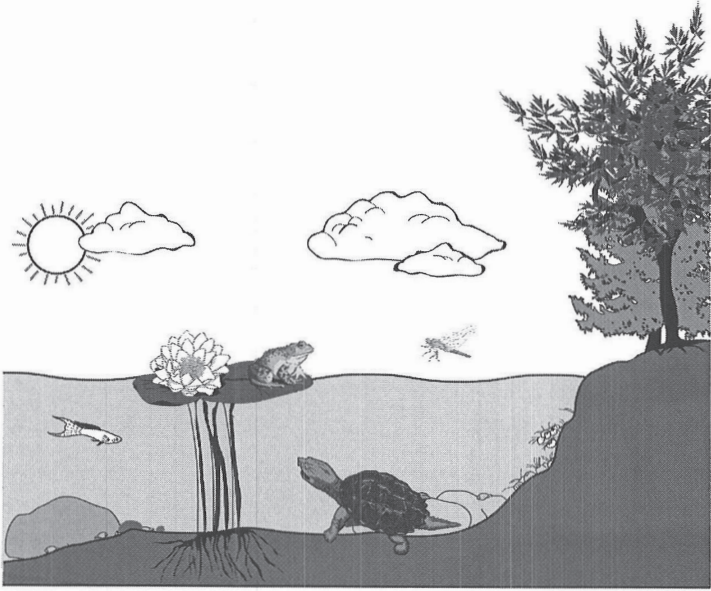
Content domain: Life Science Cognitive domain: Knowing	Country	Percent Full Credit								
<p>The picture below shows a pond.</p>  <p>In the spaces provided below, list three living things and three non-living things shown in this picture.</p> <table border="1" data-bbox="172 1305 970 1644"> <thead> <tr> <th data-bbox="172 1305 469 1346">Living things</th> <th data-bbox="469 1305 970 1346">Non-living things</th> </tr> </thead> <tbody> <tr> <td data-bbox="172 1346 469 1420">1.</td> <td data-bbox="469 1346 970 1420">1.</td> </tr> <tr> <td data-bbox="172 1420 469 1494">2.</td> <td data-bbox="469 1420 970 1494">2.</td> </tr> <tr> <td data-bbox="172 1494 469 1568">3.</td> <td data-bbox="469 1494 970 1568">3.</td> </tr> </tbody> </table> <p>Answer: List three living things in the first column, such as fish, frog, turtle, etc and three non-living things in the second column, such as sun, clouds, rock, etc.</p>	Living things	Non-living things	1.	1.	2.	2.	3.	3.	Singapore	88 (1.3)
	Living things	Non-living things								
	1.	1.								
	2.	2.								
	3.	3.								
	Finland	66 (2.1)								
	Russian Federation	60 (3.2)								
	United States	58 (1.5)								
	Florida, US	56 (3.3)								
	International Average	47 (0.3)								
	Korea, Rep of	46 (1.9)								
	North Carolina, US	42 (3.2)								
Japan	39 (1.8)									
Hong Kong SAR	39 (2.4)									
Chinese Taipei	17 (1.4)									

Figure 46: A relatively easy item for Singapore students – Example grade 4 science item 1

Content domain: Life Science Cognitive domain: Knowing	Country	Percent Full Credit
<p>Plants use energy directly from the sun. What do they use the energy from the sun for?</p> <p>(A) to make food (B) to disperse seeds (C) to fertilize the soil (D) to prevent insect damage</p> <p>Answer: A</p>	Korea, Rep of	93 (1.1)
	Singapore	88 (1.3)
	Hong Kong SAR	87 (1.6)
	Chinese Taipei	85 (1.5)
	Japan	85 (1.6)
	Finland	71 (2.2)
	Florida, US	64 (2.5)
	Russian Federation	61 (2.7)
	United States	60 (1.6)
	International Average	51 (0.3)
	North Carolina, US	46 (3.8)

Figure 47: A relatively easy item for Singapore students – Example grade 4 science item 2

Content domain: Physical Science Cognitive domain: Reasoning	Country	Percent Full Credit
<p>A metal spoon and a wooden spoon are used to stir a pot of hot soup. After a few minutes, the metal spoon feels hotter than the wooden spoon. What explains this?</p> <p>(A) Metal is always hotter than wood. (B) Metal conducts heat better than wood. (C) Metal conducts electricity better than wood. (D) Metal heats up the water better than the wood.</p> <p>Answer: B</p>	Korea, Rep of	96 (0.8)
	Singapore	89 (1.1)
	Japan	87 (1.2)
	Hong Kong SAR	86 (2.0)
	Finland	82 (2.0)
	Florida, US	71 (2.0)
	United States	70 (1.5)
	North Carolina, US	70 (1.9)
	Russian Federation	63 (2.1)
	Chinese Taipei	61 (2.2)
	International Average	56 (0.3)

Figure 48: A relatively easy item for Singapore students – Example grade 4 science item 3


Content domain: Physical Science Cognitive domain: Reasoning	Country	Percent Full Credit
 <p data-bbox="151 526 965 593">The figure shows two carts, each holding a magnet. The carts are moved close together and then let go.</p> <p data-bbox="151 604 566 638">Describe what will happen to the carts.</p> <p data-bbox="151 649 726 683">(You may draw a picture to help explain your answer.)</p> <p data-bbox="151 750 965 851">Answer: Refers to carts repelling, moving apart from each other, or NOT being attracted to each other (or similar). [May draw a diagram to indicate this.]</p> <p data-bbox="247 851 949 918">Note: May also indicate that one cart will flip/turn so that North/South poles are attracted.</p>	Singapore	90 (1.2)
	Korea, Rep of	88 (1.1)
	Japan	87 (1.7)
	Chinese Taipei	77 (1.9)
	United States	58 (1.5)
	North Carolina, US	55 (3.1)
	Florida, US	54 (2.6)
	Hong Kong SAR	49 (2.5)
	Russian Federation	48 (2.6)
	Finland	38 (2.7)
	International Average	36 (0.3)

Figure 49: A relatively easy item for Singapore students – Example grade 4 science item 4

Items that relatively more grade 4 students from Singapore found difficult

Figures 50, 51, 52, and 53 show four items that relatively more grade 4 students from Singapore found difficult.

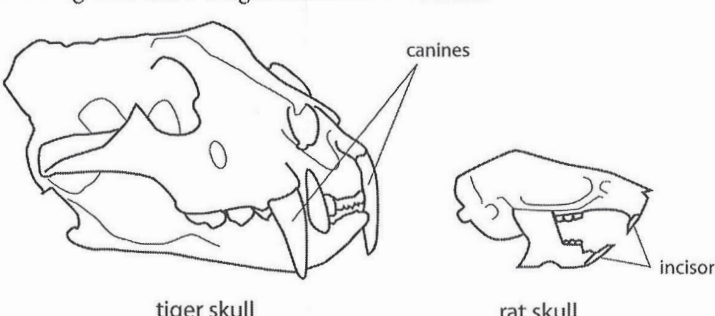
Content domain: Life Science Cognitive domain: Applying	Country	Percent Full Credit
<p>The diagrams show a tiger skull and a rat skull.</p>  <p>tiger skull rat skull</p> <p>A tiger has very large teeth called canines. A rat has very large teeth called incisors. A tiger and a rat eat different types of food.</p> <p>B. What does a rat use its incisors for?</p> <p>Answer: States that the rat uses its incisors for gnawing (nibbling) food or killing prey.</p>	Finland	54 (2.9)
	Japan	41 (1.7)
	Russian Federation	38 (2.2)
	Korea, Rep of	33 (1.8)
	Chinese Taipei	33 (2.1)
	International Average	23 (0.3)
	Singapore	13 (1.1)
	United States	13 (1.0)
	Florida, US	13 (1.8)
	North Carolina, US	13 (2.4)
	Hong Kong SAR	2 (0.6)

Figure 50: A relatively difficult item for Singapore students – Example grade 4 science item 1

Content domain: Earth Science Cognitive domain: Knowing	Country	Percent Full Credit
<p>Plants grow best in soils that are rich in which of the following?</p> <p>(A) grains of sand (B) lumps of clay (C) layers of gravel (D) decaying plants and animals</p> <p>Answer: D</p>	Korea, Rep of	67 (2.2)
	Finland	63 (1.9)
	Russian Federation	60 (2.6)
	North Carolina, US	58 (3.7)
	Chinese Taipei	57 (2.8)
	Florida, US	49 (3.0)
	United States	48 (1.6)
	Hong Kong SAR	46 (2.1)
	International Average	40 (0.3)
	Japan	29 (2.3)
	Singapore	20 (1.4)

Figure 51: A relatively difficult item for Singapore students – Example grade 4 science item 2




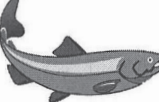




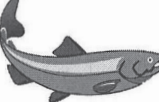




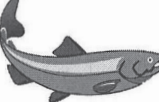

Content domain: Life Science Cognitive domain: Applying	Country	Percent Full Credit																				
<p>Which animals shown below have a backbone? Fill in one circle for each animal. One has been done for you.</p> <table border="0"> <thead> <tr> <th rowspan="2">Animal</th> <th colspan="2">Has a Backbone</th> </tr> <tr> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td> heron</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td> spider</td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td> crab</td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td> fish</td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td> lion</td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </tbody> </table> <p>Answer: A, B, B, A, A</p>	Animal	Has a Backbone		Yes	No	 heron	<input checked="" type="radio"/>	<input type="radio"/>	 spider	<input type="radio"/>	<input type="radio"/>	 crab	<input type="radio"/>	<input type="radio"/>	 fish	<input type="radio"/>	<input type="radio"/>	 lion	<input type="radio"/>	<input type="radio"/>	Japan	65 (2.0)
		Animal	Has a Backbone																			
	Yes		No																			
	 heron	<input checked="" type="radio"/>	<input type="radio"/>																			
	 spider	<input type="radio"/>	<input type="radio"/>																			
	 crab	<input type="radio"/>	<input type="radio"/>																			
	 fish	<input type="radio"/>	<input type="radio"/>																			
	 lion	<input type="radio"/>	<input type="radio"/>																			
	Russian Federation	56 (2.3)																				
	Finland	49 (2.3)																				
	Korea, Rep of	43 (2.0)																				
	International Average	41 (0.3)																				
	United States	39 (1.6)																				
Hong Kong SAR	38 (2.1)																					
Singapore	37 (1.7)																					
Florida, US	37 (2.1)																					
Chinese Taipei	31 (2.1)																					
North Carolina, US	31 (2.6)																					

Figure 52: A relatively difficult item for Singapore students – Example grade 4 science item 3

Content domain: Physical Science Cognitive domain: Knowing	Country	Percent Full Credit
<p>Some of the materials below will burn and some will not. Put an X in the box next to the materials that will burn. (You may put an X in more than one box.)</p> <ul style="list-style-type: none"> <input type="checkbox"/> water <input type="checkbox"/> wood <input type="checkbox"/> sand <input type="checkbox"/> gasoline <input type="checkbox"/> air <p>Answer: Wood AND Gasoline (no incorrect materials are checked)</p>	Russian Federation	87 (1.6)
	Finland	81 (1.7)
	Japan	68 (2.0)
	International Average	61 (0.3)
	North Carolina, US	59 (3.1)
	Florida, US	57 (2.6)
	United States	56 (1.7)
	Chinese Taipei	54 (2.1)
	Korea, Rep of	52 (2.2)
	Singapore	51 (1.5)
	Hong Kong SAR	45 (2.1)

Figure 53: A relatively difficult item for Singapore students – Example grade 4 science item 4

Science Achievement – Grade 8

Overall performance of grade 8 students

Table 18 shows the average science achievement of grade 8 students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore, which participated in TIMSS 2011.

Table 18

Grade 8 – Average science achievement

Country	Rank	Average Scale Score
Singapore	1	590 (4.3)
Chinese Taipei	2	564 (2.3)
Korea, Rep of	3	560 (2.0)
Japan	4	558 (2.4)
Finland	5	552 (2.5)
Russian Federation	7	542 (3.2)
Hong Kong SAR	8	535 (3.4)
England	9	533 (4.9)
Massachusetts, US	--	567 (5.1)
Minnesota, US	--	553 (4.6)
TIMSS Scale Centerpoint		500

() Standard errors

-- not available

From Table 18, it is apparent that grade 8 students from Singapore did exceptionally well in Science. Their counterparts from Chinese Taipei, Republic of Korea, Japan and Finland too did well.

Table 19 shows the average performance of grade 8 students from top performing East Asian countries (Singapore, Chinese Taipei, Korea Rep of, Japan, and Finland) in the respective content and cognitive domains.

Table 19

Grade 8 - Average percent correct in respective science content and cognitive domains

Domains		Average percent correct					
		Singapore	Chinese Taipei	Korea, Rep of	Japan	Finland	International Avg
Science content	Biology	64 (0.9)	57 (0.5)	58 (0.5)	57 (0.5)	56 (0.6)	42 (0.1)
	Chemistry	65 (1.0)	64 (0.7)	56 (0.4)	58 (0.6)	57 (0.6)	43 (0.1)
	Physics	63 (0.9)	53 (0.6)	58 (0.5)	55 (0.6)	49 (0.6)	38 (0.1)
	Earth Science	64 (0.9)	63 (0.6)	59 (0.5)	59 (0.5)	65 (0.6)	45 (0.1)
Science cognitive	Knowing	68 (0.9)	64 (0.5)	62 (0.4)	59 (0.5)	63 (0.5)	49 (0.1)
	Applying	63 (0.9)	60 (0.6)	58 (0.5)	58 (0.5)	55 (0.6)	41 (0.1)
	Reasoning	59 (1.0)	49 (0.6)	51 (0.5)	52 (0.6)	48 (0.6)	33 (0.1)

() Standard errors

From Table 19, it is apparent that grade 8 students from Singapore generally performed very well in both the science content domain and cognitive domain. Their counterparts from Chinese Taipei, Republic of Korea, Japan and Finland too did well.

International Benchmarks of science achievement

The International benchmarks presented as part of the TIMSS 2011 data helps to provide participating countries with a distribution of the performance of their students in an international setting. For a country the proportions of students reaching these benchmarks are perhaps telling of certain strengths and weaknesses of science education programs of the country. The benchmarks delineate performance at four points of the performance scale. Table 20 shows the percentage of grade 8 students from Singapore and selected education systems, mainly those ranked within the top 5, countries and benchmarking entities of interest to science educators in Singapore, at each of the four TIMSS 2011 international benchmarks of science achievement.

Table 20

Grade 8 - Percentages of students at the international benchmarks of science achievement

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Singapore	40 (1.7)	69 (2.0)	87 (1.6)	96 (0.7)
Chinese Taipei	24 (1.4)	60 (1.2)	85 (0.8)	96 (0.4)
Massachusetts, US	24 (2.6)	61 (2.8)	87 (1.5)	96 (0.7)
Korea, Rep of	20 (0.9)	57 (1.1)	86 (0.7)	97 (0.4)
Japan	18 (1.1)	57 (1.3)	86 (0.9)	97 (0.4)
Minnesota, US	16 (1.9)	54 (2.6)	85 (2.0)	98 (0.7)
England	14 (1.5)	44 (2.6)	76 (2.3)	93 (1.2)
Russian Federation	14 (1.1)	48 (1.8)	81 (1.2)	96 (0.7)
Finland	13 (1.2)	53 (1.7)	88 (1.0)	99 (0.3)
Hong Kong SAR	9 (1.1)	47 (1.8)	80 (1.7)	95 (1.0)
International Average	4	21	52	79

() Standard errors

From Table 20, it is apparent that 4% of grade 8 students in Singapore were below the low benchmark level and were not able to recognize basic facts from the life and physical sciences. At the other end it is noteworthy that 40% of grade 8 students from Singapore were at the advanced international benchmark. This percentage was much higher than the percentage of students in Chinese Taipei (ranked second in terms of overall performance) at the same benchmark.

What can students at each of these international benchmarks do?

Characteristics of students at each of these four points are as follows.

Grade 8 - TIMSS 2011 international benchmarks of science achievement

Advanced International Benchmark – 625

Students communicate an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science. Students demonstrate some conceptual knowledge about cells and the characteristics, classification, and life processes of organisms. They communicate an understanding of the complexity of ecosystems and adaptations of organisms, and apply an understanding of life cycles and heredity. Students also communicate an understanding of the structure of matter and physical and chemical properties and changes and apply knowledge of forces, pressure, motion, sound, and light. They reason about electrical circuits and properties of magnets. Students apply knowledge and communicate understanding of the solar system and Earth's processes, structures, and physical features. They understand basic features of scientific investigation. They also combine information from several sources to solve problems and draw conclusions, and they provide written explanations to communicate scientific knowledge.

High International Benchmark – 550

Students demonstrate understanding of concepts related to science cycles, systems, and principles. They demonstrate understanding of aspects of human biology, and of the characteristics, classification, and life processes of organisms. Students communicate understanding of processes and relationships in ecosystems. They show an understanding of the classification and compositions of matter and chemical and physical properties and changes. They apply knowledge to situations related to light and sound and demonstrate basic knowledge of heat and temperature, forces and motion, and electrical circuits and magnets. Students demonstrate an understanding of the solar system and of Earth's processes, physical features, and resources. They demonstrate some scientific inquiry skills. They also combine and interpret information from various types of diagrams, contour maps, graphs, and tables; select relevant information, analyze, and draw conclusions; and provide short explanations conveying scientific knowledge.

Intermediate International Benchmark – 475

Students recognize and apply their understanding of basic scientific knowledge in various contexts. Students apply knowledge and communicate an understanding of human health, life cycles, adaptation, and heredity, and analyze information about ecosystems. They have some knowledge of chemistry in everyday life and elementary knowledge of properties of solutions and the concept of concentration. They are acquainted with some aspects of force, motion, and energy. They demonstrate an understanding of Earth's processes and physical features, including the water cycle and atmosphere. Students interpret information from tables, graphs, and pictorial diagrams and draw conclusions. They apply knowledge to practical situations and communicate their understanding through brief descriptive responses.

Low International Benchmark – 400

Students can recognize some basic facts from the life and physical sciences. They have some knowledge of biology, and demonstrate some familiarity with physical phenomena. Students interpret simple pictorial diagrams, complete simple tables, and apply basic knowledge to practical situations.

Figures 54, 55, and 56 show items of the advanced international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Chemistry Cognitive domain: Knowing Description: Describes two things that might be observed as a chemical reaction takes place	Country	Percent Full Credit
<p>Ahmet put some powder into a test tube. He then added liquid to the powder and shook the test tube. A chemical reaction took place.</p> <p>Describe two things he might observe as the chemical reaction took place.</p> <p>1. <i>A temperature change</i></p> <p>2. <i>gas bubbles</i></p>	England	59 (2.6)
	Minnesota, US	53 (2.6)
	Massachusetts, US	52 (3.4)
	Chinese Taipei	44 (2.0)
	Russian Federation	44 (2.4)
	Singapore	44 (1.9)
	Finland	36 (2.3)
	Hong Kong SAR	35 (1.9)
	Japan	30 (2.1)
	International Average	24 (0.3)
	Korea, Rep of	23 (1.6)

Figure 54: Advanced international benchmark item – Example grade 8 science item 1

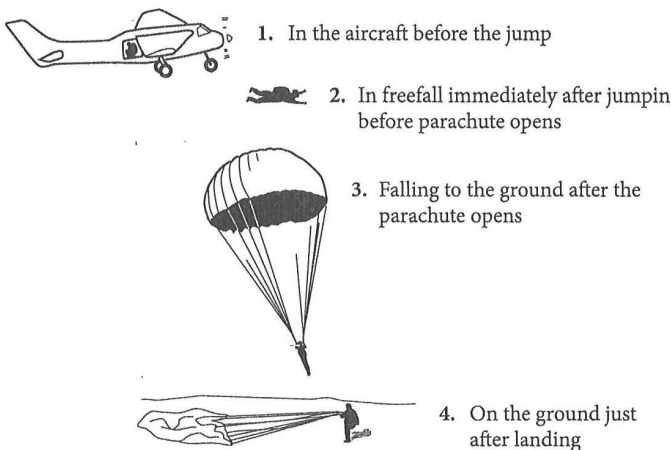
Content domain: Physics Cognitive domain: Applying Description: Recognizes that the force of gravity acts on a person regardless of position and movement	Country	Percent Full Credit
<p>The figure shows a parachute jumper in four positions.</p>  <p>1. In the aircraft before the jump</p> <p>2. In freefall immediately after jumping before parachute opens</p> <p>3. Falling to the ground after the parachute opens</p> <p>4. On the ground just after landing</p> <p>In which of the positions does the force of gravity act on the jumper?</p> <p>(A) Position 2 only.</p> <p>(B) Positions 2 and 3 only.</p> <p>(C) Positions 1, 2 and 3 only.</p> <p><input checked="" type="radio"/> (D) Positions 1, 2, 3, and 4.</p>	Korea, Rep of	63 (2.0)
	Finland	59 (2.1)
	Japan	49 (2.1)
	Minnesota, US	49 (3.7)
	Singapore	45 (1.7)
	England	43 (2.9)
	Massachusetts, US	43 (3.3)
	Russian Federation	38 (2.6)
	Hong Kong SAR	36 (2.3)
	Chinese Taipei	35 (2.0)
	International Average	32 (0.3)

Figure 55: Advanced international benchmark item – Example grade 8 science item 2

Content domain: Earth Science Cognitive domain: Reasoning Description: States what fossil evidence would support the idea that two continents were once joined	Country	Percent Full Credit
<p>Two continents are separated by water. Geologists are looking for evidence that the two continents were once joined. What fossil evidence would support this idea?</p> <p><i>The same species of extinct animals are found on the two continents</i></p>	Massachusetts, US	58 (3.7)
	Minnesota, US	53 (3.4)
	Japan	43 (2.2)
	Chinese Taipei	32 (2.1)
	Russian Federation	31 (2.1)
	Korea, Rep of	28 (1.8)
	England	28 (2.8)
	Singapore	22 (1.6)
	Hong Kong SAR	19 (2.2)
	International Average	18 (0.3)
	Finland	18 (1.6)

Figure 56: Advanced international benchmark item – Example grade 8 science item 3

Figures 57, 58, and 59 show items of the high international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Chemistry Cognitive domain: Reasoning Description: Identifies a property of metals and describe how this property can be used to determine whether an unknown substance is a metal or nonmetal	Country	Percent Full Credit
<p>David is given a sample of an unknown solid substance. He wants to know if the substance is a metal. Write down one property he can observe or measure and describe how this property could be used to help identify whether the substance is a metal.</p> <p><i>Metals conduct electricity. He could make a simple electrical circuit with the sample, a battery, and a light bulb. If the bulb lights when everything is connected correctly, the sample is probably a metal</i></p>	Japan	72 (2.4)
	Massachusetts, US	65 (2.7)
	Singapore	64 (2.0)
	England	61 (2.9)
	Chinese Taipei	56 (2.5)
	Hong Kong SAR	52 (2.5)
	Minnesota, US	50 (3.4)
	Russian Federation	48 (2.1)
	Finland	44 (2.6)
	International Average	35 (0.3)
	Korea, Rep of	31 (1.6)

Figure 57: High international benchmark item – Example grade 8 science item 4

Content domain: Physics Cognitive domain: Knowing Description: Recognizes what happens to molecules of a liquid as the liquid cools	Country	Percent Full Credit
<p>What happens to the molecules of a liquid when the liquid cools?</p> <p> <input checked="" type="radio"/> They slow down. <input type="radio"/> They speed up. <input type="radio"/> They decrease in number. <input type="radio"/> They decrease in size. </p>	Massachusetts, US	86 (2.2)
	Korea, Rep of	82 (1.4)
	Minnesota, US	79 (2.7)
	Russian Federation	77 (2.0)
	Singapore	73 (1.8)
	Finland	73 (2.0)
	England	65 (2.3)
	International Average	58 (0.3)
	Chinese Taipei	56 (1.9)
	Hong Kong SAR	52 (2.2)
	Japan	50 (2.3)

Figure 58: High international benchmark item – Example grade 8 science item 5

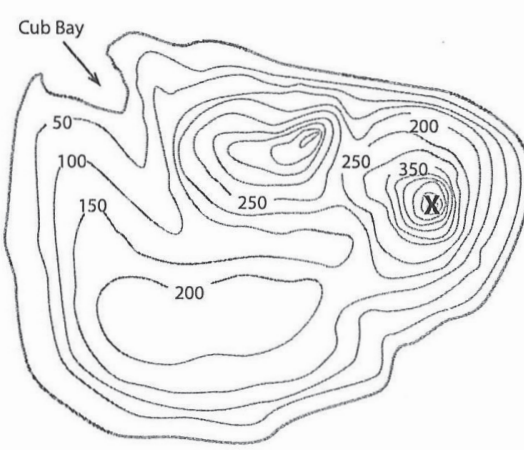
Content domain: Earth Science Cognitive domain: Applying Description: Interprets a contour map to recognize a topographical representation of a mountain top	Country	Percent Full Credit
<p style="text-align: center;">Tiger Island</p>  <p>The diagram above shows a topographic map of Tiger Island. The lines on the map are contour lines that connect points at the same elevation. The elevations shown are in meters.</p> <p>A. What geographical feature is found at point X? <u>mountain top</u></p>	Finland	84 (1.4)
	Massachusetts, US	82 (2.5)
	Chinese Taipei	81 (1.7)
	Minnesota, US	70 (2.9)
	Singapore	68 (2.2)
	Russian Federation	67 (2.1)
	Hong Kong SAR	64 (2.5)
	Korea, Rep of	60 (2.1)
	England	56 (2.8)
	Japan	52 (2.2)
	International Average	38 (0.3)

Figure 59: High international benchmark item – Example grade 8 science item 6

Figures 60, and 61 show items of the intermediate international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

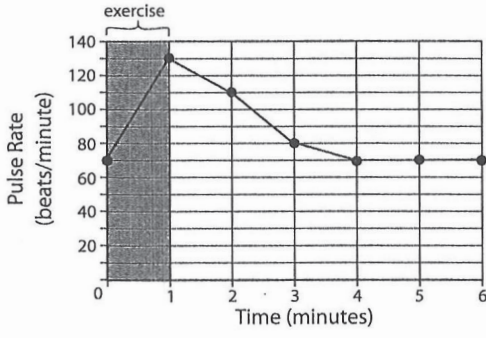
Content domain: Biology Cognitive domain: Reasoning Description: Interprets a graph showing changes in pulse rates before, during, and after exercise and recognizes what can be concluded from the graph	Country	Percent Full Credit
<p>John measures his pulse rate before he exercises. It is 70 beats per minute. He exercises for one minute and measures his pulse rate again. He then measures it every minute for several minutes. He draws a graph to show his results.</p>  <p>What can be concluded from his results?</p> <p> <input type="radio"/> (A) His pulse rate increased by 50 beats per minute. <input type="radio"/> (B) His pulse rate took less time to slow down than to increase. <input type="radio"/> (C) His pulse rate after 4 minutes was 80 beats per minute. <input checked="" type="radio"/> (D) His pulse rate returned to normal in less than 6 minutes. </p>	Japan	82 (1.7)
	Korea, Rep of	80 (1.6)
	Finland	80 (1.9)
	Minnesota, US	79 (2.5)
	Massachusetts, US	77 (2.8)
	Russian Federation	75 (1.9)
	Singapore	75 (1.6)
	England	69 (2.6)
	Chinese Taipei	64 (2.0)
	Hong Kong SAR	60 (2.3)
	International Average	57 (0.3)

Figure 60: Intermediate international benchmark item – Example grade 8 science item 7

Content domain: Earth Science Cognitive domain: Applying Description: Given a starting point, orders the processes involved in the water cycle	Country	Percent Full Credit
<p>The following five statements describe processes involved in the water cycle. Water evaporation from the sea is identified as a first step in the water cycle. Number the other statements 2 through 5 in the order in which these processes take place.</p> <p> <u>2</u> Water vapor rises in warm air. <u>5</u> Water travels along a river to the sea. <u>1</u> Water evaporates from the sea. <u>3</u> Water vapor is cooled and forms clouds. <u>4</u> Clouds move and water falls on land as rain. </p>	Finland	92 (1.2)
	Hong Kong SAR	85 (1.6)
	Singapore	83 (1.5)
	Chinese Taipei	82 (1.6)
	Korea, Rep of	81 (1.6)
	Russian Federation	79 (1.7)
	Minnesota, US	79 (2.5)
	England	79 (2.5)
	Massachusetts, US	76 (2.5)
	Japan	71 (2.2)
International Average	63 (0.3)	

Figure 61: Intermediate international benchmark item – Example grade 8 science item 8

Figures 62, and 63 show items of the low international benchmark that grade 8 students reaching the benchmark are likely to answer correctly.

Content domain: Biology Cognitive domain: Applying Description: Recognizes that genetic material is inherited from both parents	Country	Percent Full Credit
Twins are born. One is a boy and one is a girl. Which statement is correct about their genetic makeup? <input type="radio"/> (A) The boy and girl inherit genetic material from the father only. <input type="radio"/> (B) The boy and girl inherit genetic material from the mother only. <input checked="" type="radio"/> (C) The boy and girl inherit genetic material from both parents. <input type="radio"/> (D) The boy inherits genetic material from the father only and the girl inherits it from the mother only.	Japan	95 (0.9)
	Massachusetts, US	95 (1.3)
	Finland	94 (1.0)
	Minnesota, US	94 (1.1)
	Korea, Rep of	93 (0.9)
	Singapore	92 (1.0)
	Chinese Taipei	89 (1.2)
	Russian Federation	88 (1.5)
	International Average	83 (0.2)
	Hong Kong SAR	88 (1.5)
	England	88 (1.7)

Figure 62: Low international benchmark item – Example grade 8 science item 9

Content domain: Chemistry Cognitive domain: Knowing Description: Recognizes the chemical formula of carbon dioxide	Country	Percent Full Credit
What is the chemical formula for carbon dioxide? <input type="radio"/> (A) CO <input checked="" type="radio"/> (B) CO ₂ <input type="radio"/> (C) C	Japan	99 (0.3)
	Chinese Taipei	98 (0.5)
	Minnesota, US	93 (1.7)
	Russian Federation	92 (1.1)
	England	92 (1.3)
	Singapore	91 (1.1)
	Korea, Rep of	90 (1.4)
	Hong Kong SAR	89 (1.6)
	Massachusetts, US	89 (2.4)
	International Average	85 (0.2)
	Finland	81 (1.9)

Figure 63: Low international benchmark item – Example grade 8 science item 10

Items that relatively more grade 8 students from Singapore found easy

Figures 64, 65, 66, and 67 show four items that relatively more grade 8 students from Singapore found easy.

Content domain: Earth Science Cognitive domain: Knowing	Country	Percent Full Credit
State one way that a volcanic eruption can affect the environment. Answer: Option 1: States a negative environmental effect due to volcanic eruptions such as pollution (due to the release of gases, smoke, ash, etc.) or destruction of habitats or plant/animal life (due to lava flow, burning or similar). Option 2: States a positive environmental effect such as making land fertile, creating new habitats, and allowing for different life forms. Option 3: Other correct.	Singapore	81 (1.4)
	Finland	71 (2.0)
	Massachusetts, US	70 (2.5)
	England	67 (2.6)
	Minnesota, US	65 (3.1)
	Russian Federation	63 (2.3)
	Japan	63 (2.4)
	Korea, Rep of	58 (2.0)
	Chinese Taipei	55 (2.2)
	Hong Kong SAR	54 (2.3)
	International Average	48 (0.3)

Figure 64: A relatively easy item for Singapore students – Example grade 8 science item 1

Content domain: Chemistry Cognitive domain: Knowing	Country	Percent Full Credit
Robert put two drops of an indicator into vinegar, and the color turned red. He then added drops of ammonia solution until the color disappeared. What process occurred? (A) rusting (B) melting (C) evaporation (D) neutralization Answer: D	Chinese Taipei	91 (1.2)
	Finland	90 (1.3)
	Singapore	89 (1.4)
	Hong Kong SAR	88 (1.7)
	Russian Federation	87 (1.5)
	England	79 (2.3)
	Minnesota, US	79 (2.4)
	Massachusetts, US	78 (2.6)
	Japan	73 (1.9)
	International Average	67 (0.3)
	Korea, Rep of	63 (2.0)

Figure 65: A relatively easy item for Singapore students – Example grade 8 science item 2

Content domain: Biology Cognitive domain: Knowing	Country	Percent Full Credit
<p>Bacteria that enter the body are destroyed by which type of cells?</p> <p>(A) white blood cells (B) red blood cells (C) kidney cells (D) lung cells</p> <p>Answer: A</p>	Chinese Taipei	86 (1.4)
	Singapore	84 (1.4)
	Minnesota, US	84 (1.9)
	Korea, Rep of	80 (1.5)
	Massachusetts, US	79 (2.9)
	Japan	77 (1.8)
	England	71 (2.6)
	Finland	68 (1.9)
	Hong Kong SAR	66 (2.0)
	International Average	61 (0.3)
	Russian Federation	59 (2.1)

Figure 66: A relatively easy item for Singapore students – Example grade 8 science item 3

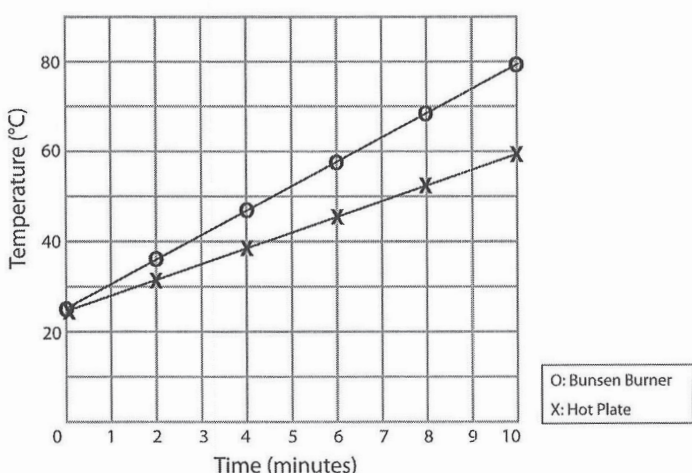
Content domain: Physics Cognitive domain: Reasoning	Country	Percent Full Credit
<p>C. Jack used his results to draw a graph as shown below.</p>  <p>Use the information in the graph to explain which heat source heated the water faster.</p> <p>Answer: States that the Bunsen Burner heated the water faster than the hot plate.</p>	Minnesota, US	93 (1.3)
	Massachusetts, US	92 (1.6)
	Singapore	91 (1.0)
	Korea, Rep of	90 (1.2)
	Finland	90 (1.5)
	Japan	86 (1.4)
	England	86 (2.3)
	Chinese Taipei	85 (1.6)
	Hong Kong SAR	82 (1.9)
	Russian Federation	71 (2.2)
	International Average	62 (0.3)

Figure 67: A relatively easy item for Singapore students – Example grade 8 science item 4

Items that relatively more grade 8 students from Singapore found difficult

Figures 68, 69, 70, and 71 show three items that relatively more grade 8 students from Singapore found difficult.

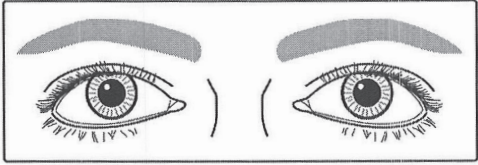
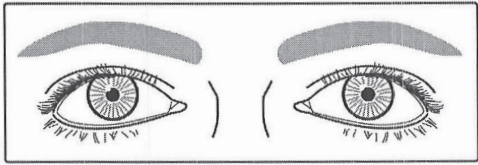
Content domain: Biology Cognitive domain: Applying	Country	Percent Full Credit
<p>Diagram 1</p>  <p>Diagram 2</p>  <p>Diagrams 1 and 2 illustrate the same pair of eyes that have reacted to a change in an environmental condition.</p> <p>What is the environmental condition and how is it different for the eyes in Diagram 1 and Diagram 2?</p> <p>Answer:</p> <p>Option 1: Indicates LIGHT and identifies which diagram corresponds to the low/high light level. Diagram 1 = dim light, low light level, darkness, or similar Diagram 2 = bright light, high light level, or similar</p> <p>Option 2: Other fully correct.</p>	Korea, Rep of	74 (2.0)
	Finland	65 (2.0)
	Minnesota, US	57 (2.9)
	Massachusetts, US	56 (3.2)
	Russian Federation	54 (2.2)
	England	46 (2.6)
	Japan	45 (2.2)
	Hong Kong SAR	43 (2.7)
	Chinese Taipei	37 (1.8)
	International Average	31 (0.3)
	Singapore	26 (1.7)

Figure 68: A relatively difficult item for Singapore students – Example grade 8 science item 1

Content domain: Chemistry Cognitive domain: Applying	Country	Percent Full Credit
<p>Write down one thing you might observe that shows that energy has been released during a chemical reaction.</p> <p>Answer: Option 1: Refers to heat of temperature increase (or similar). Option 2: Refers to explosion or hearing sound (or similar). Option 3: Other correct.</p>	Finland	49 (2.2)
	Chinese Taipei	43 (1.9)
	Singapore	30 (1.9)
	Japan	26 (2.1)
	Minnesota, US	25 (2.2)
	Hong Kong SAR	23 (2.1)
	Massachusetts, US	23 (2.9)
	Russian Federation	22 (2.1)
	England	19 (2.0)
	International Average	18 (0.3)
	Korea, Rep of	12 (1.1)

Figure 69: A relatively difficult item for Singapore students – Example grade 8 science item 2

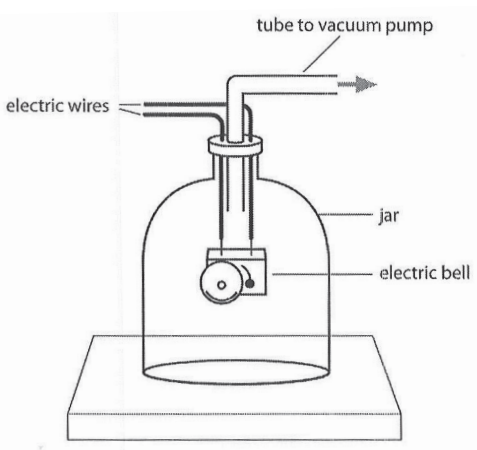
Content domain: Physics Cognitive domain: Applying	Country	Percent Full Credit
 <p>The diagram shows an electric bell inside a jar. The electric bell is switched on and a ringing sound is heard. The air is then pumped out of the jar.</p> <p>What will happen to the sound of the bell when the air is pumped out of the jar? Explain your answer.</p> <p>Answer: Option 1: Refers to sound fading AND explains that sound needs a medium to travel through (or similar). Option 2: Other fully correct.</p>	Chinese Taipei	60 (1.9)
	Japan	58 (2.5)
	Hong Kong SAR	44 (2.5)
	Korea, Rep of	40 (2.1)
	Finland	32 (2.2)
	England	29 (2.6)
	Russian Federation	28 (2.0)
	Singapore	27 (1.9)
	International Average	22 (0.3)
	Massachusetts, US	21 (3.0)
	Minnesota, US	20 (2.6)

Figure 70: A relatively difficult item for Singapore students – Example grade 8 science item 3

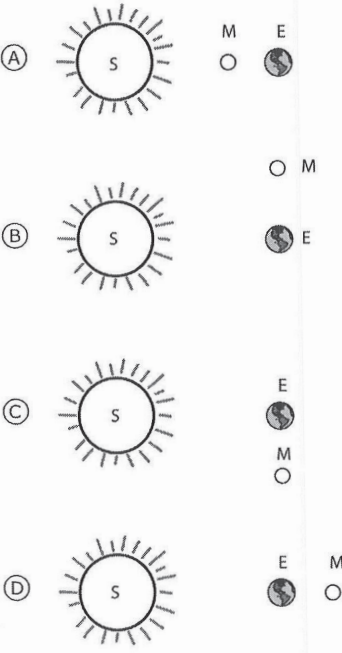
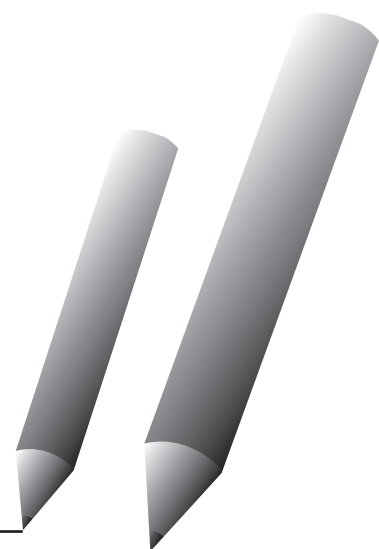
Content domain: Earth Science Cognitive domain: Applying	Country	Percent Full Credit
<p>Which diagram shows the position of the sun(S), moon(M), and Earth(E) during an eclipse of the moon? (Not drawn to scale)</p>  <p>Answer: D</p>	Finland	49 (2.4)
	Korea, Rep of	44 (2.0)
	Japan	39 (2.5)
	Chinese Taipei	38 (2.1)
	Hong Kong SAR	38 (2.1)
	Massachusetts, US	37 (3.4)
	International Average	35 (0.3)
	Russian Federation	32 (2.0)
	Minnesota, US	32 (2.4)
	Singapore	30 (1.9)
England	26 (1.8)	

Figure 71: A relatively difficult item for Singapore students – Example grade 8 science item 4

Student Attitudes

Data



Students' attitudes toward mathematics

Developing positive attitudes toward mathematics is an important goal of the school mathematics curriculum in many countries that participated in TIMSS 2011. In Singapore, as shown in Figure 72, it is one of the five critical factors that contribute toward the primary goal of mathematical problem solving.

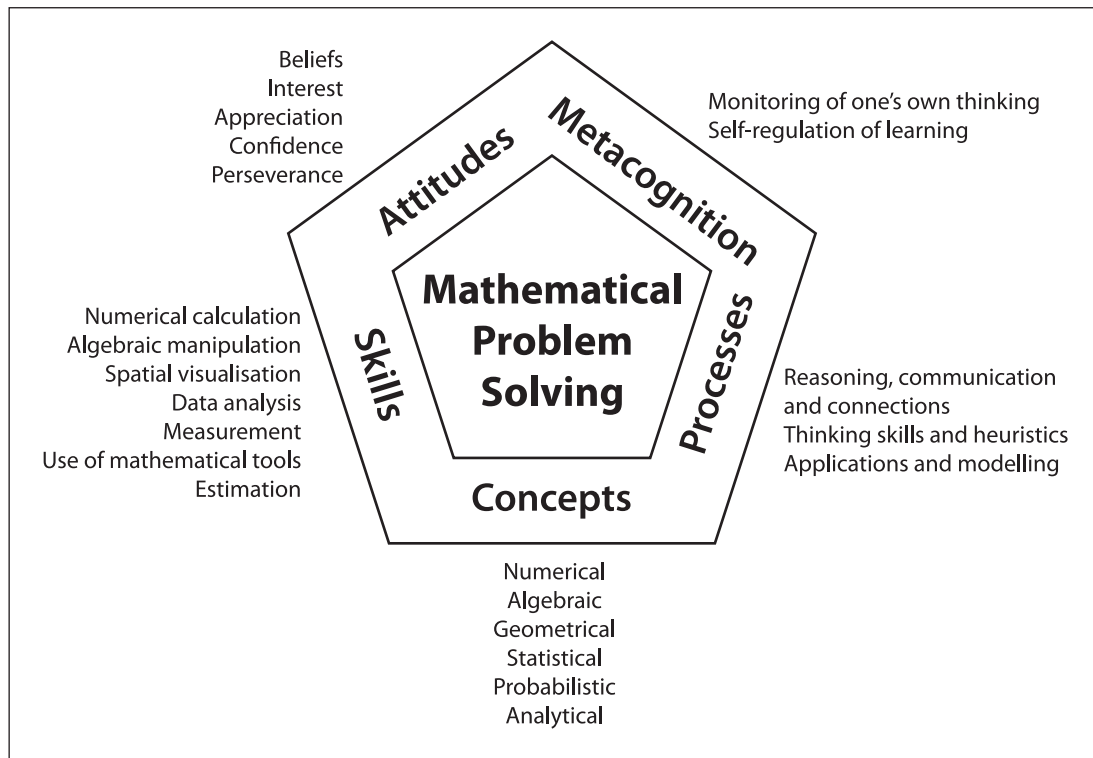


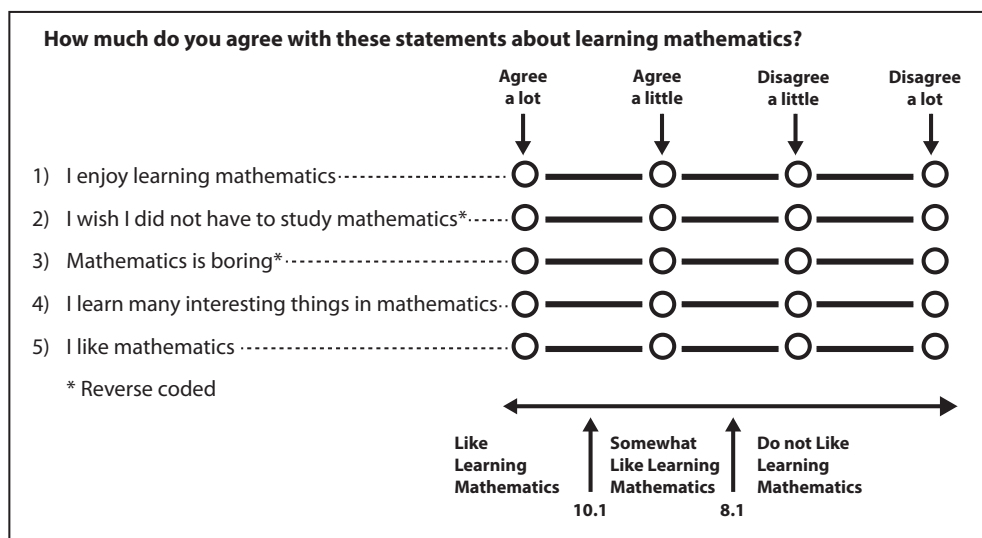
Figure 72: Framework of the Singapore school mathematics curriculum

To summarise information about progress made toward developing student attitudes, TIMSS 2011 included scales about three motivational constructs: intrinsic value (interest), utility value, and ability beliefs. The Students Like Learning Mathematics scale was developed to measure students' interest and liking of mathematics. The Students Value Mathematics scale was developed to address students' attitudes about the importance of the subject and usefulness of the subject. Lastly the Student Confidence with Mathematics scale assesses students' self-confidence and self-concept in their ability to learn mathematics.

Students Like Learning Mathematics

To investigate whether students like mathematics, students were scored according to their degree of agreement with five statements of the scale. Both grades 4 and 8 students responded to the same set of statements.

Grade 4



On average students who **Like Learning Mathematics** had a score on the scale of at least 10.1, which corresponds to their “agreeing a lot” with three of the five statements and “agreeing a little” with the other two. Students who **Do Not Like Learning Mathematics** had a score no higher than 8.1, which corresponds to their “disagreeing a little” with three of the five statements and “agreeing a little” with the other two. All other students **Somewhat Like Learning Mathematics**.

Table 21, shows the percentage of grade 4 students at each category of the scale. Data for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore, are presented in the table. From Tables 21 it is apparent that a higher proportion of students in Singapore compared to other East Asian countries, likes learning mathematics.

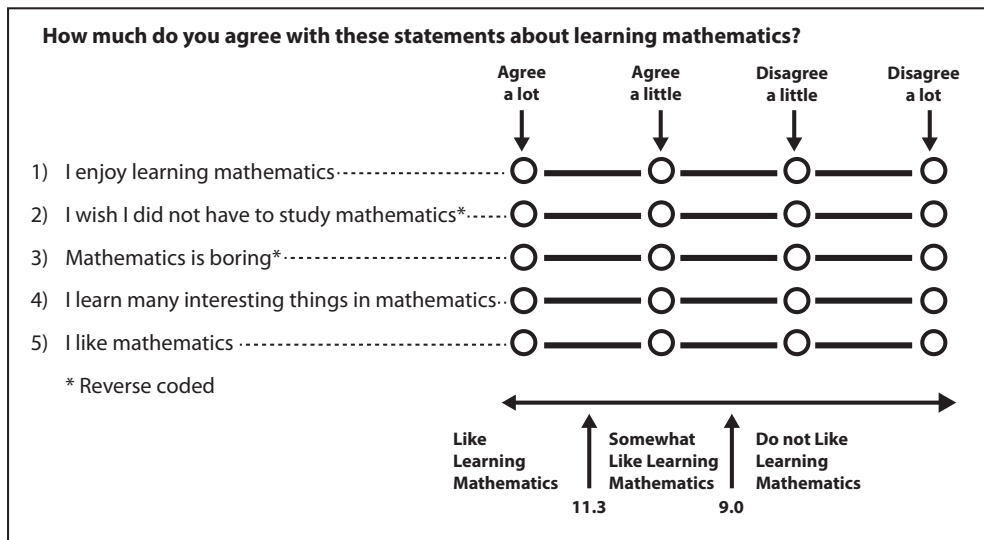
Table 21

Grade 4 – Students Like Learning Mathematics

Country	Like Learning Mathematics		Somewhat Like Learning Mathematics		Do Not Like Learning Mathematics		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Russian Federation	58 (1.2)	554 (4.0)	34 (1.1)	530 (4.0)	8 (0.6)	514 (6.2)	10.5 (0.04)
North Carolina, US	49 (1.4)	563 (4.0)	34 (1.3)	551 (5.2)	17 (1.0)	542 (6.1)	10.0 (0.07)
Singapore	48 (0.8)	625 (3.1)	33 (0.6)	597 (3.8)	19 (0.7)	577 (3.8)	9.9 (0.03)
International Avg	48 (0.2)	509 (0.5)	36 (0.1)	478 (0.6)	16 (0.1)	466 (0.9)	
Hong Kong SAR	47 (1.0)	619 (4.0)	36 (0.8)	591 (3.6)	17 (0.8)	582 (3.7)	9.9 (0.04)
Florida, US	45 (1.2)	557 (3.7)	34 (1.1)	541 (3.7)	21 (1.0)	531 (4.4)	9.8 (0.06)
England	44 (1.4)	548 (4.4)	37 (1.1)	543 (4.0)	19 (1.1)	530 (5.5)	9.8 (0.06)
Finland	34 (1.2)	556 (2.9)	35 (1.0)	548 (3.3)	31 (1.3)	533 (2.6)	9.2 (0.06)
Chinese Taipei	34 (1.1)	613 (2.8)	34 (0.7)	589 (2.6)	32 (1.0)	572 (2.5)	9.2 (0.06)
Japan	29 (1.1)	607 (2.8)	48 (1.0)	586 (2.3)	23 (1.1)	558 (2.9)	9.3 (0.05)
Korea, Rep of	23 (0.7)	627 (2.7)	48 (0.9)	606 (2.3)	29 (1.0)	586 (2.7)	9.0 (0.03)

() standard errors

Grade 8



On average students who **Like Learning Mathematics** had a score on the scale of at least 11.3, which corresponds to their “agreeing a lot” with three of the five statements and “agreeing a little” with the other two. Students who **Do Not Like Learning Mathematics** had a score no higher than 9.0, which corresponds to their “disagreeing a little” with three of the five statements and “agreeing a little” with the other two, on average. All other students **Somewhat Like Learning Mathematics**.

Table 22, shows the percentage of grade 8 students at each category of the scale. Data for students from Singapore and selected education systems, mainly those ranked within the top 5, countries and benchmarking entities of interest to mathematics educators in Singapore, are presented in the table. From Table 22, it is apparent that the proportion of Singapore students who like learning mathematics is the highest amongst the listed countries in the table.

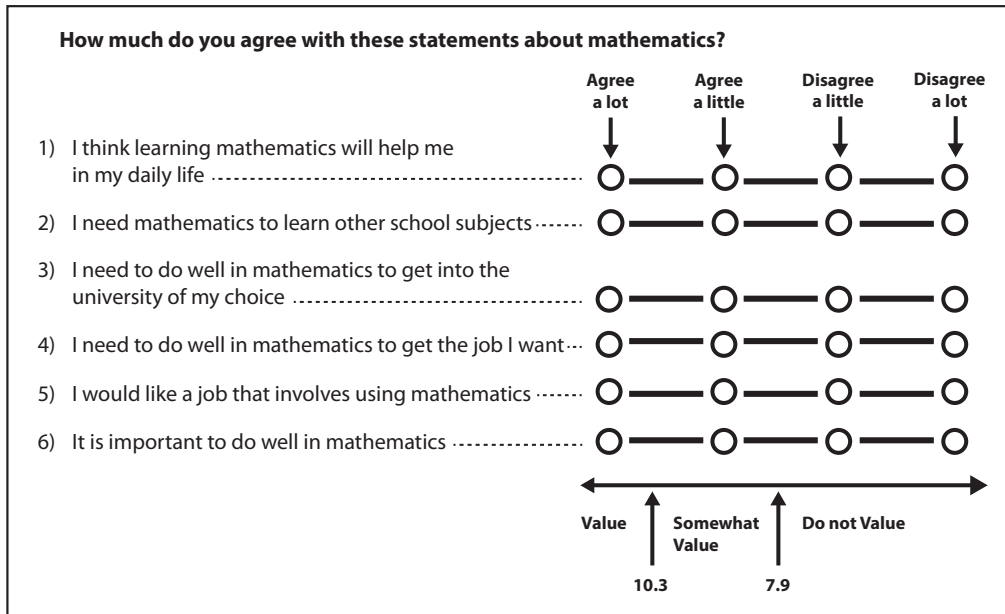
Table 22
 Grade 8 – Students Like Learning Mathematics

Country	Like Learning Mathematics		Somewhat Like Learning Mathematics		Do Not Like Learning Mathematics		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Singapore	32 (0.7)	637 (3.9)	44 (0.7)	610 (4.1)	23 (0.7)	578 (4.4)	10.4 (0.03)
Russian Federation	29 (1.1)	567 (4.7)	49 (0.9)	537 (3.6)	22 (1.0)	509 (4.1)	10.3 (0.04)
International Avg	26 (0.2)	504 (0.8)	42 (0.1)	467 (0.6)	31 (0.2)	443 (0.7)	
Massachusetts, US	19 (1.3)	585 (6.1)	40 (1.0)	568 (5.4)	41 (1.7)	543 (5.4)	9.4 (0.09)
Hong Kong SAR	19 (0.8)	635 (4.4)	44 (1.0)	595 (3.8)	37 (1.3)	551 (4.6)	9.6 (0.05)
Minnesota, US	18 (1.5)	578 (6.8)	41 (0.9)	555 (4.7)	41 (1.6)	521 (4.6)	9.5 (0.08)
England	14 (1.0)	548 (8.9)	44 (1.3)	517 (5.7)	42 (1.7)	484 (5.2)	9.4 (0.07)
Chinese Taipei	14 (0.7)	681 (4.3)	33 (0.9)	645 (3.6)	53 (1.2)	568 (3.2)	9.0 (0.06)
Finland	10 (0.6)	560 (4.1)	34 (1.0)	532 (2.8)	57 (1.1)	496 (2.6)	8.8 (0.05)
Japan	9 (0.6)	621 (5.1)	38 (1.1)	589 (3.3)	53 (1.4)	545 (3.1)	9.1 (0.05)
Korea, Rep of	8 (0.3)	677 (4.7)	36 (0.7)	649 (3.3)	56 (0.8)	581 (2.9)	8.9 (0.03)

() standard errors

Students Value Mathematics

In addition to having a positive feeling towards mathematics, students' may be attracted to mathematics and motivated to learn it if they perceive mathematics achievement as advantageous to their future education and the world of work. Students were scored according to their degree of agreement with six statements on the Students Value Mathematics scale. Only grade 8 students were asked to respond to the scale.



Students who **Value** mathematics had a score on the scale of at least 10.3, which corresponds to their “agreeing a lot” with three of the six statements and “agreeing a little” with the other three, on average. Students who **Do Not Value** mathematics had a score no higher than 7.9, which corresponds to their “disagreeing a little” with three of the six statements and “agreeing a little” with the other three, on average. All other students **Somewhat Value** mathematics.

Table 23 shows the percentage of grade 8 students at each category of the scale. Data for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore are presented in the table. From the table, it is apparent that almost 43% of grade 8 students from Singapore value mathematics which is below the international average.

Table 23

Grade 8 – Students Value Mathematics

Country	Value		Somewhat Value		Do Not Value		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Minnesota, US	55 (1.2)	560 (5.0)	36 (1.1)	532 (5.2)	9 (0.6)	514 (4.5)	10.3 (0.04)
US	51 (0.7)	521 (2.9)	38 (0.6)	503 (2.7)	11 (0.5)	488 (3.5)	10.2 (0.03)
Massachusetts, US	48 (1.3)	572 (6.0)	40 (1.3)	554 (4.9)	12 (1.0)	540 (6.4)	10.0 (0.04)
England	48 (1.2)	513 (6.1)	43 (1.1)	506 (5.8)	10 (0.6)	479 (6.6)	10.1 (0.05)
International Avg	46 (0.2)	482 (0.7)	39 (0.1)	463 (0.6)	15 (0.1)	439 (0.9)	
Singapore	43 (0.7)	619 (4.0)	47 (0.7)	608 (3.9)	10 (0.5)	591 (5.6)	10.0 (0.03)
Hong Kong SAR	26 (0.8)	617 (4.5)	49 (1.0)	589 (3.9)	25 (1.0)	548 (5.3)	9.2 (0.04)
Finland	15 (0.8)	540 (4.0)	45 (1.0)	523 (2.6)	40 (1.3)	495 (2.9)	8.5 (0.05)
Korea, Rep of	14 (0.6)	663 (5.5)	52 (0.8)	625 (3.1)	34 (0.8)	572 (3.0)	8.6 (0.03)
Japan	13 (0.7)	599 (5.9)	50 (0.9)	578 (3.0)	38 (1.1)	546 (2.9)	8.5 (0.03)
Chinese Taipei	13 (0.6)	658 (5.1)	41 (0.7)	633 (3.8)	46 (1.0)	574 (3.4)	8.3 (0.04)

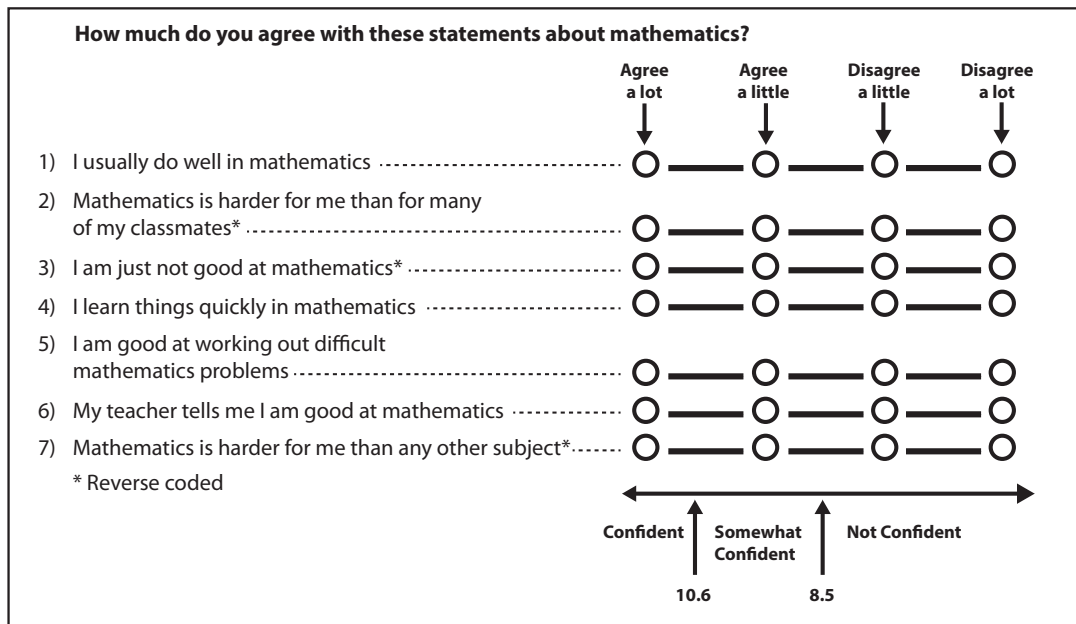
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Students Confident in Mathematics

Regardless of how much students like mathematics or value it for how it can help them in their lives, students' confidence in their ability to learn mathematics is based to some extent on their past experience in learning the subject. Their past experience is in turn likely to be determined by the difficulty of the subject as well as the individual students' own learning ability.

Grade 4

To investigate grade 4 students' perspective about their own abilities in mathematics, they were scored according to their degree of agreement with seven statements, on the *Students Confident in Mathematics* scale.



Students **Confident** in mathematics had a score on the scale of at least 10.6, which corresponds to their "agreeing a lot" with four of the seven statements and "agreeing a little" with the other three, on average. Students who were **Not Confident** has a score no higher than 8.5, which corresponds to their "disagreeing a little" with four of the seven statements and "agreeing a little" with the other three, on average. All other students were **Somewhat Confident** in mathematics.

Table 24 shows the percentage of grade 4 students at each category of the scale. The data in the table is for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to mathematics educators in Singapore. From Table 24, it is evident that grade 4 students from the top performing East Asian countries that participated in TIMSS 2011 were less confident of their mathematics ability than their counterparts in North Carolina and Florida of the US, Finland, England and the Russian Federation.

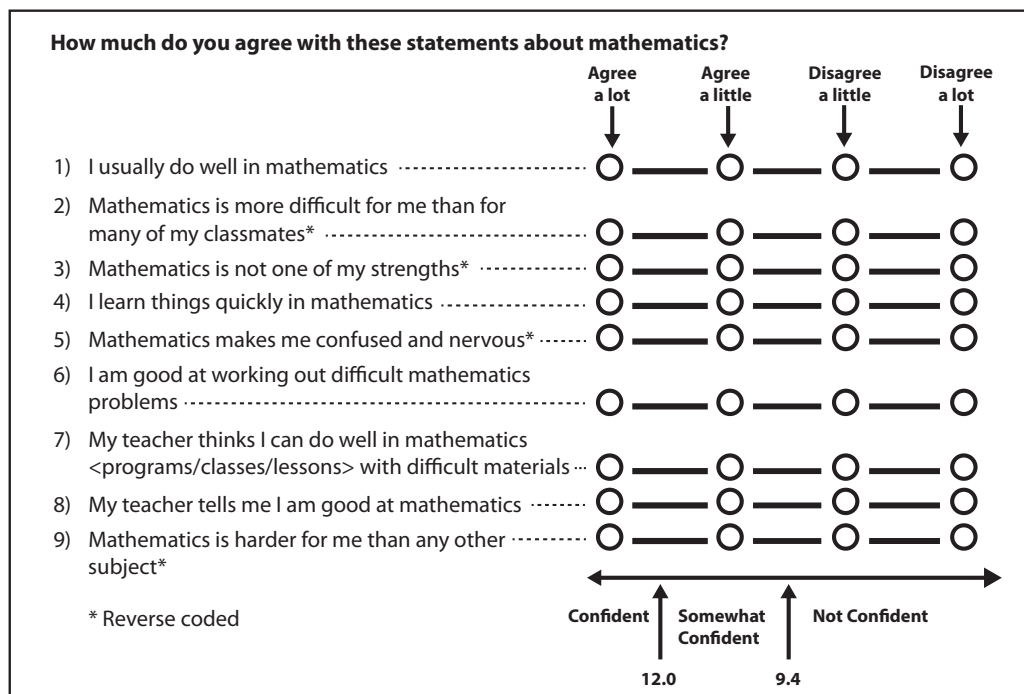
Table 24
 Grade 4 – Students Confident in Mathematics

Country	Confident		Somewhat Confident		Not Confident		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
North Carolina, US	42 (1.5)	585 (3.9)	40 (1.2)	544 (4.7)	18 (1.3)	508 (4.7)	10.3 (0.07)
Florida, US	41 (1.3)	578 (3.5)	38 (1.0)	533 (3.4)	21 (1.0)	507 (3.7)	10.3 (0.06)
Finland	35 (0.8)	579 (3.0)	42 (0.7)	543 (2.6)	23 (0.7)	503 (3.2)	9.9 (0.03)
International Avg	34 (0.1)	527 (0.5)	46 (0.1)	484 (0.5)	21 (0.1)	452 (0.7)	
England	33 (1.0)	572 (4.6)	48 (0.9)	538 (3.8)	19 (0.7)	503 (4.4)	10.0 (0.04)
Russian Federation	33 (1.0)	571 (4.3)	41 (0.7)	544 (4.2)	26 (0.8)	504 (4.0)	9.8 (0.04)
Hong Kong SAR	24 (0.9)	641 (3.1)	44 (0.9)	600 (5.1)	31 (1.0)	575 (2.9)	9.4 (0.05)
Singapore	21 (0.8)	658 (2.8)	41 (0.7)	614 (3.3)	38 (1.0)	570 (3.1)	9.2 (0.04)
Chinese Taipei	20 (0.7)	634 (2.6)	42 (0.8)	597 (2.4)	38 (0.9)	564 (2.4)	9.2 (0.04)
Korea, Rep of	11 (0.5)	660 (4.3)	50 (0.9)	622 (1.9)	38 (1.0)	567 (2.0)	9.0 (0.03)
Japan	9 (0.5)	640 (3.9)	43 (0.8)	605 (2.1)	48 (0.9)	558 (1.9)	8.6 (0.03)

() standard errors

Grade 8

To investigate grade 8 students' perspective about their own abilities in mathematics, grade 8 students were scored according to their degree of agreement with nine statements, on the *Students Confident in Mathematics scale*.



Students **Confident** in mathematics had a score on the scale of at least 12.0, which corresponds to their “agreeing a lot” with five of the nine statements and “agreeing a little” with the other four, on average. Students who were **Not Confident** had a score no higher than 9.4, which corresponds to their “disagreeing a little” with five of the nine statements and “agreeing a little” with the other four, on average. All other students were **Somewhat Confident** in mathematics.

Table 25 shows the percentage of grade 8 students at each category of the scale. The data in the table is for students from Singapore and selected education systems, mainly those ranked within the top 5, countries and benchmarking entities of interest to mathematics educators in Singapore. From Table 25, it is evident that grade 8 students from the top performing East Asian countries that participated in TIMSS 2011 were less confident of their mathematics ability than their counterparts in Massachusetts and Minnesota in the US, England and Finland.

Table 25
 Grade 8 – Students Confident in Mathematics

Country	Confident		Somewhat Confident		Not Confident		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Massachusetts, US	27 (1.6)	604 (6.2)	43 (1.5)	562 (5.3)	30 (1.7)	520 (4.3)	10.7 (0.10)
Minnesota, US	25 (1.7)	593 (5.3)	44 (1.1)	552 (4.4)	31 (1.5)	497 (4.1)	10.6 (0.09)
England	16 (1.1)	571 (6.2)	53 (1.1)	514 (5.4)	32 (1.6)	465 (5.4)	10.3 (0.07)
Finland	15 (0.8)	580 (2.9)	39 (0.8)	533 (2.5)	46 (1.2)	477 (2.5)	9.8 (0.06)
Singapore	14 (0.5)	662 (4.1)	46 (0.8)	628 (3.6)	40 (0.9)	574 (4.3)	10.0 (0.04)
International Avg	14 (0.1)	539 (0.9)	45 (0.1)	478 (0.6)	41 (0.2)	435 (0.6)	
Russian Federation	12 (0.7)	603 (4.7)	43 (1.0)	561 (3.5)	45 (1.0)	501 (3.9)	9.9 (0.04)
Chinese Taipei	7 (0.4)	709 (5.0)	26 (0.7)	670 (3.4)	67 (0.9)	575 (2.9)	8.6 (0.05)
Hong Kong SAR	7 (0.4)	655 (5.5)	37 (1.0)	610 (4.4)	55 (1.1)	561 (4.0)	9.3 (0.04)
Korea, Rep of	3 (0.2)	723 (6.7)	34 (0.8)	669 (2.9)	63 (0.8)	577 (2.8)	9.1 (0.03)
Japan	2 (3.0)	~~	24 (0.8)	623 (3.2)	73 (0.9)	548 (2.8)	8.6 (0.04)

() standard errors

~~ insufficient data to report achievement

Students' attitudes toward science

Developing positive attitudes towards science and scientific explanations is an important goal of the science curriculum in many countries that participated in TIMSS 2011. In Singapore, as shown in Figure 73, it is a critical factor that contributes toward the primary goal of science as an inquiry.

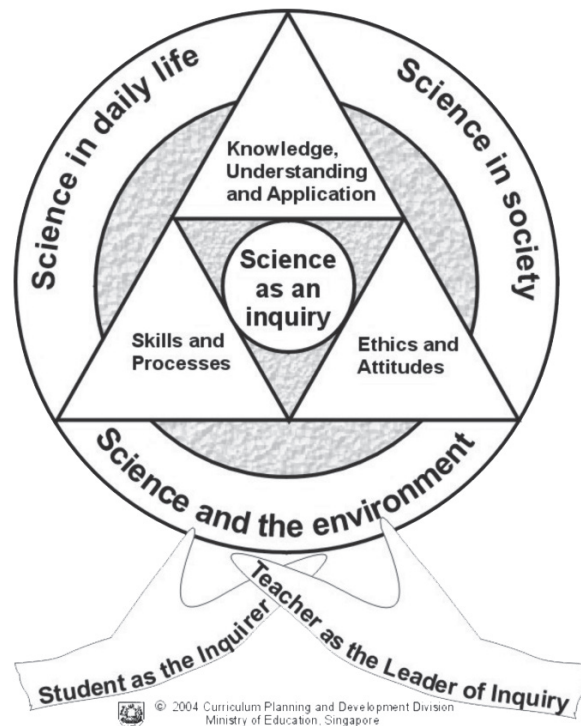


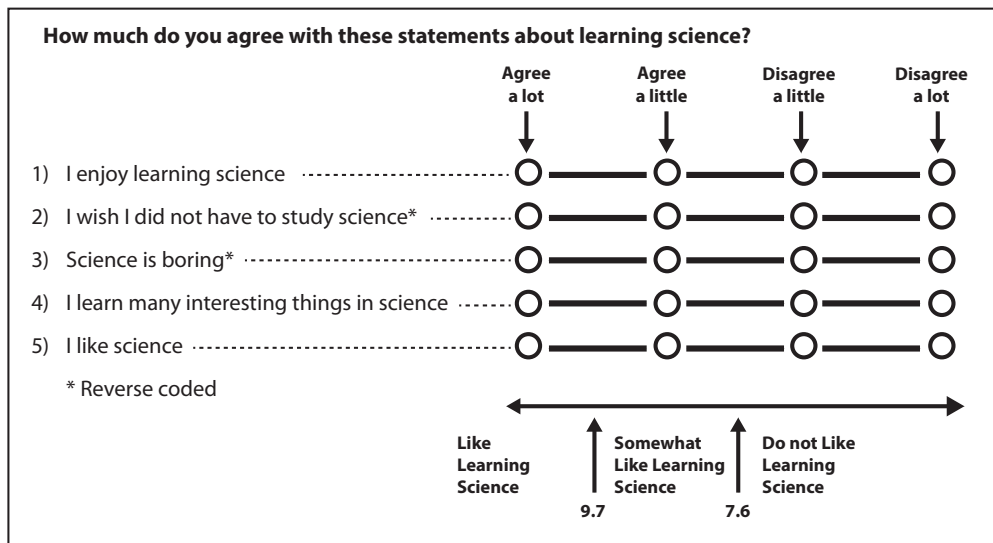
Figure 73: Framework of the Singapore school science curriculum

To summarize information about progress made toward developing student attitudes, TIMSS 2011 included scales about three motivational constructs; intrinsic value (interest), utility value, and ability beliefs. The Students Like Learning Science scale was developed to measure students' interest in and liking of learning science. The Students Value Science scale developed to address students' attitudes about the importance of the subject and usefulness of the subject. Lastly the Student Confidence with Science scale assesses students' self-confidence or self-concept in their ability to learn science.

Students Like Learning Science

To investigate whether students like science, students were scored according to their degree of agreement with five statements on the Students Like Learning Science scale. Both grades 4 and grade 8 students responded to the same set of statements.

Grade 4



Students who **Like Learning Science** had a score on the scale of at least 9.7, which corresponds to their “agreeing a lot” with three of the five statements and “agreeing a little” with the other two, on average. Students who **Do Not Like Learning Science** had a score on the scale no higher than 7.6, which corresponds to their “disagreeing a little” with three of the five statements and “agreeing a little” with the other two, on average. All other students **Somewhat Like Learning Science**.

Table 26 shows the percentage of grade 4 students at each category of the scale. The data in the table is for Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore. From table 26, it is apparent that grade 4 students from Singapore have generally positive affect towards science, compared to their counterparts in the top performing countries.

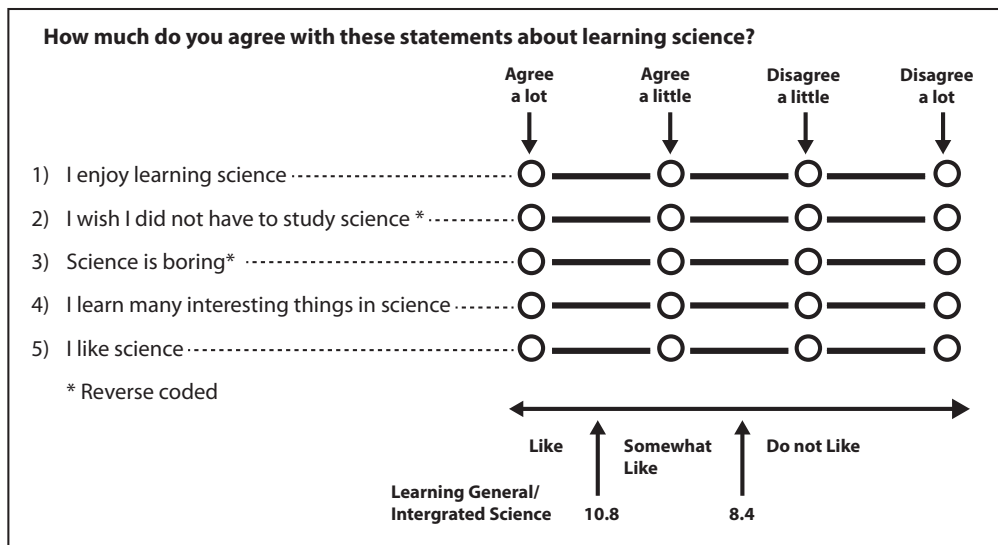
Table 26

Grade 4 – Students Like Learning Science

Country	Like Learning Science		Somewhat Like Learning Science		Do Not Like Learning Science		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
North Carolina, US	64 (1.9)	547 (4.0)	26 (1.4)	527 (6.7)	10 (0.9)	520 (8.2)	10.4 (0.08)
Russian Federation	62 (1.2)	561 (3.6)	30 (0.9)	540 (4.1)	7 (0.5)	542 (5.6)	10.4 (0.05)
Chinese Taipei	58 (1.4)	564 (2.2)	30 (0.9)	537 (3.5)	11 (0.8)	533 (5.3)	10.1 (0.06)
Singapore	57 (0.7)	600 (3.4)	31 (0.6)	567 (4.3)	12 (0.5)	555 (5.4)	10.1 (0.03)
United States	56 (0.8)	555 (2.3)	29 (0.5)	535 (3.3)	15 (0.6)	530 (3.3)	10.0 (0.04)
International Avg	53 (0.2)	504 (0.5)	35 (0.1)	469 (0.7)	12 (0.1)	461 (1.1)	
Hong Kong SAR	52 (1.3)	551 (3.5)	35 (0.9)	523 (4.9)	14 (0.8)	507 (6.6)	9.9 (0.05)
Japan	52 (1.2)	566 (2.0)	40 (0.9)	554 (2.3)	9 (0.8)	538 (5.7)	9.9 (0.05)
Florida, US	51 (1.7)	556 (4.2)	30 (1.2)	540 (4.1)	18 (1.0)	529 (5.4)	9.8 (0.07)
Korea, Rep of	39 (0.9)	604 (3.1)	45 (0.9)	583 (2.0)	16 (0.7)	559 (3.6)	9.4 (0.04)
Finland	36 (1.2)	578 (3.2)	39 (1.0)	571 (3.2)	25 (1.1)	561 (3.4)	9.1 (0.06)

() standard errors

Grade 8



Students who **Like Learning Science** had a score on the scale of at least 10.8, which corresponds to their “agreeing a lot” with three of the five statements and “agreeing a little” with the other two, on average. Students who **Do Not Like Learning Science** had a score on the scale no higher than 8.4, which corresponds to their “disagreeing a little” with three of the five statements and “agreeing a little” with the other two, on average. All other students **Somewhat Like Learning Science**.

Table 27 shows the percentage of grade 8 students at each category of the scale. The data in the table is for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore. From Tables 27, it is apparent that Singapore students have high positive affect toward science compared to their counterparts in top performing countries.

Table 27

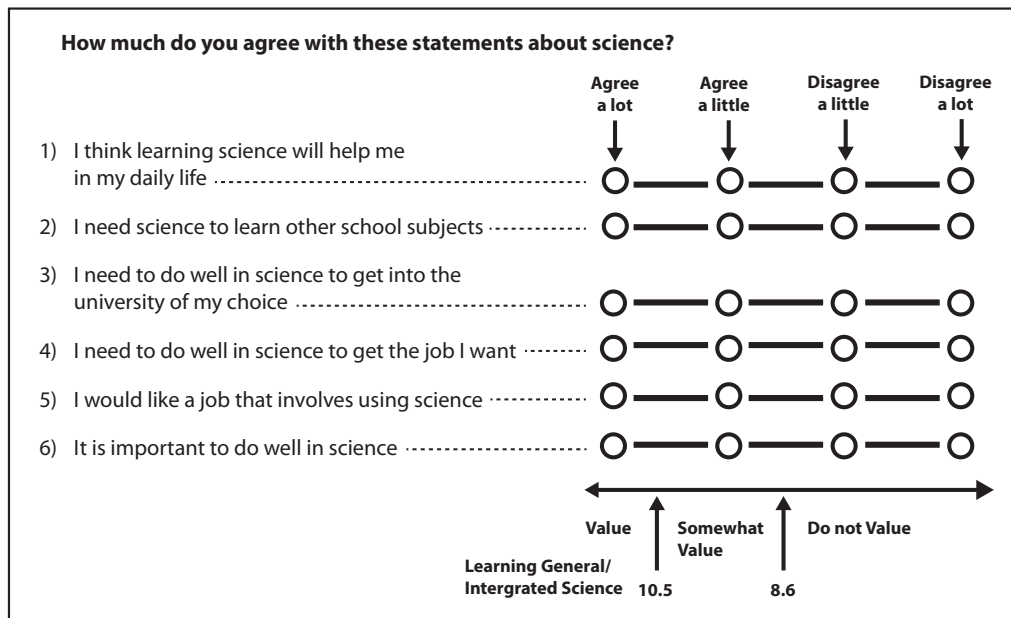
Grade 8 – Students Like Learning Science

Country	Like Learning Science		Somewhat Like Learning Science		Do Not Like Learning Science		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Singapore	38 (0.8)	617 (5.2)	46 (0.7)	584 (4.2)	16 (0.5)	542 (5.4)	10.2 (0.03)
Massachusetts, US	37 (1.9)	589 (5.6)	41 (1.3)	565 (5.3)	22 (2.0)	536 (5.4)	10.0 (0.10)
International Avg	35 (0.2)	515 (0.8)	44 (0.2)	472 (0.8)	21 (0.2)	450 (1.1)	
England	32 (1.3)	562 (5.4)	45 (0.9)	532 (5.0)	23 (1.1)	500 (4.9)	9.9 (0.06)
Minnesota, US	29 (2.0)	582 (5.0)	44 (1.3)	549 (4.4)	28 (1.8)	532 (5.7)	9.6 (0.10)
Hong Kong SAR	28 (1.2)	561 (4.1)	51 (0.9)	534 (3.3)	21 (1.1)	506 (4.9)	9.8 (0.06)
Chinese Taipei	17 (0.8)	618 (3.4)	43 (0.7)	571 (2.7)	40 (1.1)	534 (2.6)	9.0 (0.05)
Japan	15 (0.8)	595 (3.7)	47 (1.1)	566 (2.2)	38 (1.5)	531 (3.1)	9.0 (0.06)
Korea, Rep of	11 (0.5)	623 (3.8)	43 (0.9)	576 (2.1)	46 (1.1)	531 (2.2)	8.7 (0.04)

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Students Value Science

In addition to having a positive feeling towards science, students' may be attracted to science and motivated to learn it if they perceive science achievement as advantageous to their future education and the world of work. To understand how much students value science, students were scored according to their degree of agreement with six statements on the Students Value Science scale. Only grade 8 students were asked to respond to the scale.



Students who **Value** science had a score on the scale of at least 10.5, which corresponds to their “agreeing a lot” with three of the six statements and “agreeing a little” with the other three, on average. Students who **Do Not Value** science had a score no higher than 8.6, which corresponds to their “disagreeing a little” with three of the six statements and “agreeing a little” with the other three, on average. All other students **Somewhat Value** science.

Table 28 shows the percentage of grade 8 students, from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore. From Table 28, it is apparent that amongst the high performing countries, grade 8 students from Singapore valued the learning of science the most.

Table 28

Grade 8 – Students Value Science

Country	Value		Somewhat Value		Do Not Value		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
England	41 (1.3)	547 (5.9)	37 (0.9)	530 (4.7)	22 (0.9)	516 (5.9)	10.1 (0.05)
Singapore	41 (0.8)	616 (4.6)	43 (0.7)	583 (4.3)	17 (0.6)	546 (5.9)	10.2 (0.03)
International Avg	41 (0.2)	502 (0.8)	33 (0.2)	477 (0.8)	26 (0.2)	457 (1.1)	
Minnesota, US	38 (1.7)	575 (4.7)	36 (1.1)	550 (5.0)	25 (1.5)	530 (5.3)	9.9 (0.07)
Massachusetts, US	34 (1.4)	587 (5.9)	36 (1.1)	567 (5.3)	30 (1.5)	546 (6.4)	9.7 (0.07)
Hong Kong SAR	26 (1.0)	559 (4.1)	43 (0.8)	535 (3.8)	32 (1.1)	518 (4.0)	9.5 (0.04)
Korea, Rep of	14 (0.6)	607 (4.1)	40 (0.9)	574 (2.3)	46 (1.0)	535 (2.2)	8.8 (0.03)
Chinese Taipei	12 (0.7)	612 (4.2)	30 (0.7)	586 (2.8)	58 (1.1)	543 (2.2)	8.5 (0.05)
Japan	10 (0.7)	595 (4.9)	34 (1.0)	574 (2.7)	56 (1.1)	540 (2.7)	8.5 (0.04)

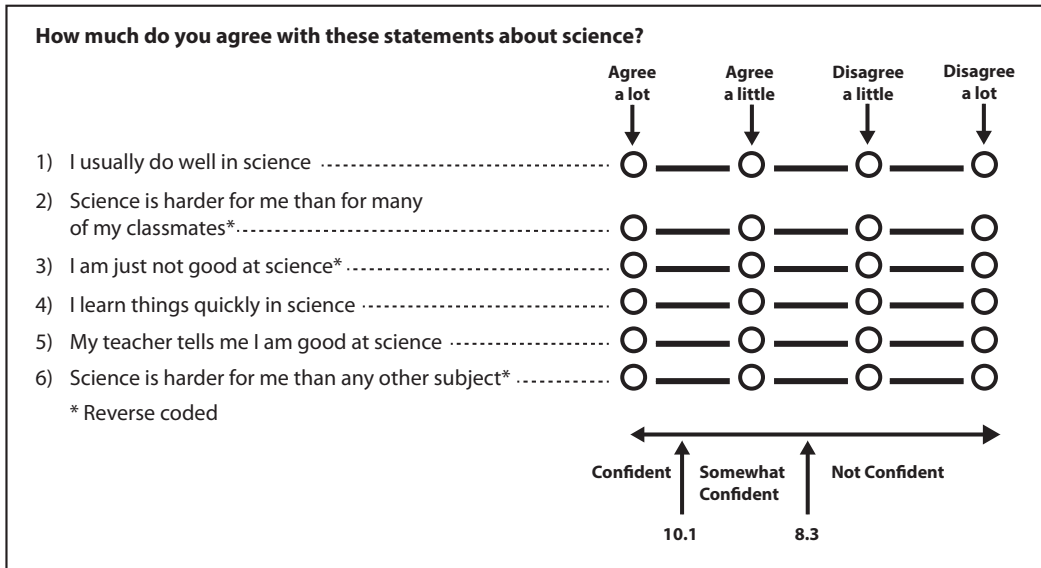
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Students Confident in Science

Regardless of how much students like science or value it for how it can help them in their lives, students’ confidence in their ability to learn science is based to some extent on their past experience in learning the subject. Their past experience is in turn likely to be determined by the difficulty of the subject as well as the individual students’ own learning ability.

Grade 4

To investigate how confident students are in their abilities in science, they were scored according to their degree of agreement with six statements on the *Students Confident in Science* scale.



Students **Confident** in science had a score on the scale of at least 10.1 which corresponds to their “agreeing a lot” with three of the six statements and “agreeing a little” with the other three, on average. Students who were **Not Confident** had a score no higher than 8.3, which corresponds to their “disagreeing a little” with three of the six statements and “agreeing a little” with the other three, on average. All other students were **Somewhat Confident** in science.

Table 29 shows the percentage of grade 4 students at each category of the scale. The data in the table is for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to science educators in Singapore. From Table 29, it is apparent that grade 4 students from Singapore were less confident in their science ability compared to their counterparts in Russia, the United States, Chinese Taipei and Finland.

Table 29

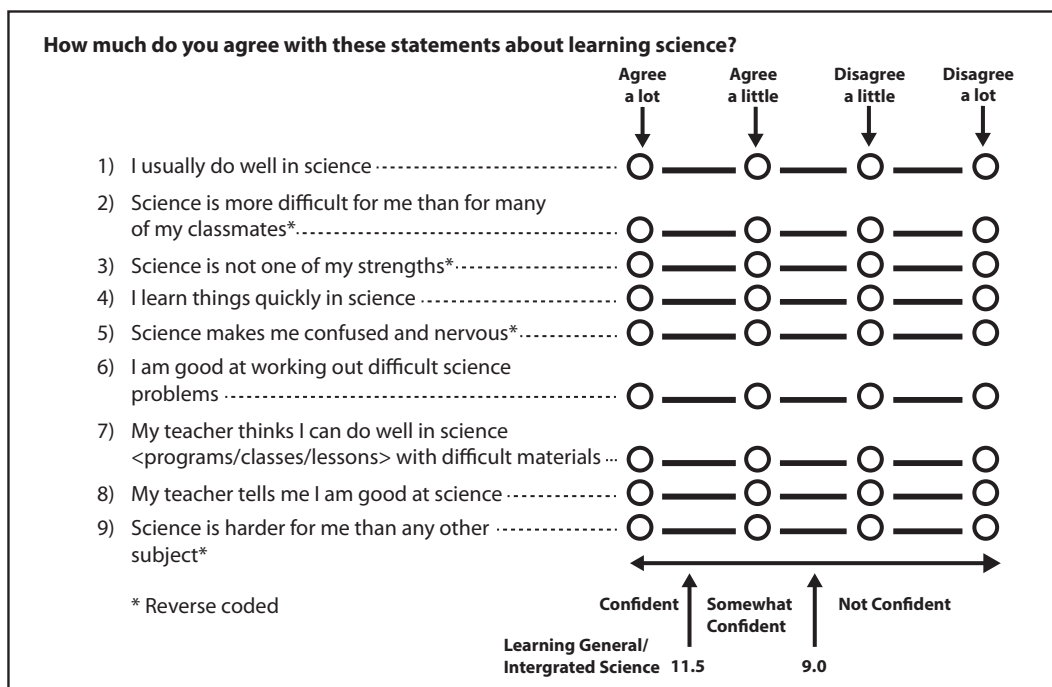
Grade 4 – Students Confident in Science

Country	Confident		Somewhat Confident		Not Confident		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
North Carolina, US	55 (1.5)	556 (4.5)	30 (1.4)	531 (5.5)	16 (1.2)	498 (6.5)	10.4 (0.06)
Russian Federation	48 (1.2)	570 (3.9)	32 (0.8)	548 (4.2)	20 (0.8)	521 (4.1)	10.2 (0.05)
United States	48 (0.8)	567 (2.0)	32 (0.6)	538 (3.2)	20 (0.6)	507 (3.0)	10.1 (0.03)
Florida, US	47 (1.6)	565 (4.5)	30 (1.5)	540 (4.2)	23 (1.3)	517 (4.5)	10.1 (0.07)
Chinese Taipei	44 (1.3)	573 (2.4)	35 (0.8)	550 (3.2)	21 (1.0)	512 (4.4)	10.1 (0.06)
International Avg	43 (0.2)	514 (0.5)	36 (0.1)	480 (0.6)	21 (0.1)	446 (0.8)	
Finland	38 (1.1)	587 (3.3)	43 (0.9)	571 (2.6)	19 (0.8)	540 (4.6)	9.7 (0.04)
Singapore	26 (0.6)	620 (3.6)	36 (0.6)	592 (3.6)	37 (0.7)	552 (4.0)	9.1 (0.03)
Hong Kong SAR	25 (0.9)	560 (4.6)	36 (0.9)	539 (3.8)	39 (1.3)	516 (4.8)	9.1 (0.05)
Japan	17 (0.8)	581 (3.1)	48 (0.9)	564 (2.2)	34 (1.0)	541 (3.2)	8.9 (0.03)
Korea, Rep of	15 (0.7)	623 (3.8)	45 (0.8)	598 (2.1)	40 (1.0)	562 (2.3)	8.8 (0.03)

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Grade 8

To investigate how confident grade 8 students are in their abilities in science, grade 8 students were scored according to their degree of agreement with nine statements on the *Students Confident in Science* scale.



Students **Confident** in science had a score on the scale of at least 11.5, which corresponds to their “agreeing a lot” with five of the nine statements and “agreeing a little” with the other four, on average. Students who were **Not Confident** had a score no higher than 9.0, which corresponds to their “disagreeing a little” with five of the nine statements and “agreeing a little” with the other four, on average. All other students were **Somewhat Confident** in science.

Table 30 shows the percentage of grade 8 students at each category of the scale. The data in the table is for students from Singapore and selected education systems, mainly those ranked within the top 5, and countries and benchmarking entities of interest to educators in Singapore. From Table 30, it is apparent that grade 8 students from Singapore were the most confident in their science ability when compared to their counterparts in East Asia, even though they were still less confident than their counterparts in US and England.

Table 30

Grade 8 – Students Confident in Science

Country	Confident		Somewhat Confident		Not Confident		Average Scale Score
	Percent of students	Average Achievement	Percent of students	Average Achievement	Percent of students	Average Achievement	
Massachusetts, US	33 (2.1)	604 (6.4)	46 (1.2)	561 (5.0)	21 (1.9)	526 (4.4)	10.7 (0.12)
Minnesota, US	27 (2.0)	595 (4.4)	45 (1.2)	553 (3.9)	27 (1.7)	515 (5.3)	10.3 (0.10)
England	23 (1.2)	579 (5.2)	52 (1.2)	529 (5.4)	25 (1.2)	503 (5.0)	10.2 (0.06)
International Avg	20 (0.2)	536 (1.0)	49 (0.2)	482 (0.8)	31 (0.2)	450 (0.9)	
Singapore	14 (0.5)	630 (5.9)	48 (0.7)	600 (4.8)	37 (0.8)	562 (4.2)	9.6 (0.03)
Hong Kong SAR	8 (0.6)	579 (4.9)	47 (1.1)	544 (4.1)	45 (1.3)	520 (3.4)	9.2 (0.04)
Chinese Taipei	6 (0.4)	648 (4.9)	27 (0.9)	599 (3.1)	67 (1.0)	543 (2.3)	8.3 (0.05)
Korea, Rep of	4 (0.3)	652 (4.6)	33 (0.8)	603 (2.1)	63 (0.9)	532 (1.9)	8.7 (0.03)
Japan	3 (0.3)	631 (7.7)	28 (0.9)	591 (2.6)	69 (1.1)	540 (2.6)	8.4 (0.04)

() standard errors

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useful resources

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For TIMSS 2011 you may view the released items with useful data at the following webpages:

- <http://www.nie.edu.sg/centre-international-comparative-studies/trends-international-mathematics-and-science-study-timss-2011>
- <http://timss.bc.edu/timss 2011>



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