Engaging in Kyozaikenkyu through the lens of TIMSS

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

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What is Kyozaikenkyu?

What is TIMSS?

What is the relationship between them?

What is their connection to Lesson Study?
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?
Engaging in kyozaikenkyu

“Investigation of instructional materials”, which encompasses:

• not only textbooks, teacher manuals, mathematics manipulatives

• but also standards, the educational context, learning goals…and ideas gained from research lesson observations

• investigation of students’ prior knowledge, learning experiences, state of learning and understanding

from Building our Understanding of Lesson Study, p. 152
What is TIMSS?

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

*In 1999, no grade 4 assessment
TIMSS Participating Education Systems (in either/both grades)

74 Education Systems

2011
## TIMSS 2011 Mathematics Framework

<table>
<thead>
<tr>
<th>Content dimensions</th>
<th>TIMSS mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4 Number</td>
<td></td>
</tr>
<tr>
<td>Geometric Shapes and Measures</td>
<td></td>
</tr>
<tr>
<td>Data Display</td>
<td></td>
</tr>
<tr>
<td>Grade 8 Number</td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td></td>
</tr>
<tr>
<td>Data and Chance</td>
<td></td>
</tr>
<tr>
<td>Cognitive dimensions</td>
<td>Knowing</td>
</tr>
<tr>
<td>Applying</td>
<td></td>
</tr>
<tr>
<td>Reasoning</td>
<td></td>
</tr>
</tbody>
</table>
# TIMSS Grade 8: Across Content Areas

<table>
<thead>
<tr>
<th>Country</th>
<th>Aver.</th>
<th>Number</th>
<th>Algebra</th>
<th>Geometry</th>
<th>Data/Change</th>
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<tbody>
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<td>509</td>
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<td>+3</td>
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<td>+18</td>
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<tr>
<td>C Taipei</td>
<td>609</td>
<td>–11</td>
<td>+19</td>
<td>+16</td>
<td>–25</td>
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<tr>
<td>HK SAR</td>
<td>586</td>
<td>+2</td>
<td>–3</td>
<td>+11</td>
<td>–5</td>
</tr>
<tr>
<td>Japan</td>
<td>570</td>
<td>–13</td>
<td>0</td>
<td>+16</td>
<td>+9</td>
</tr>
<tr>
<td>S. Korea</td>
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<td>+4</td>
<td>–1</td>
<td>+3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>440</td>
<td>+11</td>
<td>–10</td>
<td>–8</td>
<td>–11</td>
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<tr>
<td>Singapore</td>
<td>611</td>
<td>0</td>
<td>+3</td>
<td>–2</td>
<td>–4</td>
</tr>
</tbody>
</table>
**TIMSS Grade 8: MATHEMATICS COGNITIVE DOMAIN—2011**

<table>
<thead>
<tr>
<th>Country</th>
<th>Aver.</th>
<th>Knowing</th>
<th>Applying</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>509</td>
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<td>−6</td>
<td>−6</td>
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<tr>
<td>C Taipei</td>
<td>609</td>
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</tr>
<tr>
<td>HK SAR</td>
<td>586</td>
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<td>+1</td>
<td>−6</td>
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<tr>
<td>Japan</td>
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<td>−12</td>
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<td>S. Korea</td>
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<td>Malaysia</td>
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<td>+4</td>
<td>−21</td>
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<tr>
<td>Singapore</td>
<td>611</td>
<td>+6</td>
<td>+2</td>
<td>−7</td>
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</tbody>
</table>
Singapore Mathematics
Pentagonal Framework

Attitudes
- Appreciation
- Interest
- Confidence
- Perseverance

Metacognition
- Monitoring one’s own thinking

Mathematical Problem Solving
- Estimation and Approximation
- Mental calculation
- Communication
- Use of mathematical tools
- Arithmetic manipulation
- Algebraic manipulation
- Handling data

Concepts
- Numerical
- Geometrical
- Algebraic
- Statistical

Processes
- Thinking skills
- Heuristics
CANINE COGNITIVE DIMENSIONS

EMPATHY
Reading and responding to the emotions of others

MEMORY
Storing past experience to make future choices

CUNNING
Using information from others to avoid detection

REASONING
Inferring the solution to new problems

COMMUNICATION
Using information from others to learn about the environment

From dognition.com
Lesson Study Cycle

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

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Select research lesson
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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?

Assessment for 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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<td>Less than 150</td>
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<tr>
<td>150 to 175</td>
<td>Singapore (152)</td>
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<tr>
<td>176 to 200</td>
<td>Hong Kong-Chinese (198)</td>
<td>Hong Kong-Chinese (181)</td>
<td>United States (198)</td>
</tr>
<tr>
<td>201 to 225</td>
<td>International Average (201)</td>
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<tr>
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<td>Japan (201)</td>
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<td>United States (214)</td>
<td>Australia (205)</td>
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<td>Republic of Korea (217)</td>
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<td>International Average (215)</td>
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<td></td>
<td>Thailand (218)</td>
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<td></td>
<td>United States (223)</td>
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<td>226 to 250</td>
<td>New Zealand (229)</td>
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<td>Philippines (250)</td>
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<tr>
<td>251 to 275</td>
<td>Indonesia (258)</td>
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<tr>
<td></td>
<td>Chinese Taipei (266)</td>
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<tr>
<td>more than 276</td>
<td></td>
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</tbody>
</table>
Singapore Grade 8 Math Scores At Selected Percentiles

![Graph showing Singapore Grade 8 Math Scores at selected percentiles over years](image)
# International Comparison of Gap Score between Gr. 8 Low/High Performing Students in Mathematics Overall, Geometry, Algebra

## Grade 8

<table>
<thead>
<tr>
<th>Score-point gap between bottom 10th and top 90th percentiles</th>
<th>Mathematics (TIMSS 2011) Geometry Subscale</th>
<th>Mathematics (TIMSS 2011) Algebra Subscale</th>
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<tr>
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<td>150 to 175</td>
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<td>176 to 200</td>
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<td>Indiana-USA (183)</td>
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<tr>
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<tr>
<td><strong>United States (198)</strong></td>
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<td>Colorado-USA (200)</td>
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</tr>
<tr>
<td>201 to 225</td>
<td>Alabama-USA (206)</td>
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<td>California-USA (206)</td>
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<td>North Carolina-USA (206)</td>
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<td>Japan (216)</td>
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<td>New Zealand (223)</td>
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<tr>
<td>226 to 250</td>
<td><strong>International Average (228)</strong></td>
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<td>Republic of Korea (232)</td>
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<tr>
<td></td>
<td>Malaysia (241)</td>
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<td></td>
<td>Connecticut-USA (233)</td>
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<td>Republic of Korea (234)</td>
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<td></td>
<td>Thailand (235)</td>
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<td><strong>International Average (246)</strong></td>
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<tr>
<td>251 to 275</td>
<td>Chinese Taipei (275)</td>
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<tr>
<td></td>
<td>Indonesia (256)</td>
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<td>Malaysia (291)</td>
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<tr>
<td></td>
<td>Chinese Taipei (300)</td>
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<tr>
<td></td>
<td>Chinese Taipei (319)</td>
<td></td>
</tr>
</tbody>
</table>
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

[Graphs showing TIMSS: Science scores for Grade 4 and Grade 8 over the years.]
Singapore Gr. 4 Reading Scores at Selected Percentiles Across the Years
Grade 4: Public Release Items
Joan had 12 apples. She ate some apples, and there were 9 left. Which number sentence describes what happened?

A) $12 + 9 = \square$
B) $9 = 12 + \square$
C) $12 - \square = 9$
D) $9 - \square = 12$
Highest score: 98%  Korea, Rep. of

International average: 78%

Chinese Taipei: 96%
Japan: 94%
U.S.: 92%
Singapore: 91%
Hong Kong: 91%
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?

A

B

C

D
Highest score: 93%  Portugal

International average: 69%

Hong Kong: 92%
Japan: 90%
Singapore: 88%
Korea, Rep. of: 85%
Chinese Taipei: 84%
U.S.: 83%
# Grade 4: Data Display; Reading and Interpreting; Knowing

## Favorite Ice Cream Flavors

<table>
<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>

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%
How much do the apples weigh in grams?

A  200
B  202
C  210
D  220
Highest score: 90%  Korea, Rep. of, Singapore

International average: 56%

Hong Kong: 89%
Japan: 88%
Chinese Taipei: 87%
U.S.: 66%
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%

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.

Pine School

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

- A 20
- B 25
- C 30
- D 35
Highest score: 79%  Chinese Taipei

International average: 54%

Hong Kong: 78%

Korea, Rep. of: 75%

Singapore: 73%

Japan: 71%

U.S.: 63%
### Responses

<table>
<thead>
<tr>
<th>Country</th>
<th>20 (%)</th>
<th>25 (%)</th>
<th>30 (%)</th>
<th>35* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Taipei</td>
<td>5.2%</td>
<td>5.3%</td>
<td>10%</td>
<td>78.7%</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>5.1</td>
<td>5.6</td>
<td>10.1</td>
<td>78.3</td>
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<td>4.1</td>
<td>18.2</td>
<td>74.9</td>
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<td>9.2</td>
<td>11.2</td>
<td>72.7</td>
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<tr>
<td>Japan</td>
<td>6.5</td>
<td>7.4</td>
<td>13.8</td>
<td>70.7</td>
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<tr>
<td>U.S.</td>
<td>8.2</td>
<td>9.2</td>
<td>17.0</td>
<td>62.9</td>
</tr>
</tbody>
</table>
Grade 4: Number; Knowing

23 x 19
**Highest score: 90%**  
*(Girls: 90.7%; Boys: 90.0%)*

**Chinese Taipei**

**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%)**
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.

<table>
<thead>
<tr>
<th></th>
<th>Has 4 Sides</th>
<th>Does Not Have 4 Sides</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sides are</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>the same length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sides are</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT the same</td>
<td></td>
<td></td>
</tr>
<tr>
<td>length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has 4 sides</td>
<td>Not 4 sides</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>All sides the same length</td>
<td>A, F</td>
<td>D</td>
</tr>
<tr>
<td>All sides are NOT the same length</td>
<td>C, E</td>
<td>B</td>
</tr>
</tbody>
</table>
Highest score: 45%  
(>1 pt. 76%)  

Northern Ireland

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

HK: 33% (68%)

Japan: 32% (72%)

Korea: 28% (70%)

Chinese Taipei: 26% (62%)

U.S.: 13% (50%)

Singapore: 12% (64%)
Grade 8: Public Release Items
Grade 8: Algebra; Knowing

What does $xy + 1$ mean?

A. Add 1 to $y$, then multiply by $x$.
B. Multiply $x$ and $y$ by 1.
C. Add $x$ to $y$, then add 1.
D. 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%
In this triangle:

\[ AC = BC \]

\[ AB \text{ is twice as long as } CX. \]

What is the size of angle \( B \)?

Answer: \( \underline{ }^\circ \)
Highest score: 89%  Korea, Rep. of

International Average: 41%

Japan: 85%
Singapore: 83%
Hong Kong: 72%
Chinese Taipei: 72%
U.S.: 39%
Which shows a correct method for finding $\frac{1}{3} - \frac{1}{4}$?

(A) $\frac{1 - 1}{4 - 3}$

(B) $\frac{1}{4 - 3}$

(C) $\frac{3 - 4}{3 \times 4}$

(D) $\frac{4 - 3}{3 \times 4}$
C. Highest score: 86%  Korea, Rep. of Korea

International average: 37%

Singapore: 83%

Chinese Taipei: 82%

Hong Kong: 77%

Japan: 65%

U.S.: 29%
# Responses

<table>
<thead>
<tr>
<th>Country</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>2.7%</td>
<td>6.9%</td>
<td>4.2%</td>
<td>86.0%</td>
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<tr>
<td>Singapore</td>
<td>4.8</td>
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<td>Taipei</td>
<td>2.9</td>
<td>7.7</td>
<td>7.0</td>
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<td>Hong Kong</td>
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<td>8.7</td>
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<td>Japan</td>
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<td>65.3</td>
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<td>10.7</td>
<td>29.1</td>
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<tr>
<td>Finland</td>
<td>42.3</td>
<td>29.5</td>
<td>8.7</td>
<td>16.1</td>
</tr>
</tbody>
</table>
Grade 8: Numbers; Applying

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

A) $\frac{1 - 1}{4 - 3}$

B) $\frac{1}{4 - 3}$

C) $\frac{3 - 4}{3 \times 4}$

D) $\frac{4 - 3}{3 \times 4}$
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%

U.S.: 27%
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%
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?

A

B

C

D
Highest score: 53%  Chinese Taipei

International average: 23%

Hong Kong: 47%
Singapore: 45%
Korea, Rep. of: 44%
Japan: 43%
U.S.: 22%
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

2011

<table>
<thead>
<tr>
<th>Singapore Gr. 4 Score</th>
<th>Very Collaborative</th>
<th>Collaborative</th>
<th>Somewhat Collaborative</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th %</td>
<td>495</td>
<td>505</td>
<td>489</td>
</tr>
<tr>
<td>25th %</td>
<td>553</td>
<td>562</td>
<td>539</td>
</tr>
<tr>
<td>50th %</td>
<td>610</td>
<td>614</td>
<td>589</td>
</tr>
<tr>
<td>75th %</td>
<td>661</td>
<td>663</td>
<td>627</td>
</tr>
<tr>
<td>90th %</td>
<td></td>
<td>702</td>
<td>662</td>
</tr>
</tbody>
</table>
Effect of Teacher Collaboration on Gr. 8 Student Performance
Gr. 4 Student Performance vs. Teachers Sharing Learning

2011

- Never
- 2-3x/mo.
- 1-3x/wk
- Daily

Gr. 4 Teachers Share Learning

- 10th %
- 25th %
- 50th %
- 75th %
- 90th %

Graph showing the distribution of Gr. 4 teachers' practice of sharing learning in 2011.
Gr. 8 Student Performance vs. Teachers Sharing Learning
Why Lesson Study?
Why Kyozaikenkyu during Lesson Study?

- More eyes, fresh eyes on student learning
- Different and objective perspectives of student learning
- Deeper and broader understanding of content
- Generation of more questions …
Outcome of Lesson Study

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


References


References

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