Engaging in Kyozaikenkyu through the lens of TIMSS

Singapore Lesson Study Symposium 2013:
Improving Teaching and Learning through Lesson Study

6 June 2013

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What is Kyozaikenkyu?

What is TIMSS?

What is the relationship between them?

What is their connection to Lesson Study?

Why should we care?

Important Ingredients for Preparing an Effective Lesson: Responses from 3:30 session

- knowing what to teach; content knowledge
- Knowing your students
- Pedagogy
- Assessment
- Resources needed
- Objectives of the lesson
- Time and space
- Ability to anticipate student response
- Designing appropriate questions
- Feedback of students followed by review

Important Ingredients for Preparing an Effective Lesson: Responses from 1:30 session

- Learning needs of students
- Determining what is to be taught/learned
- Assessment of learning
- Activate pupils' prior knowledge
- Lesson objectives
- Pedagogy
- Trying to make it joyful and fun
- Making connections to real-life experience
- Curriculum endpoint

Important Ingredients for Preparing an Effective Lesson

- ***Subject content knowledge***
- ***Subject pedagogical knowledge***
- ***Knowledge about students' thinking and learning process***
- ***Clear goals and outcomes***

Kyozaikenkyu 教材研究
(Instructional Material Investigation)

- *Studying:*
  - *– Subject content and the scope and sequence (standards, textbooks, teacher's manuals, etc.)*
  - *– Instructional tools and manipulatives*
  - *– Student learning (state of learning, process of thinking & understanding, misunderstanding)*
- *Establishing:*
  - *– Clear understanding of the goals and outcomes*
- *Developing:*
  - *– Instruction, instructional materials, learning activities, and manipulatives to help students to achieve the goals*

What Do Japanese Teachers Say About Kyozaikenkyu?

"Teachers can provide the richness of learning experiences for the students in the classroom only up to the level of their understanding of the instructional materials, so it is important for the teachers to carry out kyozaikenkyu every day through classroom practice."

Ways in which Chinese Teachers Deepen their Mathematics Content Knowledge

- ***Study instructional materials intensively***
- ***Learn from other teachers***
- ***Solve problems together***
- ***Learn from students***
- ***Teach round-by-round***

from Liping Ma, *Knowing and Teaching Elementary Mathematics*

Lesson Study Cycle

1. *STUDY*

Study instructional materials, standards, assessment items
Consider long-term goals for student learning and development
(***kyozaikenkyu***)

2. *PLAN*

Select research lesson
Anticipate student thinking
Plan data collection and lesson

3. *CONDUCT RESEARCH LESSON*

One team member teaches,
others, including outside observer(s), collect data

Assessment for learning!

4. *DISCUSS AND REFLECT*

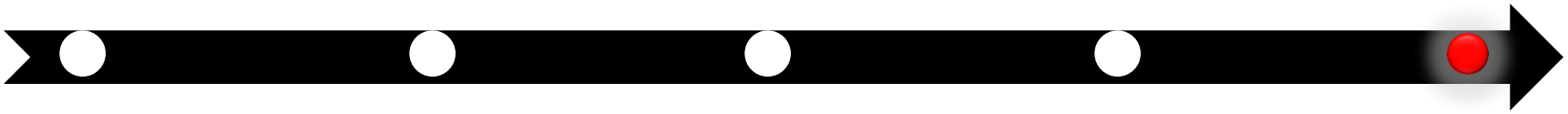
Share and discuss data:
What was learned about student thinking?
What are implications for this unit
and more broadly?
What learning and new questions do we
want to carry forward in our work?

Conducting Kyozainkenkyu During Lesson Study

- ***Lesson Study* enhances the level of investigation:**
  - ✓ ***Collaboration helps deepen understanding of the 'instructional materials'***
  - ✓ ***Teachers can grow together by sharing and comparing different points of views***

What is TIMSS?

- *Trends in International Mathematics and Science Study (TIMSS)*
- *4th and 8th grade mathematics and science assessment*



1995 1999* 2003 2007 2011

**In 1999, no grade 4 assessment*

TIMSS Participating Education Systems (in either/both grades)

74 Education Systems

2011

TIMSS 2011 Mathematics Framework

	TIMSS Mathematics
Content dimensions	**Grade 4** **Number** **Geometric Shapes and Measures** **Data Display** **Grade 8** **Number** **Algebra** **Geometry** **Data and Chance**
Cognitive dimensions	**Knowing** **Applying** **Reasoning**

Using TIMSS to:

Examine student learning

- ✓ *state of learning*
- ✓ *process of thinking & understanding*
- ✓ *misunderstanding*

"…asking of questions by teachers as a central starting point."
"U.S. Lesson Study: challenge of taking on researcher stance."

Lynn Paine (6 June 2013)

Where do questions originate?

Generating questions and "taking on researcher stance" with kyozaikenkyu

through TIMSS

TIMSS Grade 4: ACROSS CONTENT AREAS

Country	Aver.	Number	Geom. Shapes & Measurement	Data Display
C. Taipei	591	+8	–19	+9
HK SAR	602	+3	+3	–8
Japan	585	–1	+4	+4
S. Korea	605	+1	+2	–2
Singapore	606	+13	–17	–18
England	542	–3	+3	+7
U.S.	541	+2	–6	+4

TIMSS Grade 8: ACROSS CONTENT AREAS

Country	Aver.	Number	Algebra	Geometry	Data/Chance
C Taipei	609	–12	+19	+16	–25
HK SAR	586	+2	–3	+11	–5
Japan	570	–13	0	+16	+9
S. Korea	613	+5	+4	–1	+3
Singapore	611	0	+3	–2	–4
U.S.	509	+5	+3	–24	+18
England	507	+5	–17	–9	+36

TIMSS 2011 Grade 4: MATHEMATICS COGNITIVE DOMAIN

Country	Aver.	Knowing	Applying	Reasoning
C Taipei	609	+2	+5	0
HK SAR	602	+17	–4	–13
Japan	585	+5	–6	+6
S. Korea	605	+9	–5	–2
Singapore	606	+23	–4	–18
England	542	+10	0	–11
U.S.	541	+15	–2	–15

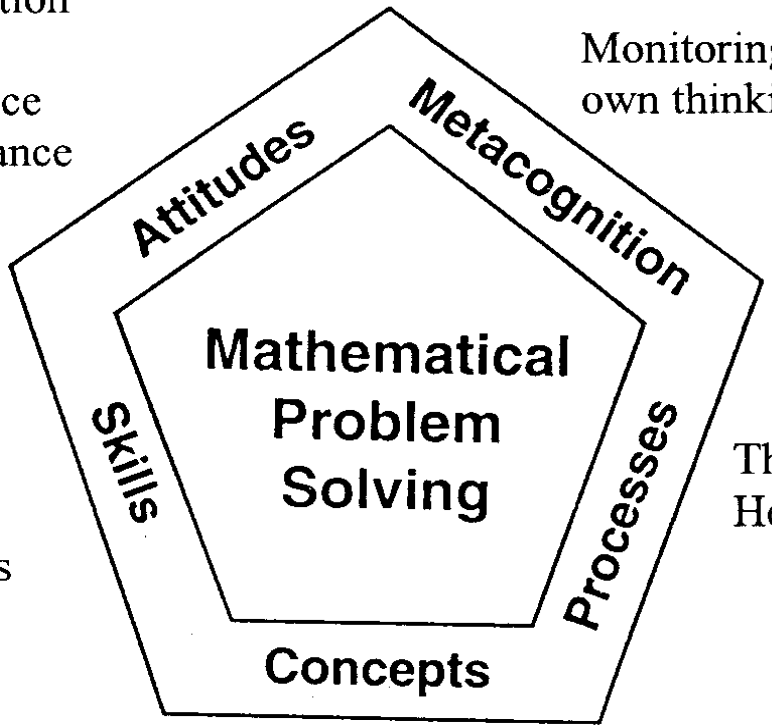
TIMSS Grade 8:
MATHEMATICS COGNITIVE DOMAIN–2011

Country	Aver.	Knowing	Applying	Reasoning
C Taipei	609	+2	+5	0
HK SAR	586	+5	+1	–6
Japan	570	–12	+4	+9
S. Korea	613	+3	+4	–1
Malaysia	440	+4	–21	–14
Singapore	611	+6	+2	–7
U.S.	509	+10	–6	–6
England	507	–5	+2	+3

Singapore Mathematics Pentagonal Framework

Appreciation
Interest
Confidence
Perseverance

Monitoring one's own thinking



Estimation and
Approximation
Mental calculation
Communication
Use of mathematical tools
Arithmetic manipulation
Algebraic manipulation
Handling data

Thinking skills
Heuristics

Numerical
Geometrical
Algebraic
Statistical

TIMSS 2011 Science Framework

	TIMSS Science
Content dimensions	**Grade 4** Earth science Life science Physical science **Grade 8** Biology Chemistry Earth science Physics
Cognitive dimensions	Knowing Applying Reasoning

TIMSS Grade 4: ACROSS CONTENT AREAS

Country	Aver.	Life Sci.	Physical Sci.	Earth Sci.
C. Taipei	552	–14	+17	+1
HK SAR	535	–11	+4	+13
Japan	559	–19	+30	–7
S. Korea	587	–16	+10	+16
Singapore	583	+14	+15	–42
U.S.	544	+3	0	–5
England	529	+1	+7	–7

TIMSS Grade 8:

ACROSS CONTENT AREAS

Country	Aver.	Biology	Chemistry	Physics	Earth Science
C. Taipei	564	+4	0	–11	+5
HK SAR	535	0	–9	+4	+4
Japan	558	+3	+2	0	–9
S. Korea	560	+1	–9	+16	–13
Singapore	590	+4	0	+12	–24
England	533	0	–4	0	+3
U.S.	525	+6	–5	–11	+9

TIMSS 2011 Grade 4: SCIENCE COGNITIVE DOMAIN

Country	Aver.	Knowing	Applying	Reasoning
C Taipei	552	–10	+1	+16
HK SAR	535	+2	–6	+6
Japan	559	–21	+4	+33
S. Korea	587	–17	+7	+18
Singapore	583	–13	+6	+13
U.S.	544	+2	0	–7
England	529	0	+4	–2

TIMSS Grade 8:
Science COGNITIVE DOMAIN–2011

Country	Aver.	Knowing	Applying	Reasoning
C. Taipei	564	+5	+6	–13
HK SAR	535	+9	–6	+3
Japan	558	–17	+3	+10
S. Korea	560	–7	+1	+3
Singapore	590	–2	–1	+2
England	533	0	–2	+4
U.S.	525	+3	–2	–1

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Assessment for learning!

Grade 4: Public Release Items

Grade 4: Number; Applying

Joan had 12 apples. She ate some apples, and there were 9 left. Which number sentence describes what happened?

Ⓐ $12 + 9 = \square$

Ⓑ $9 = 12 + \square$

Ⓒ $12 - \square = 9$

Ⓓ $9 - \square = 12$

Highest score: 98% *Korea, Rep. of*

International average: 78%

Chinese Taipei: 96%

Japan: 94%

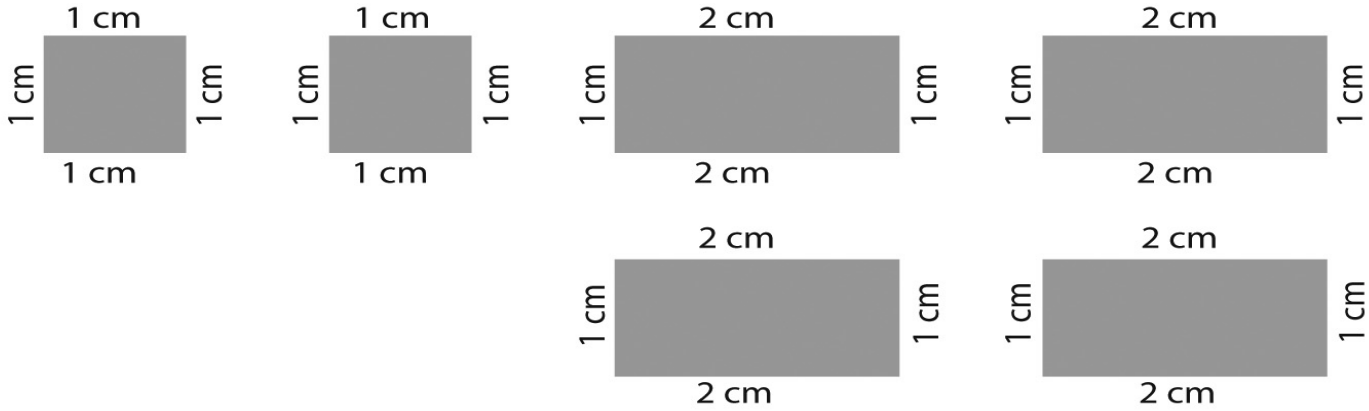
U.S.: 92%

Singapore: 91%

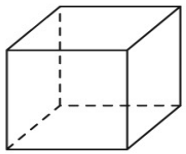
Hong Kong: 91%

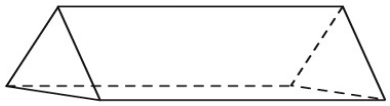
England: 84%

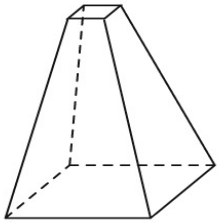
Grade 4: Geometric Shapes and Measures; Knowing

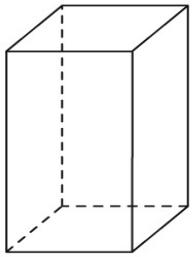


Susan has the 6 pieces of cardboard shown above. Which of the following shapes could Susan make using all 6 of these pieces without cutting them?

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

Highest score: 93% *Portugal*

International average: 69%

Hong Kong: 92%

Japan: 90%

Singapore: 88%

Korea, Rep. of: 85%

Chinese Taipei: 84%

U.S.: 83%

England: 78%

Grade 4: Data Display; Reading and Interpreting; Knowing

Favorite Ice Cream Flavors

Flavor	Number of Children
Vanilla	
Chocolate	
Strawberry	
Lemon	

 stands for 4 children

How many children chose vanilla as their favorite flavor?

Answer: _____

Highest score: 93% *Singapore*

International average: 54%

U.S.: 86%

Hong Kong: 84%

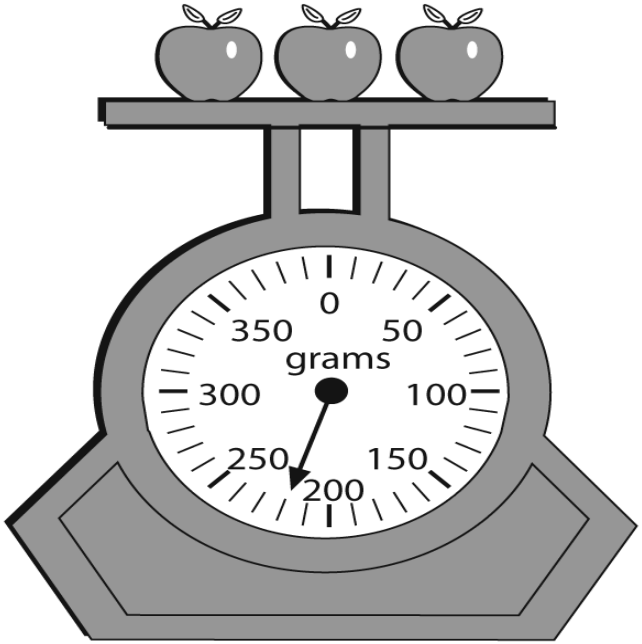
Korea, Rep. of: 84%

Chinese Taipei: 79%

Japan: 78%

England: 78%

Grade 4: Data Display; Reading and Interpreting; Knowing



How much do the apples weigh in grams?

Ⓐ 200

Ⓑ 202

Ⓒ 210

Ⓓ 220

Highest score: 90% *Korea, Rep. of, Singapore*

International average: 56%

Hong Kong: 89%

Japan: 88%

Chinese Taipei: 87%

England: 77%

U.S.: 66%

Grade 4: Number; Fractions and Decimals; Knowing

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?

Answer: _____

Highest score: 84% *Singapore*

International average: 23%

Chinese Taipei: 54%

Hong Kong: 53%

England: 51%

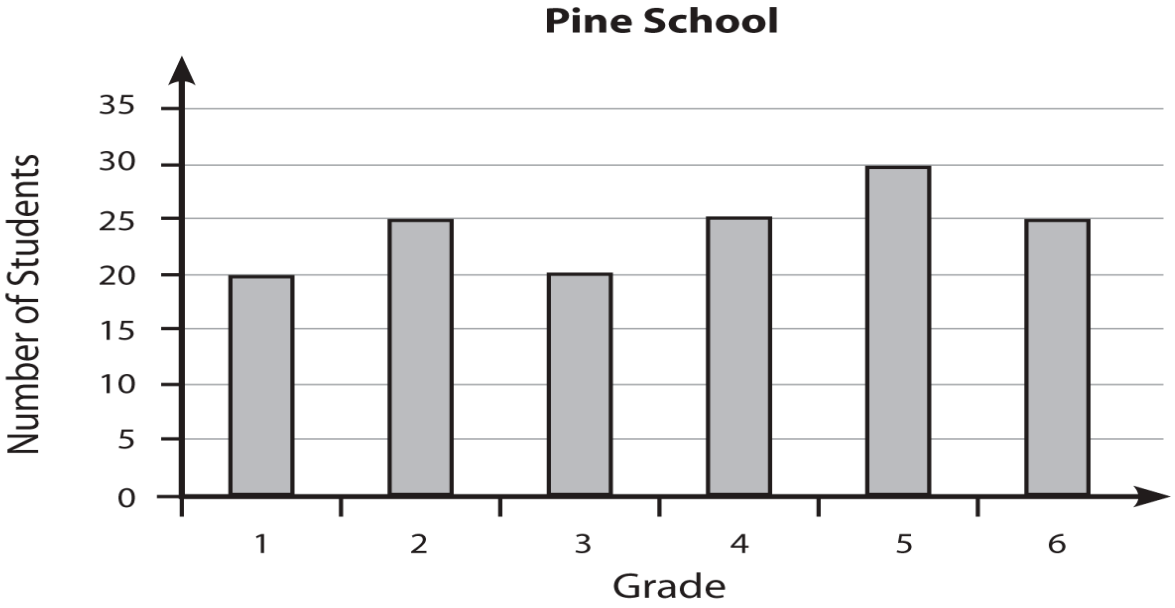
Korea, Rep. of: 36%

U.S.: 35%

Japan: 28%

Grade 4: Data Display; Reading and Interpreting; Reasoning

The graph shows the number of students at each grade in the Pine School.



In the Pine School there is room in each grade for 30 students.
How many more students could be in the school?

Ⓐ 20

Ⓑ 25

Ⓒ 30

Ⓓ 35

Highest score: 79% *Chinese Taipei*

International average: 54%

Hong Kong: 78%

Korea, Rep. of: 75%

Singapore: 73%

Japan: 71%

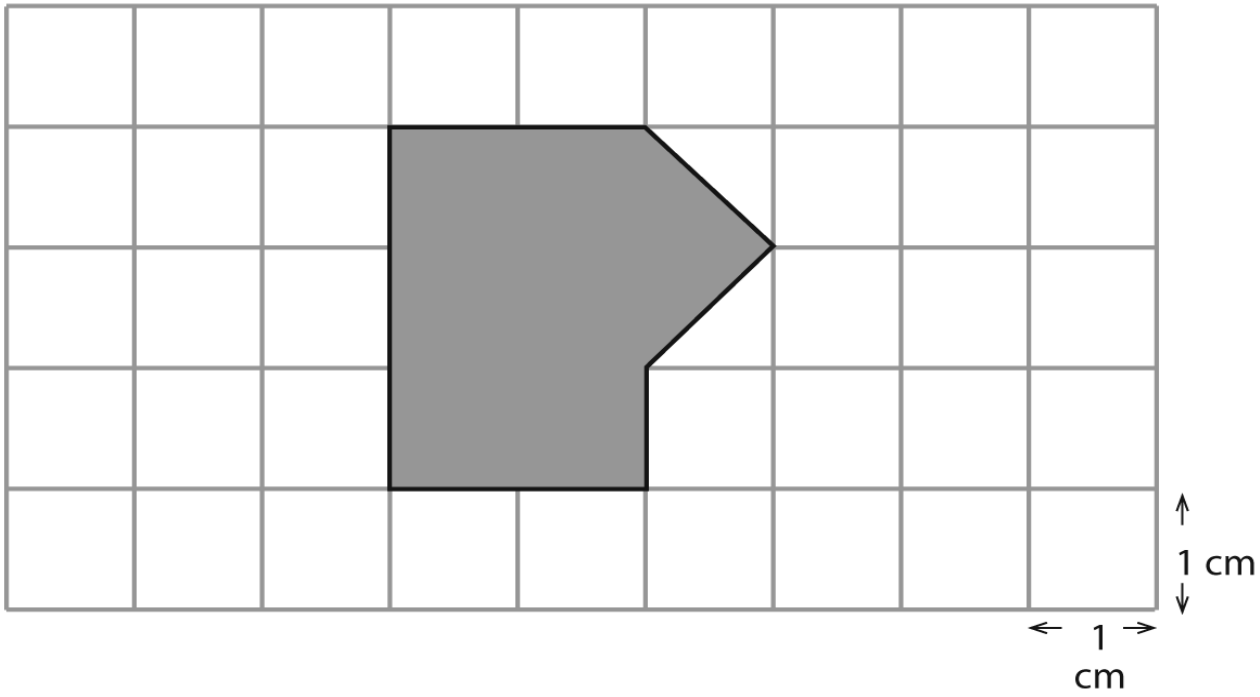
England: 65%

U.S.: 63%

Responses

Country	20	25	30	35*
C. Taipei	5.2%	5.3%	10%	78.7%
Hong Kong	5.1	5.6	10.1	78.3
S. Korea	1.5	4.1	18.2	74.9
Singapore	6.6	9.2	11.2	72.7
Japan	6.5	7.4	13.8	70.7
U.K.	6.2	8.5	18.0	65.4
U.S.	8.2	9.2	17.0	62.9

Grade 4: Geometric shapes and measures; 2- and 3-D shapes; Applying



The squares in the grid above are 1 cm by 1 cm.
What is the shaded area in square centimeters?

Answer: _____ square centimeters

Highest score: 70% *Japan*

International average: 30%

Hong Kong: 67%

Chinese Taipei: 63%

Korea, Rep. of: 48%

Singapore: 39%

U.S.: 38%

England: 32%

Grade 4: Geometric shapes and measures; 2- and 3-D shapes; Knowing

Figure A

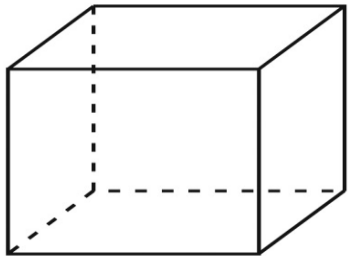
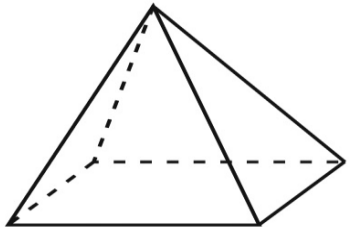


Figure B



Here are some statements about Figure A and Figure B. Put an X to show whether each statement is true or false.

Statement	True	False
A and B both have a square face.	X	
A and B both have the same number of faces.		
All the angles in A are right angles.		
B has more edges than A.		
Some of the edges in B are curved.		

Highest score: 70% (>1 pt. 91%) *Portugal*

International average: 32% (66%)

England: 58% (82%)

Hong Kong: 57% (81%)

Chinese Taipei: 53% (84%)

Japan: 53% (86%)

U.S.: 50% (78%)

Korea, Rep. of: 44% (81%)

Singapore: 41% (76%)

Grade 4: Number; Reasoning

Mary left Apton and rode at the same speed for 2 hours.

She reached this sign.

Mary continues to ride at the same speed to Brandon.

How many hours will it take her to ride from the sign to Brandon?

Highest score: 55% *Kazahkstan*

International average: 43%

Singapore: 50%

Hong Kong: 45%

Chinese Taipei: 44%

Japan: 40%

England: 39%

U.S.: 33%

Grade 4: Number; Knowing

23 *x* 19

http://www.guardian.co.uk/news/datablog/2013/may/31/times-tables-hardest-easiest-children

Highest score: 90% *Chinese Taipei*
(Girls: 90.7%; Boys: 90.0%)

International average: 41%
G: 42.4%; B: 39.4%

Korea, Rep. of: 83% (G: 82.9%; B: 83.4%)

Singapore: 79% (G: 81.1%; B: 77.2%)

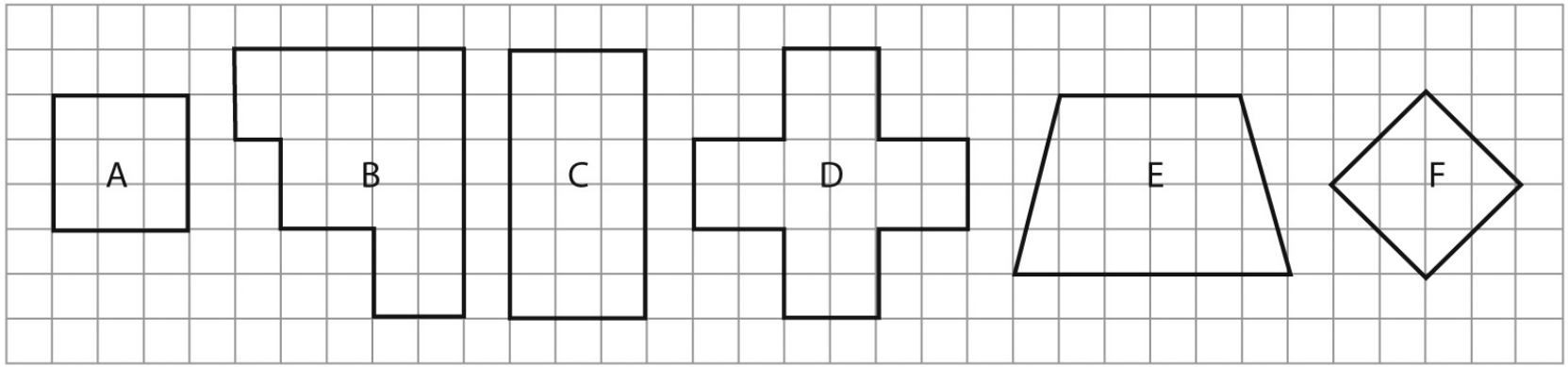
Japan: 78% (G: 80.2%; B: 75.7%)

Hong Kong: 77% (G: 81.4%; B: 73.6%)

U.S.: 59% (G: 62%; B: 55%)

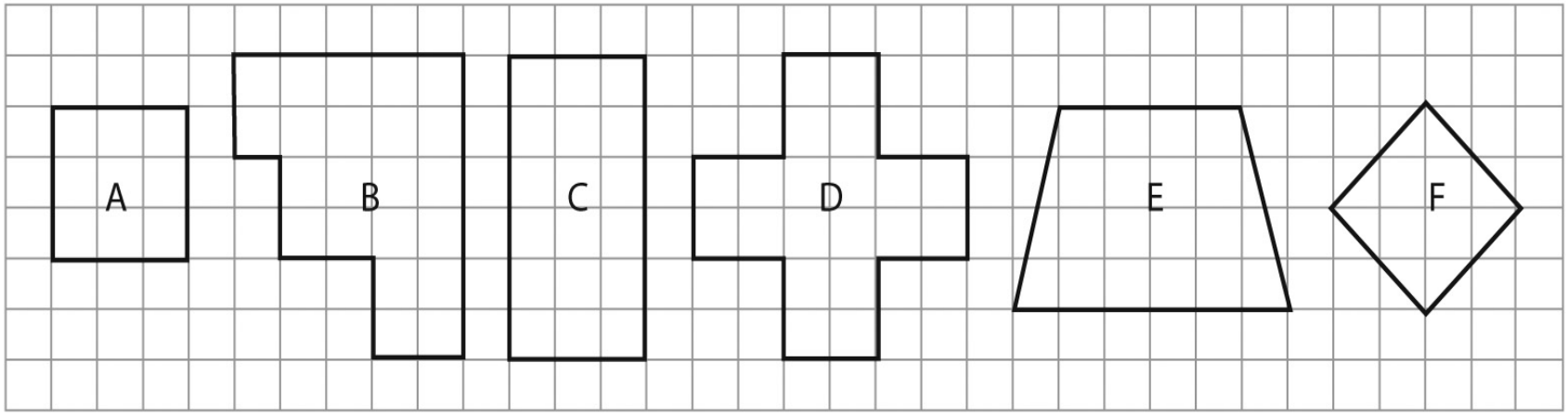
England: 37% (G: 40.4%; B: 34.5%)

Grade 4: Geometric Shapes and Measures; Reasoning



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.

	Has 4 Sides	Does Not Have 4 Sides
All sides are the same length	A	
All sides are NOT the same length		



	Has 4 sides	*Not 4 sides*
All sides the same length	***A, F***	***D***
All sides are NOT the same length	***C, E***	***B***

Highest score: 45%
(>1 pt. 76%)

Northern Ireland

International Average: 15% (>1 pt. 45%)

England: 38% (73%)

HK: 33% (68%)

Japan: 32% (72%)

Korea: 28% (70%)

Chinese Taipei: 26% (62%)

U.S.: 13% (50%)

Singapore: 12% (64%)

Your Conclusions: 1:30 session

- **Work on visualization**
- **Reasoning**
- **Examine experiential learning**
- **Geometry?**

Grade 8: Public Release Items

Grade 8: Algebra; Knowing

What does $xy + 1$ mean?

Ⓐ Add 1 to y, then multiply by x.

Ⓑ Multiply x and y by 1.

Ⓒ Add x to y, then add 1.

Ⓓ Multiply x by y, then add 1.

Highest score: 94% *Hong Kong SAR*

International average: 65%

Korea, Rep. of: 91%

Singapore: 91%

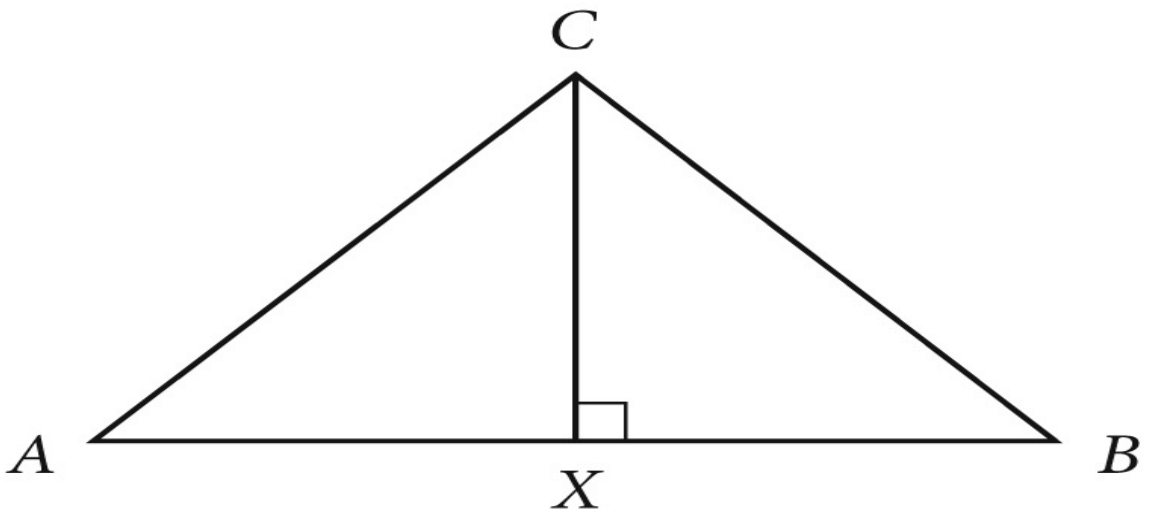
Chinese Taipei: 90%

Japan: 87%

U.S.: 80%

England: 72%

Grade 8: Geometry; Reasoning



In this triangle:

$AC = BC$

AB is twice as long as CX.

What is the size of angle B?

Answer: _____ °

Highest score: 89% *Korea, Rep. of*

International Average: 41%

Japan: 85%

Singapore: 83%

Hong Kong: 72%

Chinese Taipei: 72%

England: 52%

U.S.: 39%

Grade 8:
Numbers; Applying

Which shows a correct method for finding $\frac{1}{3} - \frac{1}{4}$?

Ⓐ $\frac{1-1}{4-3}$

Ⓑ $\frac{1}{4-3}$

Ⓒ $\frac{3-4}{3\times 4}$

Ⓓ $\frac{4-3}{3\times 4}$

C. Highest score: 86% *Korea, Rep. of*

International average: 37%

Singapore: 83%

Chinese Taipei: 82%

Hong Kong: 77%

Japan: 65%

U.S.: 29%

England: 28%

Responses

Country	A	B	C	D*
Korea	2.7%	6.9%	4.2%	86.0%
Singapore	4.8	5.5	6.5	83.1
Taipei	2.9	7.7	7.0	82.0
Hong Kong	4.0	8.7	10.0	77.0
Japan	15.4	11.1	8.2	65.3
England	24.5	32.8	12.4	28.2
U.S.	32.5	26.1	10.7	29.1
Finland	42.3	29.5	8.7	16.1

Grade 8:
Numbers; Applying

Which shows a correct method for finding $\frac{1}{3} - \frac{1}{4}$?

Ⓐ $\frac{1-1}{4-3}$

Ⓑ $\frac{1}{4-3}$

Ⓒ $\frac{3-4}{3\times 4}$

Ⓓ $\frac{4-3}{3\times 4}$

Grade 8: Geometry; Applying

The length of side of each of the small squares represents 1 cm. Draw an isosceles triangle with a base of 4 cm and a height of 5 cm.

Highest score: 85% *Japan*

International average: 48%

Korea, Rep. of: 84%

Hong Kong: 82%

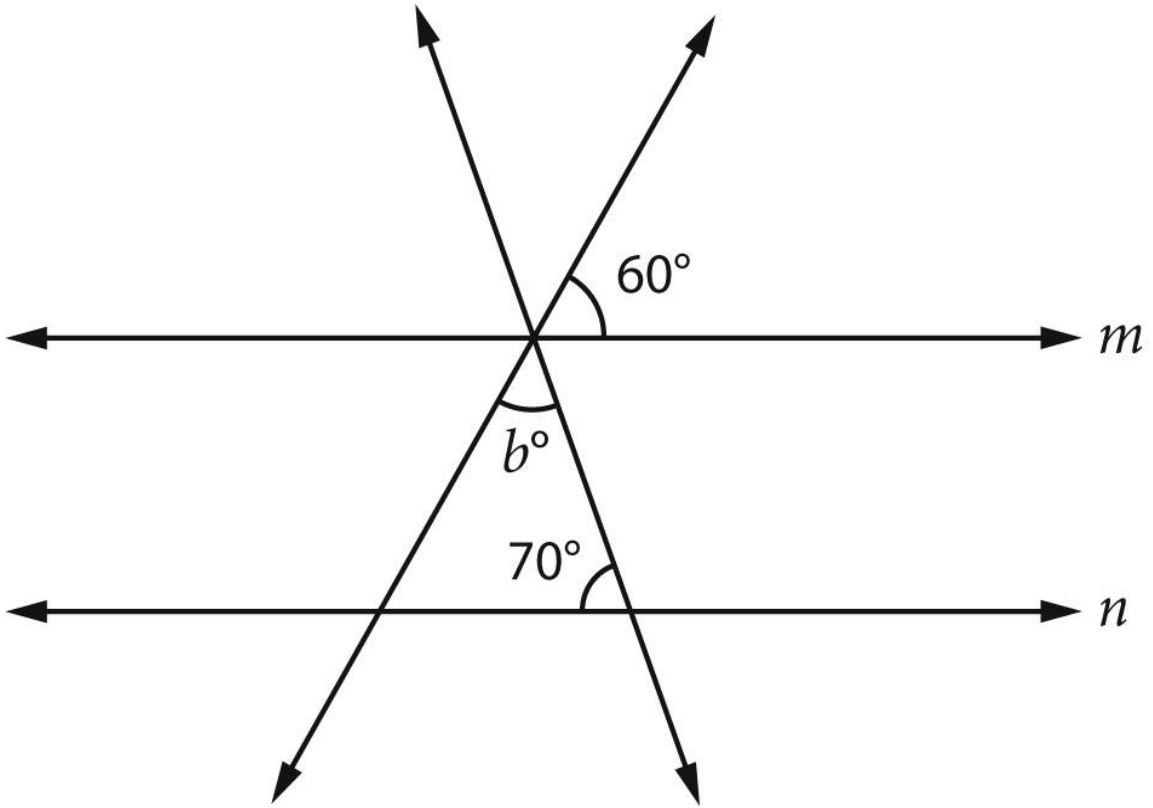
Chinese Taipei: 82%

Singapore: 72%

England: 40%

U.S.: 27%

Grade 8: Geometry; Reasoning



Lines m and n are parallel.

What is the value of b?

Highest score: 86% *Japan*

International Average: 33%

Korea, Rep. of: 85%

Singapore: 80%

Hong Kong: 75%

Chinese Taipei: 49%

England: 30%

U.S.: 24%

Grade 8:
Numbers; Fractions/Decimals; Reasoning

P and Q represent two fractions on the number line above.

$P \times Q = N$.

Which of these shows the location of N on the number line?

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

Highest score: 53% *Chinese Taipei*

International average: 23%

Hong Kong: 47%

Singapore: 45%

Korea, Rep. of: 44%

Japan: 43%

England: 29%

U.S.: 22%

Desired Outcome of Lesson Study

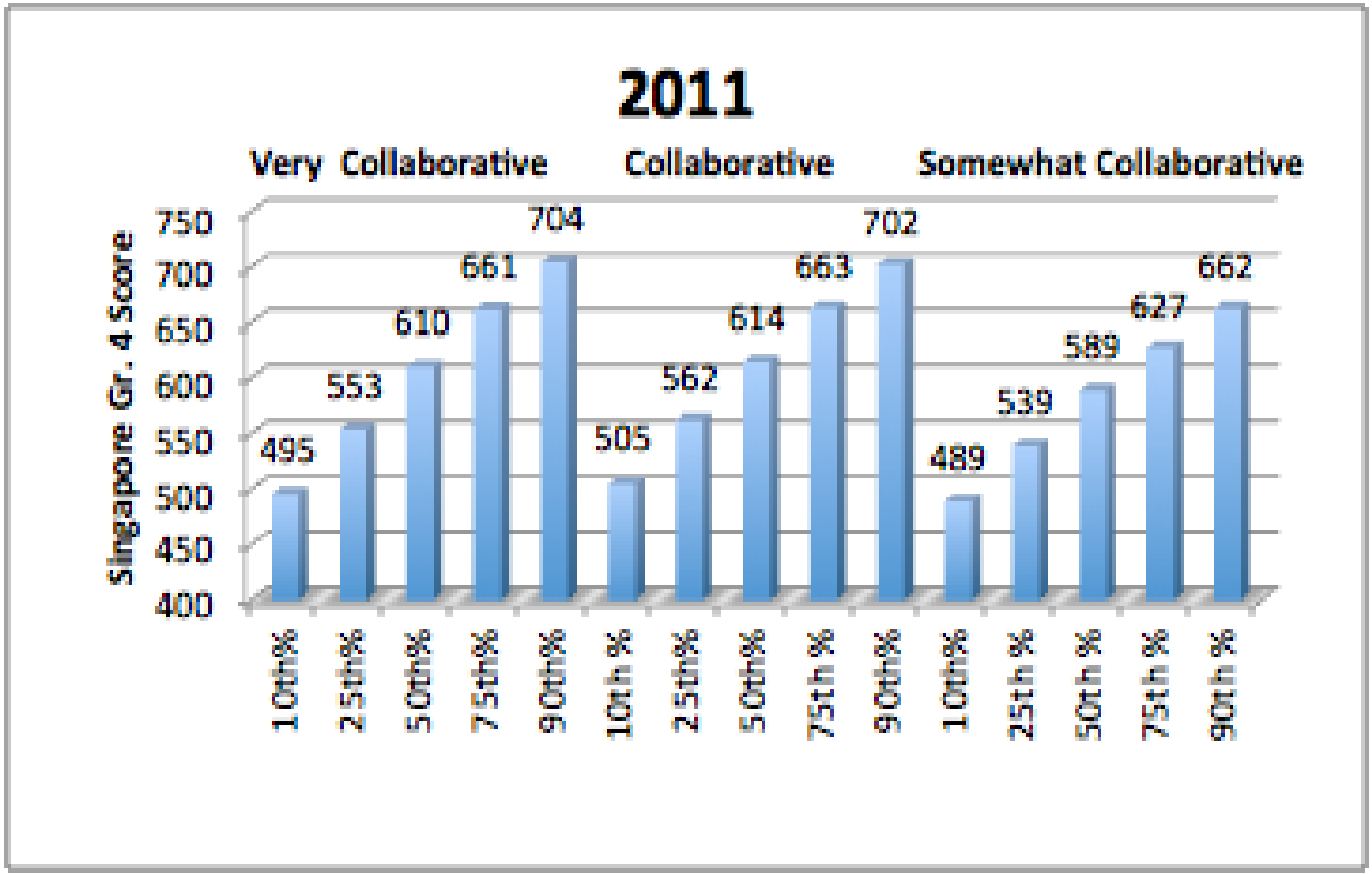
Where teachers and students are the agents of change, not the objects of change.

Assessing Effectiveness of Teacher Collaboration through the Lens of TIMSS

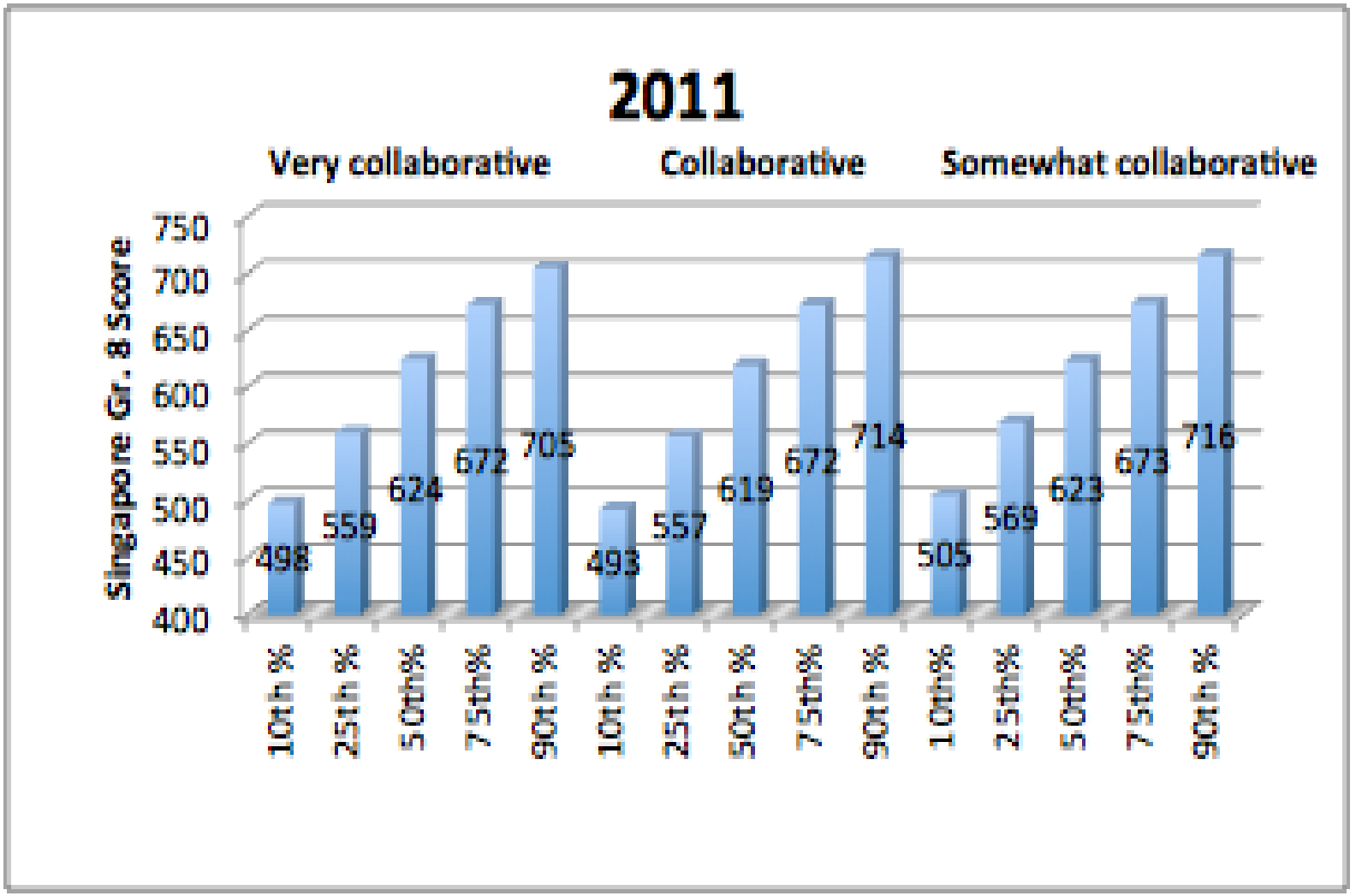
with the International Data Explorer:

http://nces.ed.gov/surveys/international/ide/

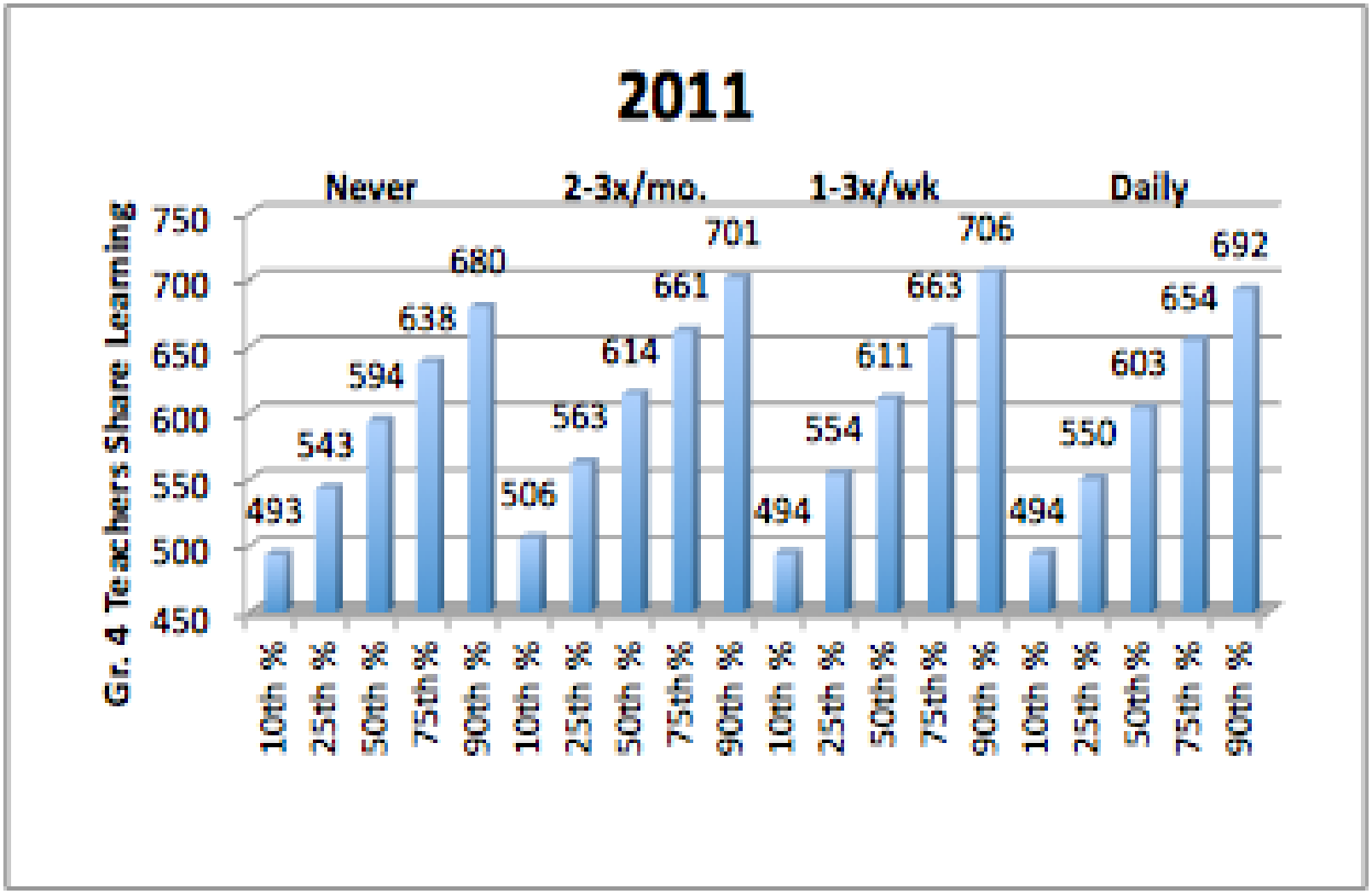
Effect of Teacher Collaboration on Gr. 4 Student Performance



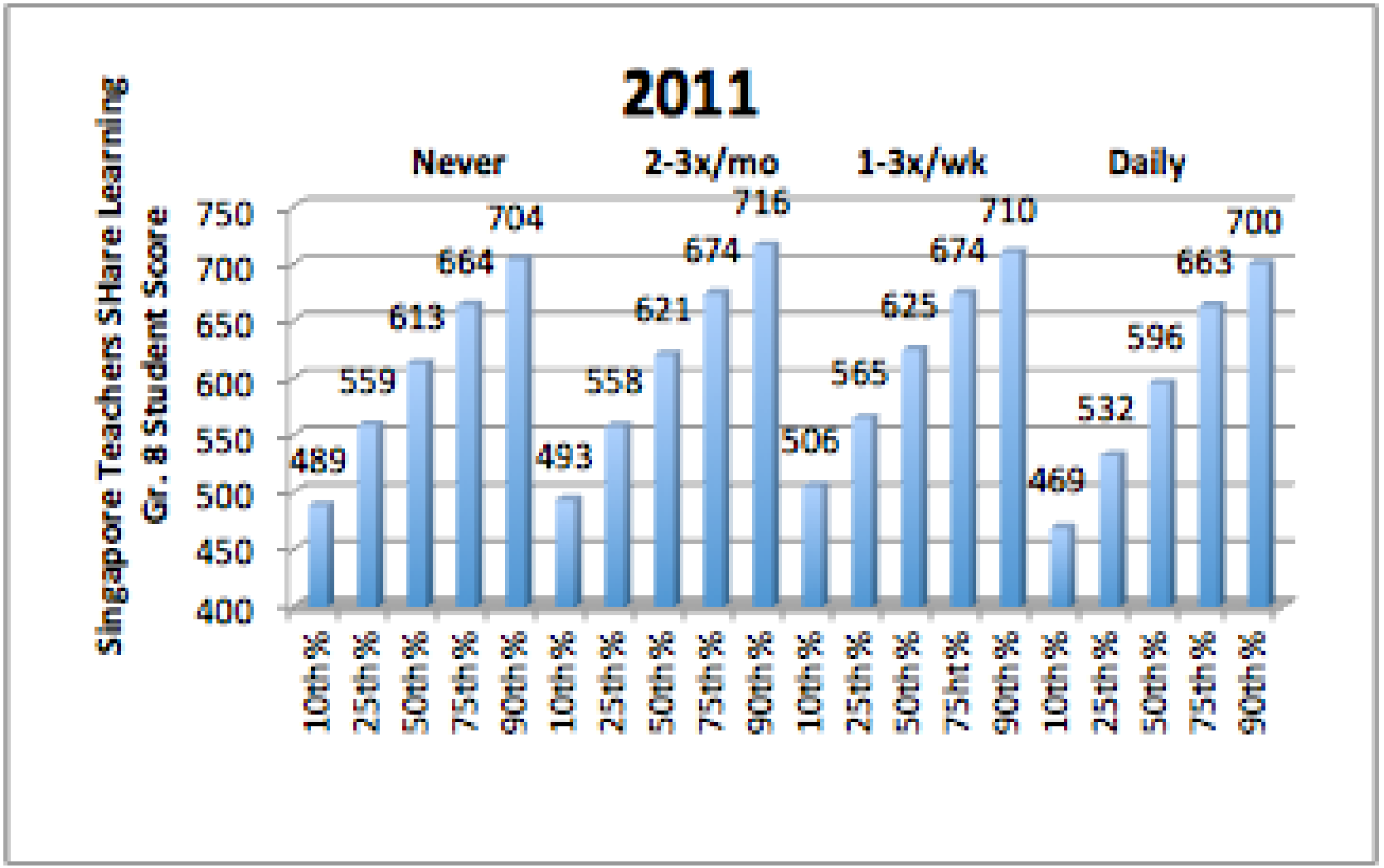
Effect of Teacher Collaboration on Gr. 8 Student Performance



Gr. 4 Student Performance vs. Teachers Sharing Learning

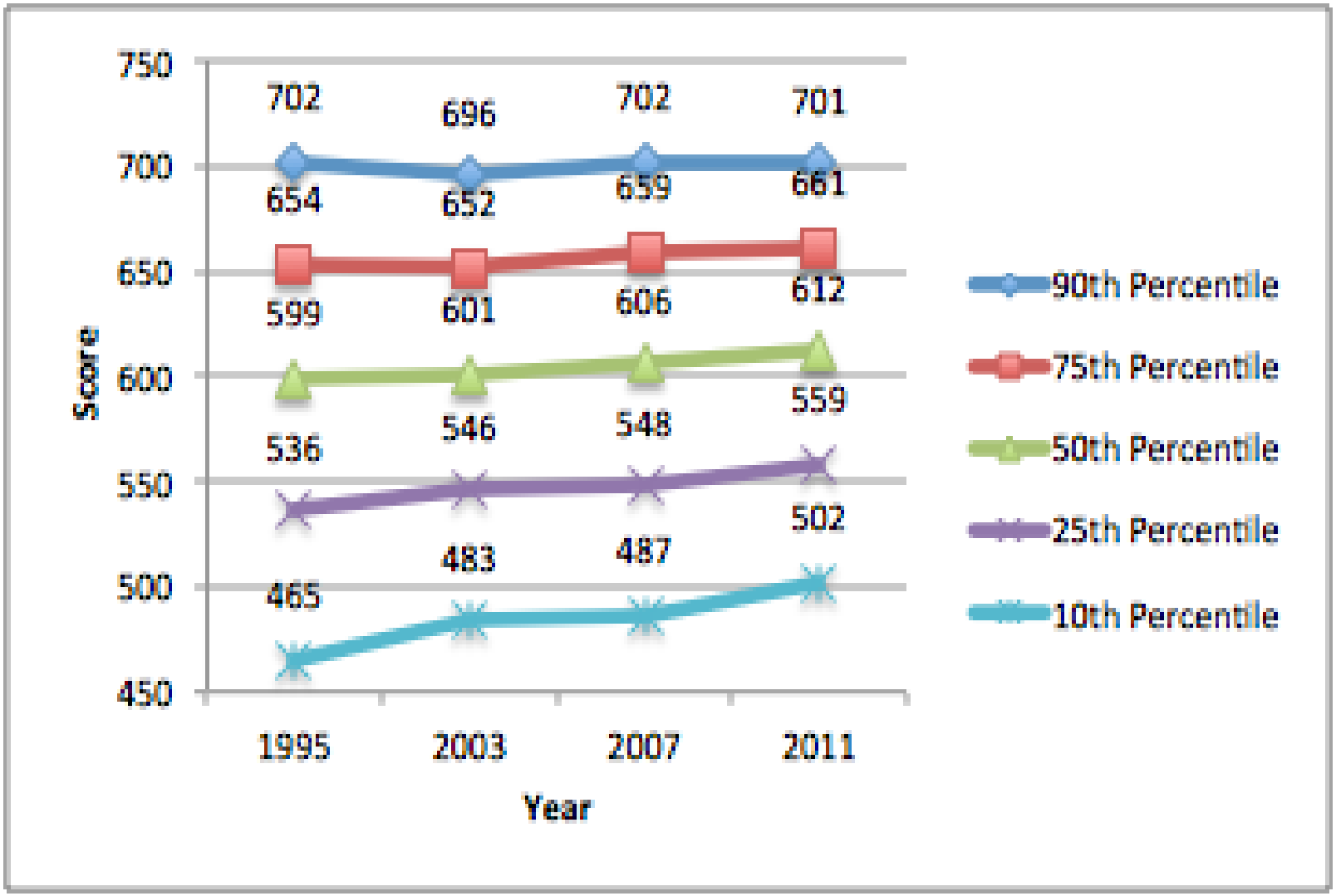


Gr. 8 Student Performance vs. Teachers Sharing Learning



Examining the trends in Singapore student performance across the years

Singapore Grade 4 Math Scores At Selected Percentiles

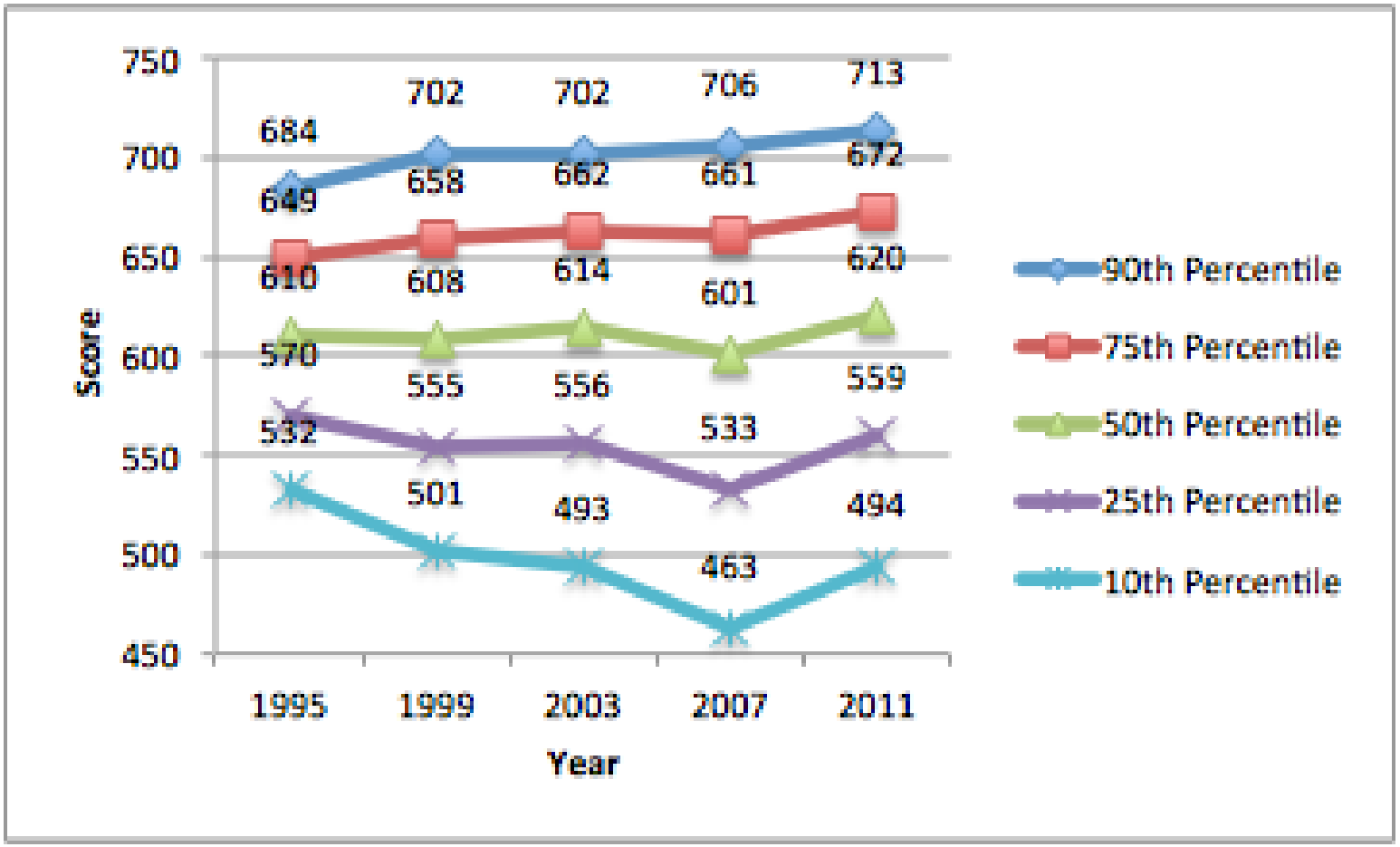


International Comparison of Gap Score between Gr. 8 Low/High Performing Students in 1995, 1999, 2011

Grade 8

Score-point gap between bottom 10th and top 90th percentiles	Mathematics (TIMSS 1995)	Mathematics (TIMSS 1999)	Mathematics (TIMSS 2011)
Less than 150			
150 to 175	Singapore (152)		
176 to 200	Hong Kong-Chinese (198) Japan (198)	Hong Kong-Chinese (181)	**United States (198)**
201 to 225	**International Average (201)** Thailand (201) New Zealand (211) Australia (212) **United States (214)** Republic of Korea (217)	Japan (201) Singapore (201) Republic of Korea (202) Australia (205) Malaysia (209) **International Average (215)** Thailand (218) **United States (223)**	Japan (216) Indonesia (214) Hong Kong-Chinese (215) Thailand (218) Singapore (219) Australia (221) New Zealand (223)
226 to 250		New Zealand (229) Philippines (250)	**International Average (228)** Republic of Korea (232) Malaysia (241)
251 to 275		Indonesia (258) Chinese Taipei (266)	Chinese Taipei (275)
more than 276			

Singapore Grade 8 Math Scores At Selected Percentiles



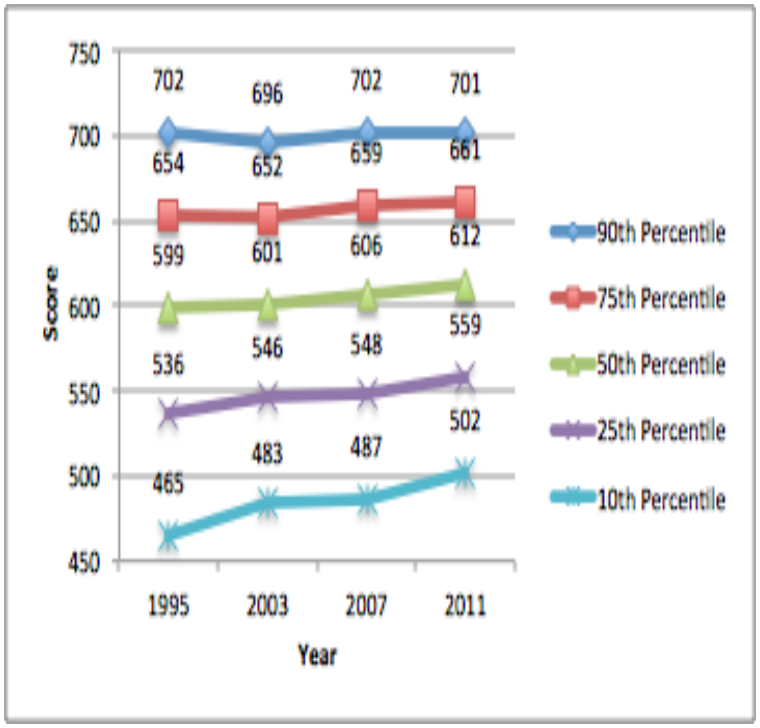
International Comparison of Gap Score between Gr. 8 Low/High Performing Students in Mathematics Overall, Geometry, Algebra

Grade 8

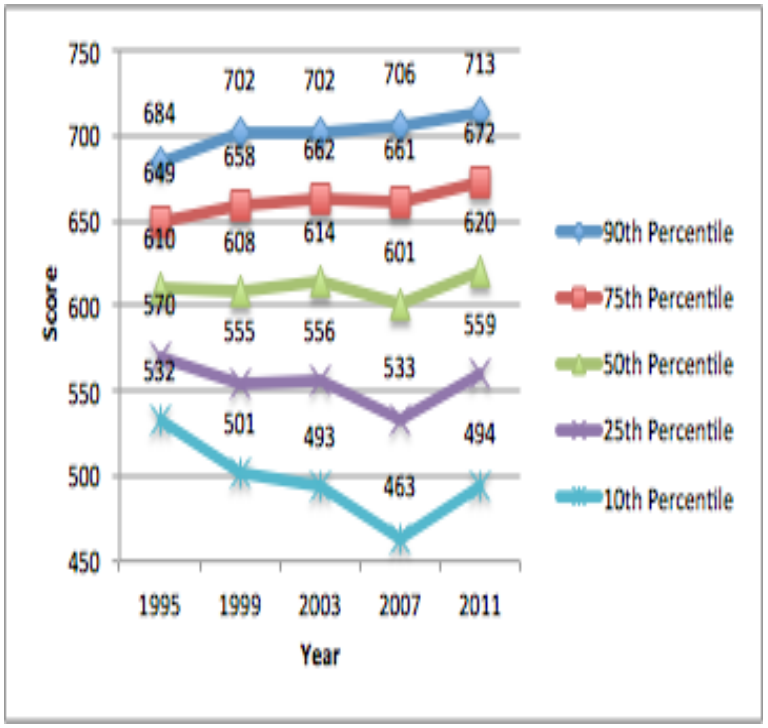
Score-point gap between bottom 10th and top 90th percentiles	Mathematics (TIMSS 2011)	Mathematics (TIMSS 2011) Geometry Subscale	Mathematics (TIMSS 2011) Algebra Subscale
Less than 150			
150 to 175			
176 to 200	Indiana-USA (185) Minnesota-USA (186) Massachusetts-USA (187) Florida-USA (196) **United States (198)** Colorado-USA (200)	Massachusetts-USA (191)	Indiana-USA (183) Minnesota-USA (183) Massachusetts-USA (190) Florida-USA (190) Alabama-USA (191) **United States (192)** California-USA (196)
201 to 225	Alabama-USA (206) California-USA (206) North Carolina-USA (206) Japan (216) Indonesia (214) Hong Kong-Chinese (215) Thailand (218) Singapore (219) Australia (221) Connecticut-USA (222) New Zealand (223)	Japan (206) Colorado-USA (208) **United States (209)** Indiana-USA (209) Florida-USA (211) Singapore (219) California-USA (221) Minnesota-USA (221)	North Carolina-USA (202) Colorado-USA (205) Indonesia (220)
226 to 250	**International Average (228)** Republic of Korea (232) Malaysia (241)	Alabama-USA (226) New Zealand (229) Australia (233) Hong Kong-Chinese (233) North Carolina-USA (233) Connecticut-USA (233) Republic of Korea (234) Thailand (235) **International Average (246)**	Thailand (228) Connecticut-USA (229) New Zealand (229) Australia (230) Hong Kong-Chinese (233) Malaysia (236) Singapore (237) **International Average (241)** Japan (245)
251 to 275	Chinese Taipei (275)	Indonesia (256)	Republic of Korea (280)
more than 276		Malaysia (291) Chinese Taipei (300)	Chinese Taipei (319)

TIMSS: Mathematics

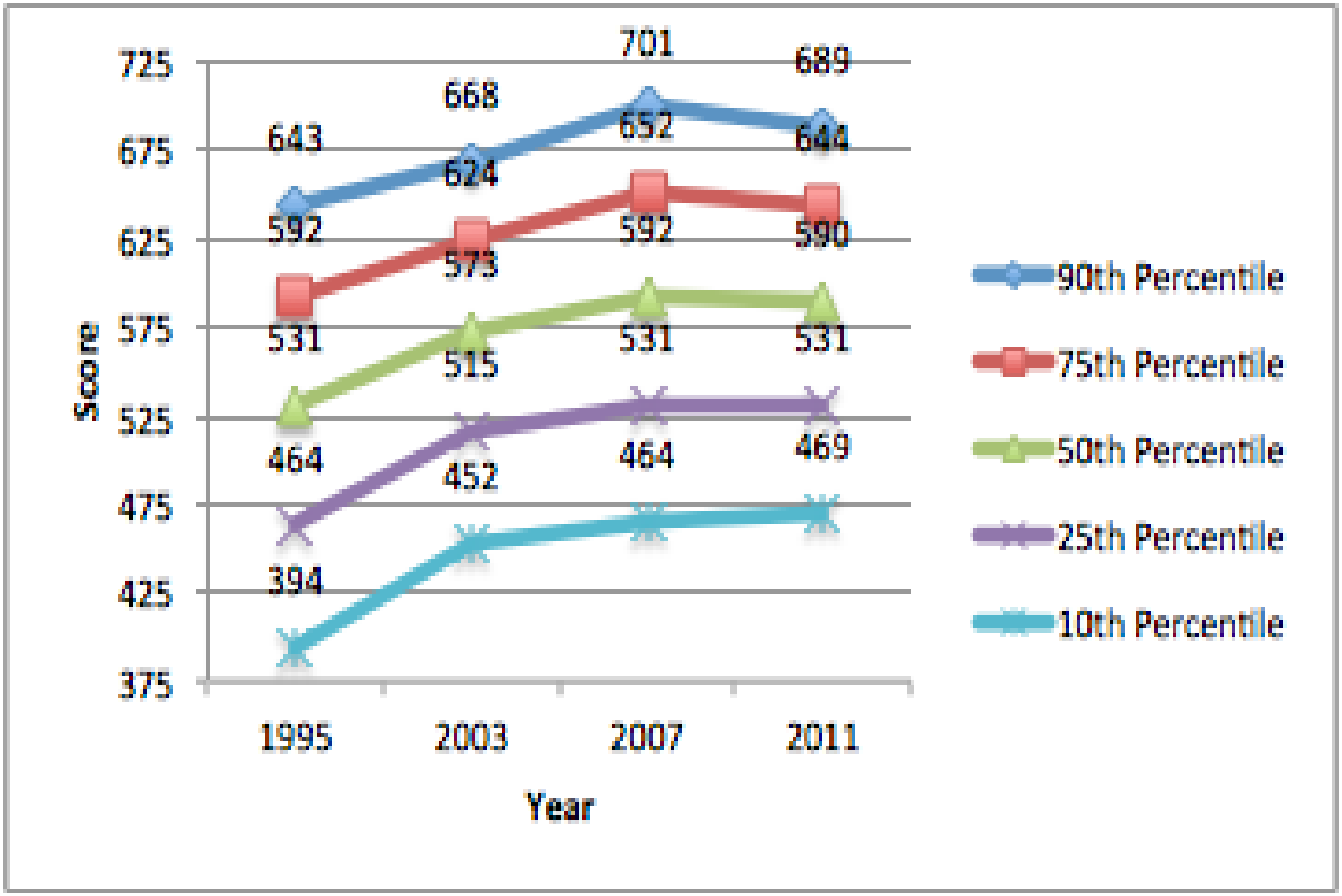
Grade 4



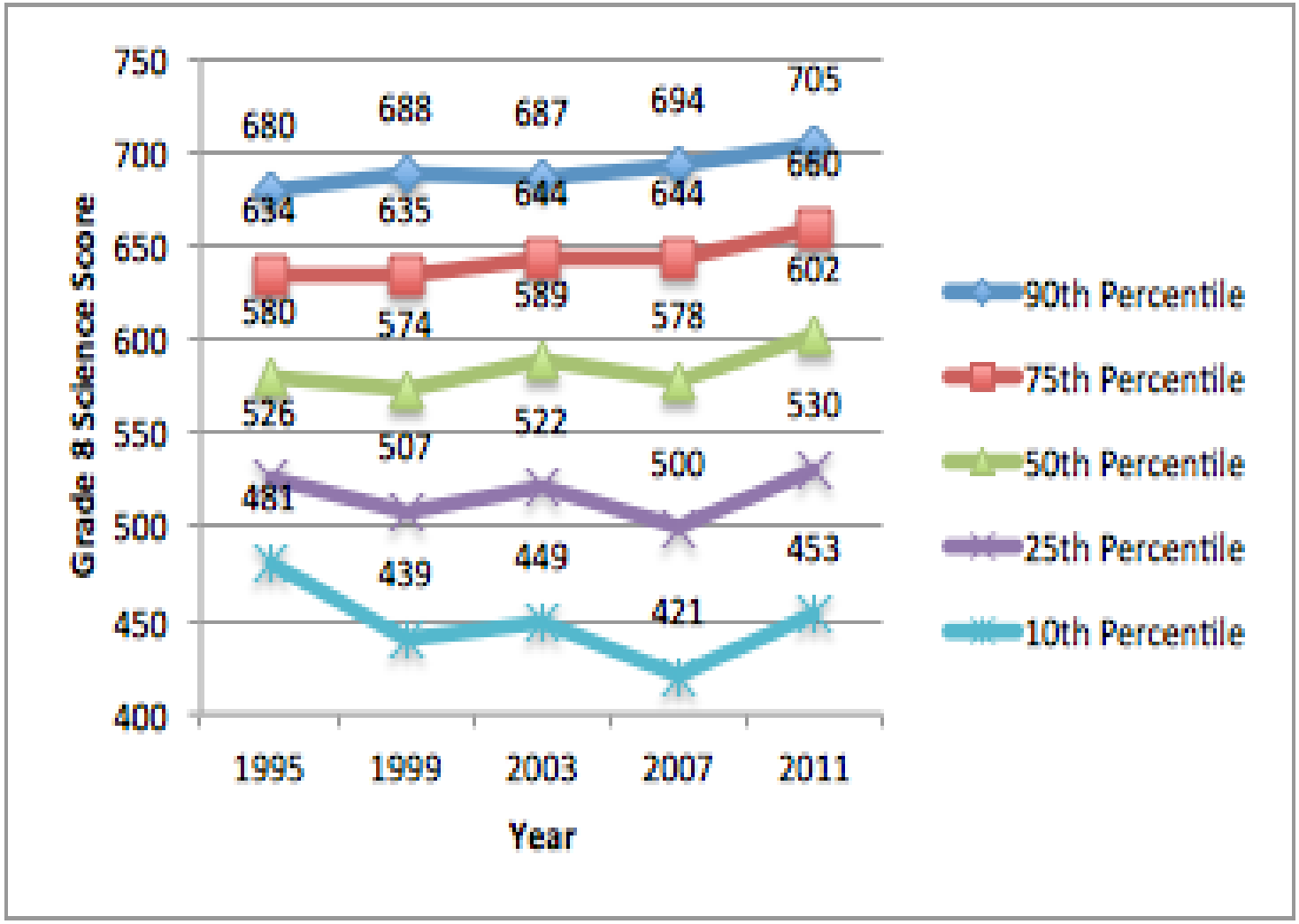
Grade 8



Singapore Grade 4 Science Scores at Selected Percentiles

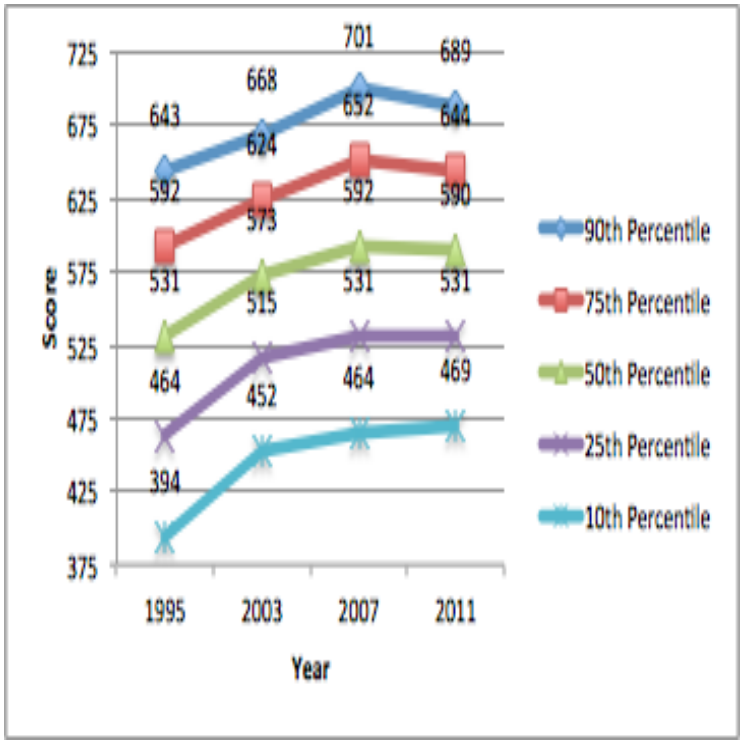


Singapore Grade 8 Science Scores at Selected Percentiles Across the Years

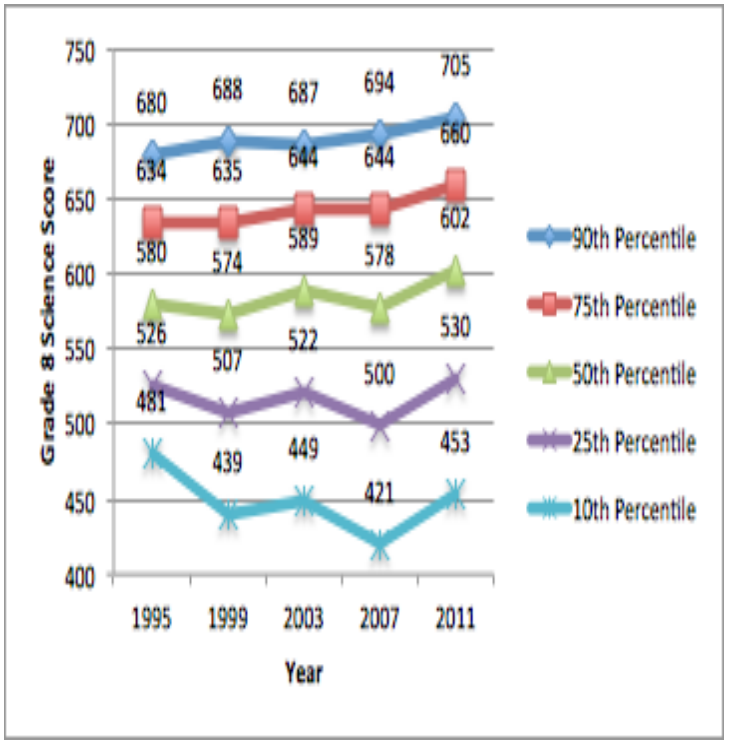


TIMSS: Science

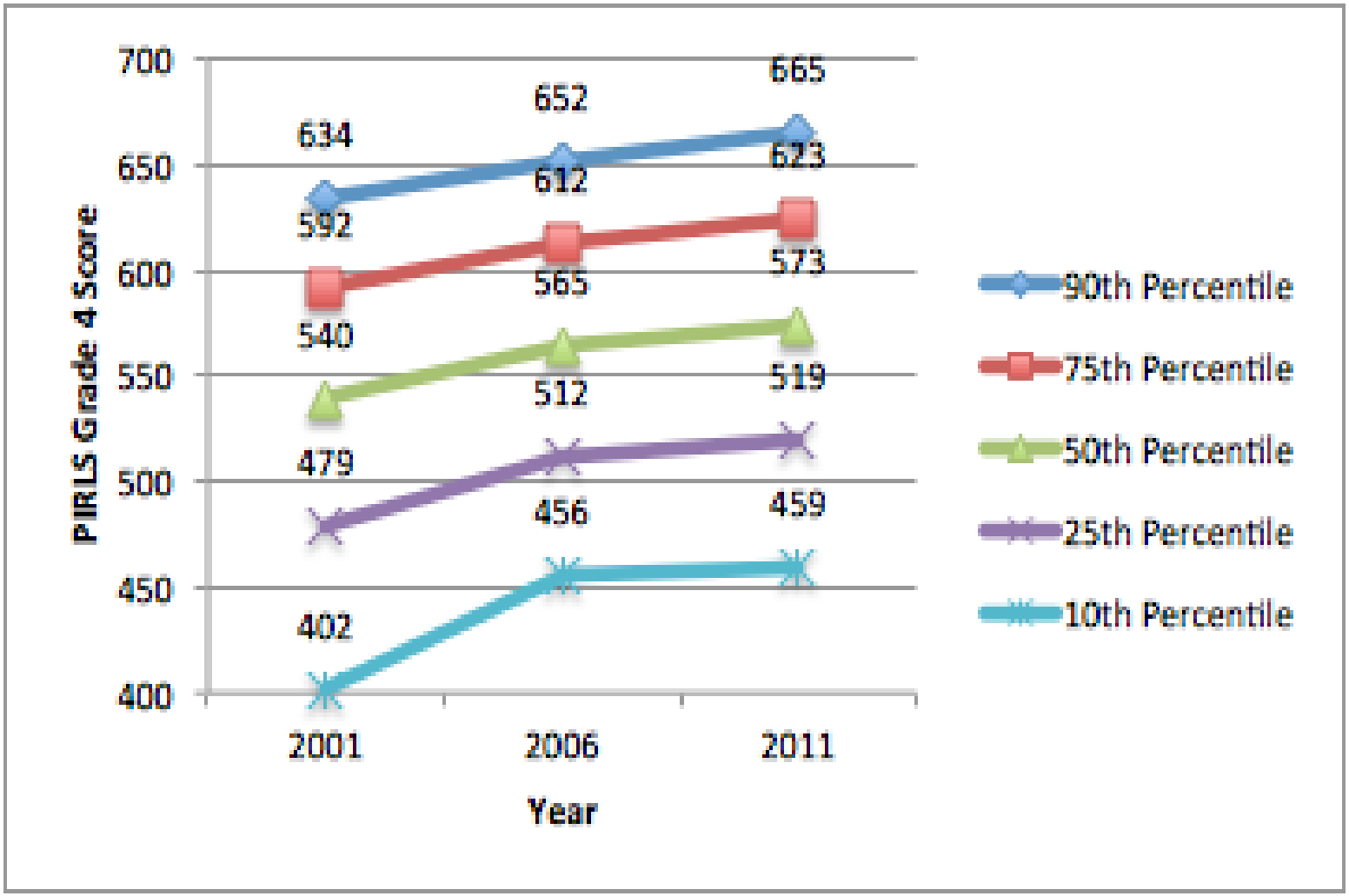
Grade 4



Grade 8

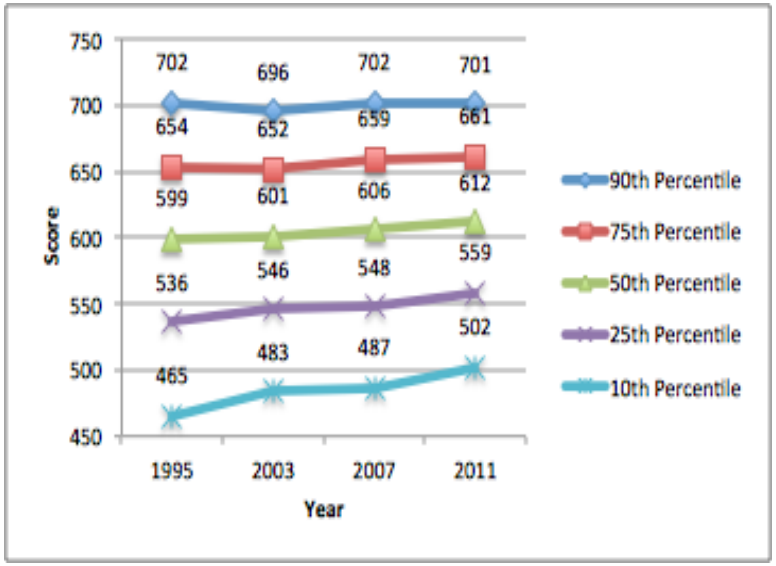


Singapore Gr. 4 Reading Scores at Selected Percentiles Across the Years

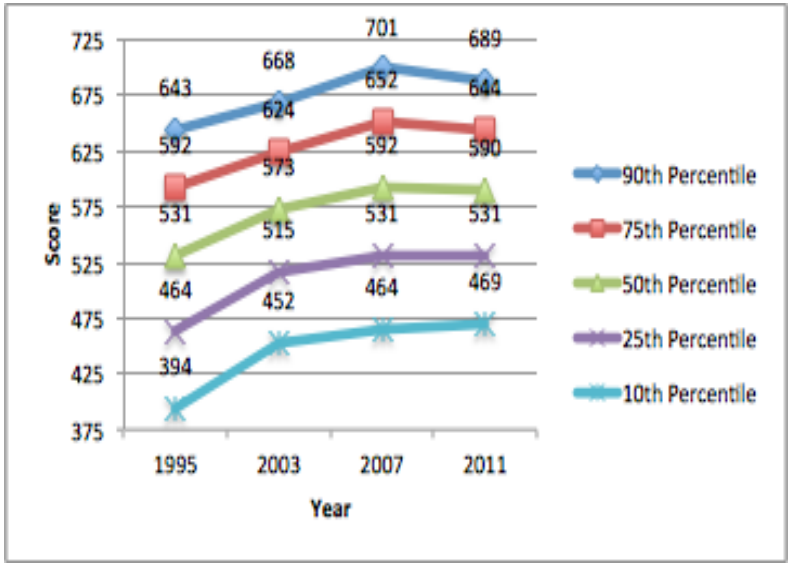


Grade 4

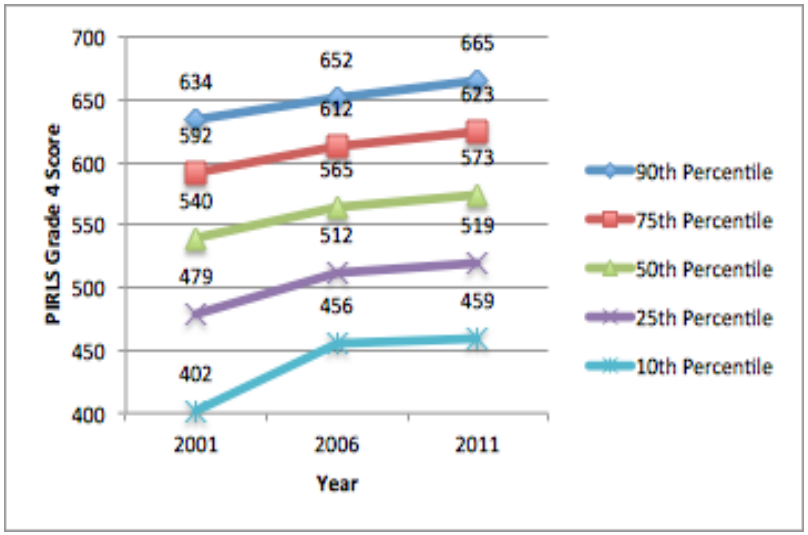
Math



Science



Reading



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TIMSS 2011 Released Items: timssandpirls.bc.edu/timss2011/international-released-items.html

TIMSS 2011 Database:

- **Released Items with % Correct Statistics**
- **Almanacs with Item analysis**

http://timssandpirls.bc.edu/timss2011/international-database.html