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 Kyozaikenkenkyu 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

*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></th>
<th>TIMSS Mathematics</th>
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<tbody>
<tr>
<td><strong>Content dimensions</strong></td>
<td>Grade 4</td>
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<tr>
<td></td>
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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
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**TIMSS 2011 Grade 4: MATHEMATICS COGNITIVE DOMAIN**

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**Singapore Mathematics Pentagonal Framework**

- **Attitudes**
  - Appreciation
  - Interest
  - Confidence
  - Perseverance

- **Metacognition**
  - Monitoring one’s own thinking

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

- **Processes**
  - Thinking skills
  - Heuristics

- **Concepts**
  - Numerical
  - Geometrical
  - Algebraic
  - Statistical

- **Problem Solving**
# TIMSS 2011 Science Framework

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## TIMSS Grade 4: Across Content Areas

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### TIMSS 2011 Grade 4: SCIENCE COGNITIVE DOMAIN

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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?
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%
England: 84%
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

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<td>Lemon</td>
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How many children chose vanilla as their favorite flavor?

Answer: ______________
Speakers

Highest score: 93%  Singapore

International average: 54%

U.S.: 86%

Hong Kong: 84%

Korea, Rep. of: 84%

Chinese Taipei: 79%

Japan: 78%

England: 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%
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.

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%
England: 65%
U.S.: 63%
## Responses

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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

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

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<td>X</td>
<td></td>
</tr>
<tr>
<td>A and B both have the same number of faces.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All the angles in A are right angles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B has more edges than A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some of the edges in B are curved.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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%)
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%  Kazakhstan

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%  
(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%)

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.

<table>
<thead>
<tr>
<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>
</tr>
<tr>
<td></td>
<td>Has 4 sides</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>All sides the same length</td>
<td>A, F</td>
</tr>
<tr>
<td>All sides are NOT the same length</td>
<td>C, E</td>
</tr>
</tbody>
</table>
Highest score: 45%  Northern Ireland
( >1 pt. 76%)
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?

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%

England: 72%
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 $\frac{1}{3} - \frac{1}{4}$?

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
International average: 37%

Singapore: 83%
Chinese Taipei: 82%
Hong Kong: 77%
Japan: 65%
U.S.: 29%
England: 28%
<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>
</tr>
<tr>
<td>Singapore</td>
<td>4.8</td>
<td>5.5</td>
<td>6.5</td>
<td>83.1</td>
</tr>
<tr>
<td>Taipei</td>
<td>2.9</td>
<td>7.7</td>
<td>7.0</td>
<td>82.0</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>4.0</td>
<td>8.7</td>
<td>10.0</td>
<td>77.0</td>
</tr>
<tr>
<td>Japan</td>
<td>15.4</td>
<td>11.1</td>
<td>8.2</td>
<td>65.3</td>
</tr>
<tr>
<td>England</td>
<td>24.5</td>
<td>32.8</td>
<td>12.4</td>
<td>28.2</td>
</tr>
<tr>
<td>U.S.</td>
<td>32.5</td>
<td>26.1</td>
<td>10.7</td>
<td>29.1</td>
</tr>
<tr>
<td>Finland</td>
<td>42.3</td>
<td>29.5</td>
<td>8.7</td>
<td>16.1</td>
</tr>
</tbody>
</table>
Which shows a correct method for finding $\frac{1}{3} - \frac{1}{4}$?

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

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

(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.
Speakers

Highest score: 85% Japan

International average: 48%

Korea, Rep. of: 84%

Hong Kong: 82%

Chinese Taipei: 82%

Singapore: 72%

England: 40%

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%
England: 30%
U.S.: 24%
Grade 8: Numbers; Fractions/Decimals; Reasoning

\[ P \times Q = N. \]

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%
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

2011

Singapore Gr. 8 Score

Very collaborative

Collaborative

Somewhat collaborative

498 559 624 672 705
493 557 619 672 714
505 569 623 673 716

10th % 25th % 50th % 75th % 90th %
Gr. 4 Student Performance vs. Teachers Sharing Learning

2011

Gr. 4 Teachers Share Learning

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

- 10th %: 493, 638, 543, 493
- 25th %: 506, 614, 506, 506
- 50th %: 563, 661, 563, 563
- 75th %: 680, 701, 680, 680
- 90th %: 706, 706, 706, 706

Gr. 4 Students Performance

- 10th %: 494, 611, 494, 494
- 25th %: 554, 614, 554, 554
- 50th %: 663, 701, 663, 663
- 75th %: 692, 706, 692, 692
- 90th %: 654, 706, 654, 654
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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 to 175</td>
<td>Singapore (152)</td>
<td></td>
<td></td>
</tr>
<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><strong>International Average (201)</strong>&lt;br&gt;Thailand (201)&lt;br&gt;New Zealand (211)&lt;br&gt;Australia (212)&lt;br&gt;<strong>United States (214)</strong>&lt;br&gt;Republic of Korea (217)</td>
<td>Japan (201)&lt;br&gt;Singapore (201)&lt;br&gt;Republic of Korea (202)&lt;br&gt;Australia (205)&lt;br&gt;Malaysia (209)&lt;br&gt;<strong>International Average (215)</strong>&lt;br&gt;Thailand (218)&lt;br&gt;<strong>United States (223)</strong></td>
<td>Japan (216)&lt;br&gt;Indonesia (214)&lt;br&gt;Hong Kong-Chinese (215)&lt;br&gt;Thailand (218)&lt;br&gt;Singapore (219)&lt;br&gt;Australia (221)&lt;br&gt;New Zealand (223)</td>
</tr>
<tr>
<td>226 to 250</td>
<td></td>
<td>New Zealand (229)&lt;br&gt;Philippines (250)</td>
<td><strong>International Average (228)</strong>&lt;br&gt;Republic of Korea (232)&lt;br&gt;Malaysia (241)</td>
</tr>
<tr>
<td>251 to 275</td>
<td></td>
<td>Indonesia (258)&lt;br&gt;Chinese Taipei (266)</td>
<td>Chinese Taipei (275)</td>
</tr>
<tr>
<td>more than 276</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Score-point gap between bottom 10th and top 90th percentiles</th>
<th>Mathematics (TIMSS 2011)</th>
<th>Geometry Subscale</th>
<th>Algebra Subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 to 175</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 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)  
**United States (209)**  
Colorado-USA (208) | Indiana-USA (209)  
Florida-USA (211)  
Singapore (219)  
California-USA (221)  
Minnesota-USA (221) |
| 226 to 250 | **International Average (228)**  
Republic of Korea (232)  
Malaysia (241) | | |
| 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
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