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Lesson Study: Nice-to-have, or Must-have?

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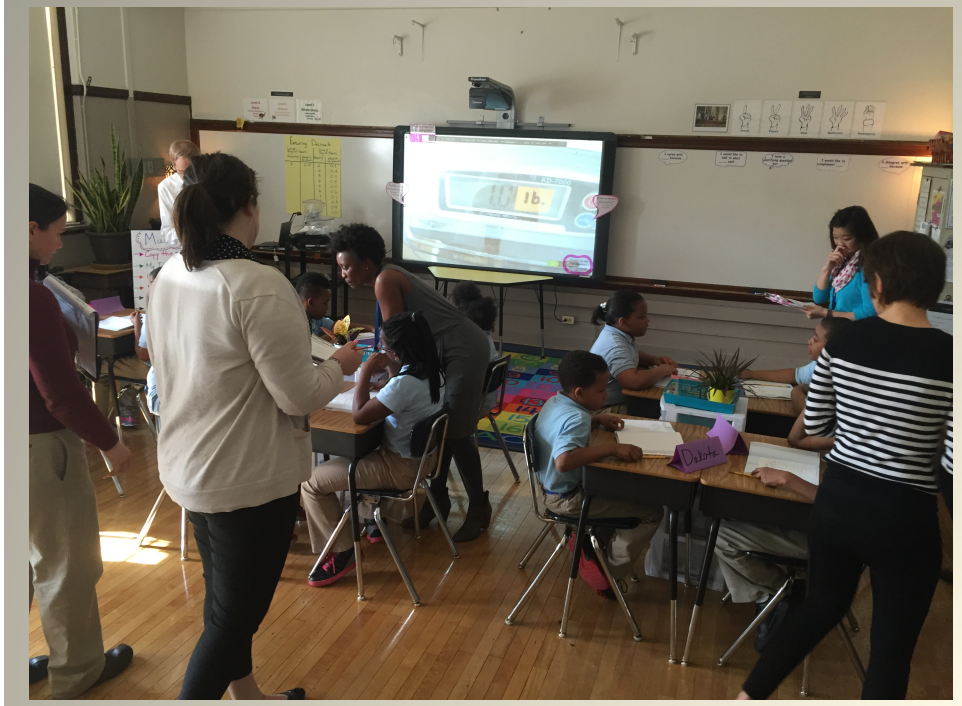


1) Why Lesson Study?
2) What do we learn from more than 15 years of Lesson Study endeavor outside Japan?
3) A Proposal
4) A New Project based on our learning

This is a summary and updates of research projects supported by

- Project IMPULS at Tokyo Gakugei University, Tokyo, Japan
- Lesson Study Alliance and Chicago Lesson Study Group, Chicago, IL
- Mills College Lesson Study Research Group, Oakland, CA
- McDoulga Family Foundation, Chicago, IL
- Bill & Melinda Gates Foundation, USA

Why Lesson Study?

Stigler and Hiebert argue that Japanese mathematics lessons better exemplify current U.S. reform ideas than do typical U.S. mathematics lessons (1999).

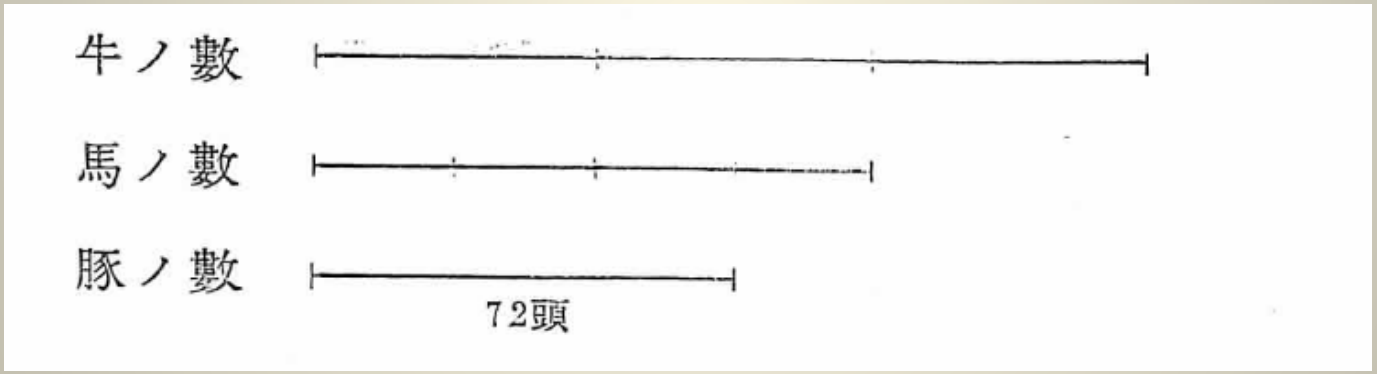
> When we watched a Japanese Lesson, for example, we noticed that the teacher presents a problem to the students without first demonstrating how to solve the problem. We realized that U.S. teachers almost never do this. U.S. teacher almost always demonstrates a procedure for solving problems before assigned them to students.

Lesson Study was introduced a form of professional development to improve mathematics teaching and learning.

Emphasis on Problem Solving

Based on the long history of teaching mathematics using story problems

- The number of the horses is 2/3 of the number of the cow. The number of the pigs is 3/4 of the number of the horses and 72. How many horses and how many cows are there? (A problem from the Japanese math textbook in 1935)



An Agenda For Action (NCTM 1980)

Recommendation 1

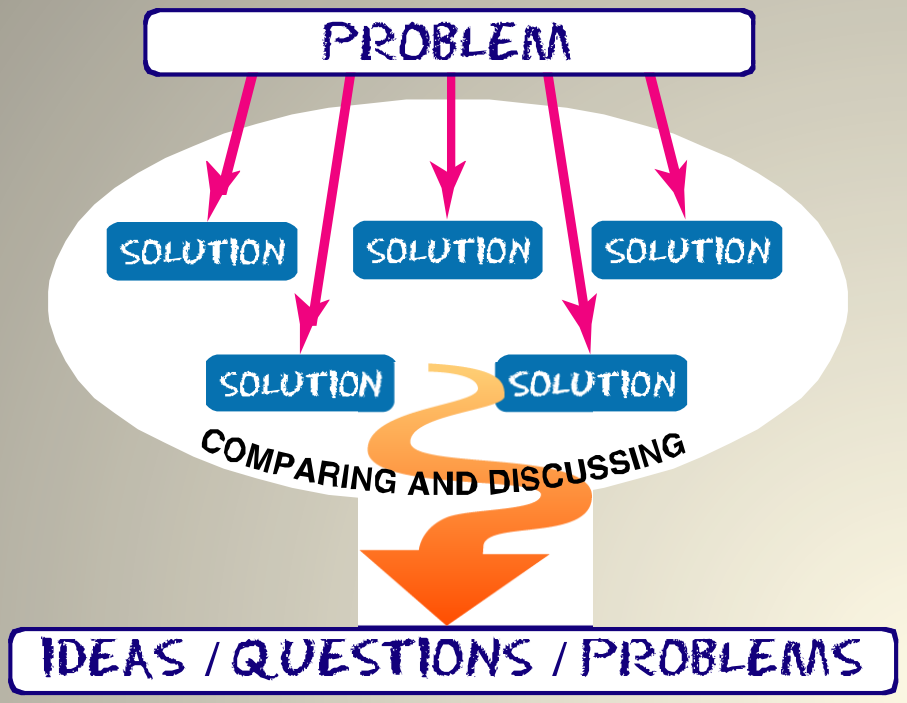
Problem Solving must be the Focus of School Mathematics in the 1980s

Emphasis on Problem Solving

Standards and Focal Points, NCTM

- Problem solving means engaging in a task for which the solution is not known in advance.
- Good problems give students the chance to solidify and extend their knowledge and to stimulate new learning. Most mathematical concepts can be introduced through problems based on familiar experiences coming from students' lives or from mathematical contexts.
- Students need to develop a range of strategies for solving problems, such as using diagrams, looking for patterns, or trying special values or cases.

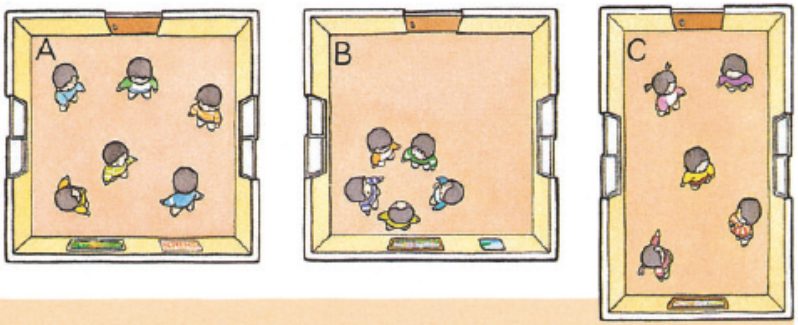
By early 1990s Japanese math textbooks, especially for elementary grades, using an approach based on Problem Solving (Teaching through Problem Solving).



Crowdedness

1 Kiyoshi and his friends will sleep in cabins A, B and C at camp.

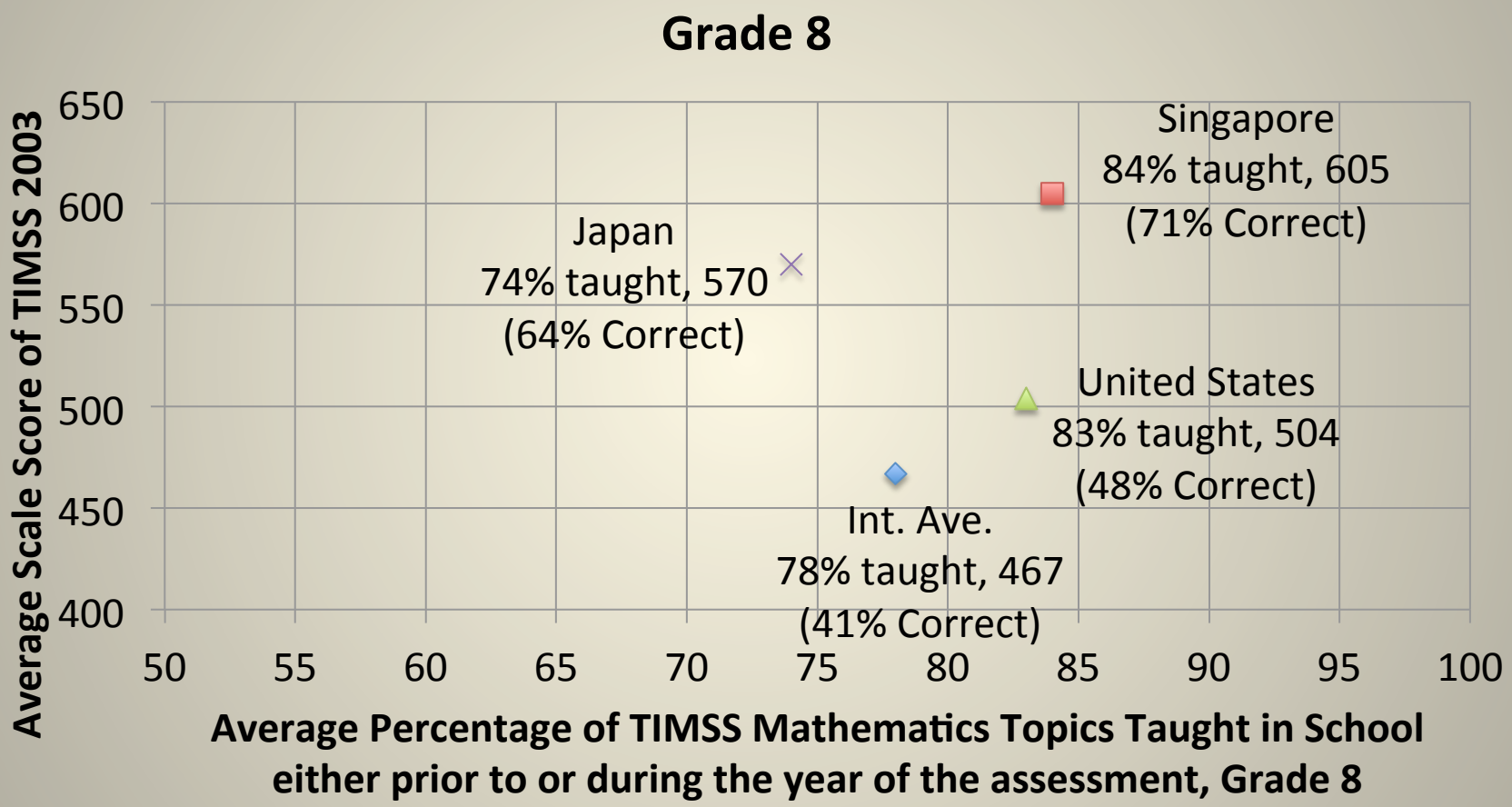
Which cabin is the most crowded?



Let's think about how we can figure out how crowded something is!

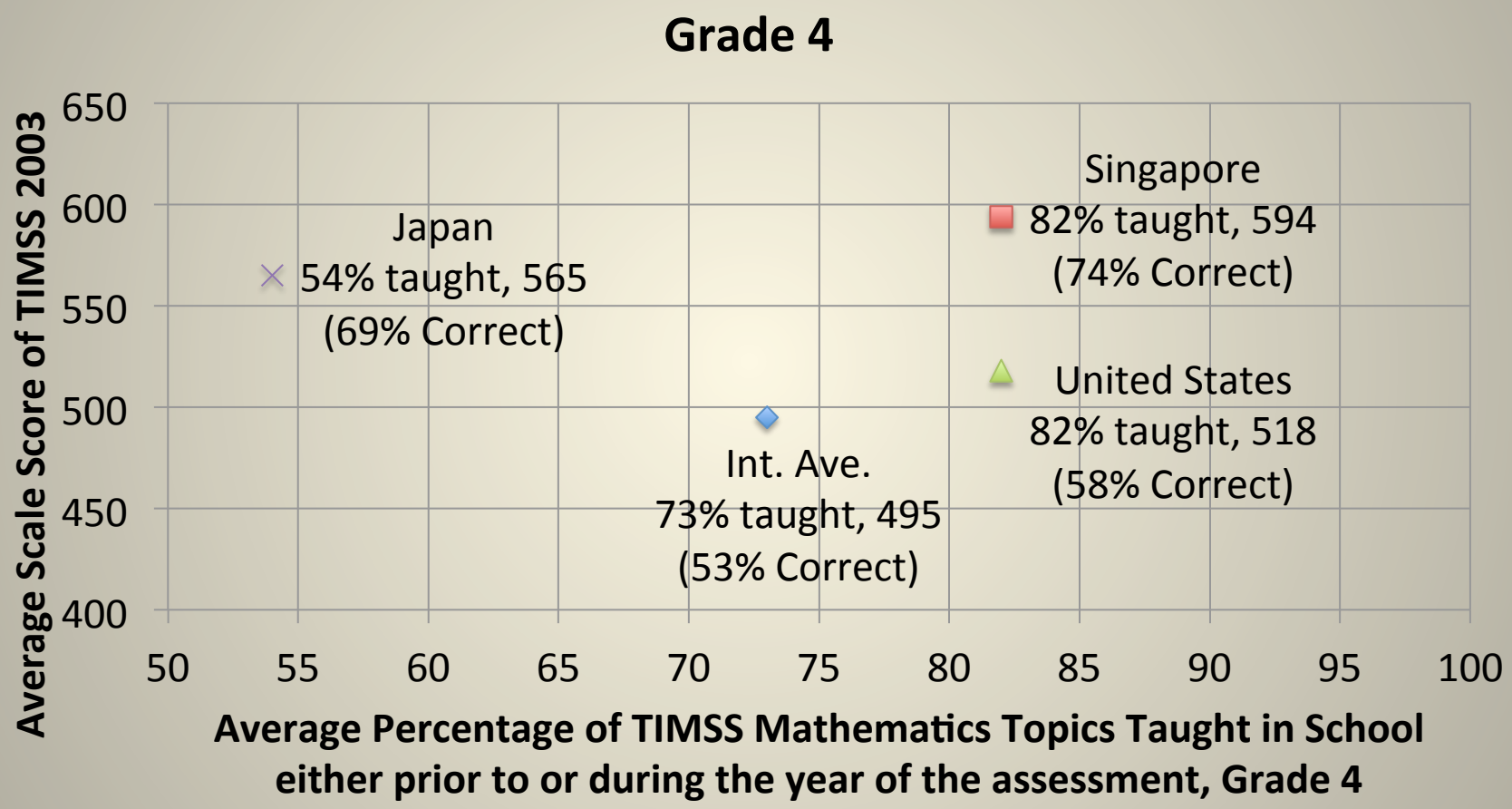
90s Japanese Math Textbook
Grade 5B p.23-25

Average Percentage of TIMSS Mathematics Topics Taught in School and the Achievement (Average Scale Score) of the TIMSS 2003



Source TIMSS 2003 International Mathematics Report
Grade 8: Exhibit 5.7 (p.192), Exhibit C. 1 (p.400)
Grade 4: Exhibit 5.7 (p.193), Exhibit C. 1 (p.402)

Average Percentage of TIMSS Mathematics Topics Taught in School and the Achievement (Average Scale Score) of the TIMSS 2003



Source TIMSS 2003 International Mathematics Report
Grade 8: Exhibit 5.7 (p.192), Exhibit C. 1 (p.400)
Grade 4: Exhibit 5.7 (p.193), Exhibit C. 1 (p.402)

Three Levels of Teaching

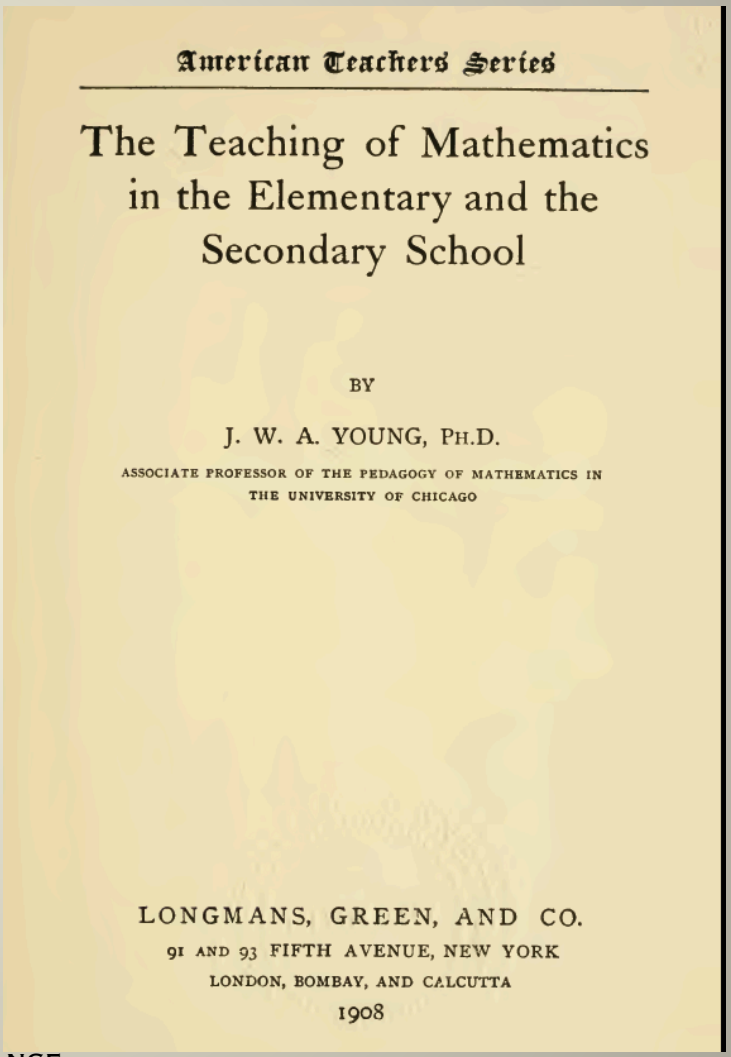
Japanese mathematics educators and teachers identify three levels of expertise of mathematics teaching:

- Level 1: The teacher can tell students the important basic ideas of mathematics such as facts, concepts, and procedures.
- Level 2: The teacher can explain the meanings and reasons of the important basic ideas of mathematics in order for students to understand them.
- Level 3: The teacher can provide students with opportunities to understand these basic ideas, and support their learning so that the students become independent learners.

(Sugiyama, Y. 2008, Trans. Takahashi, A., 2011a)

Why we teach mathematics in primary and secondary Schools?

- The facts of mathematics, important and valuable as they are, are not the strongest justification for the study of the subject by all pupils.
- Still more important than the subject matter of mathematics is the fact that it exemplifies most typically, clearly and simply certain modes of thought which are of the utmost importance to everyone.


American Teachers Series

The Teaching of Mathematics in the Elementary and the Secondary School

BY

J. W. A. YOUNG, PH.D.

ASSOCIATE PROFESSOR OF THE PEDAGOGY OF MATHEMATICS IN THE UNIVERSITY OF CHICAGO

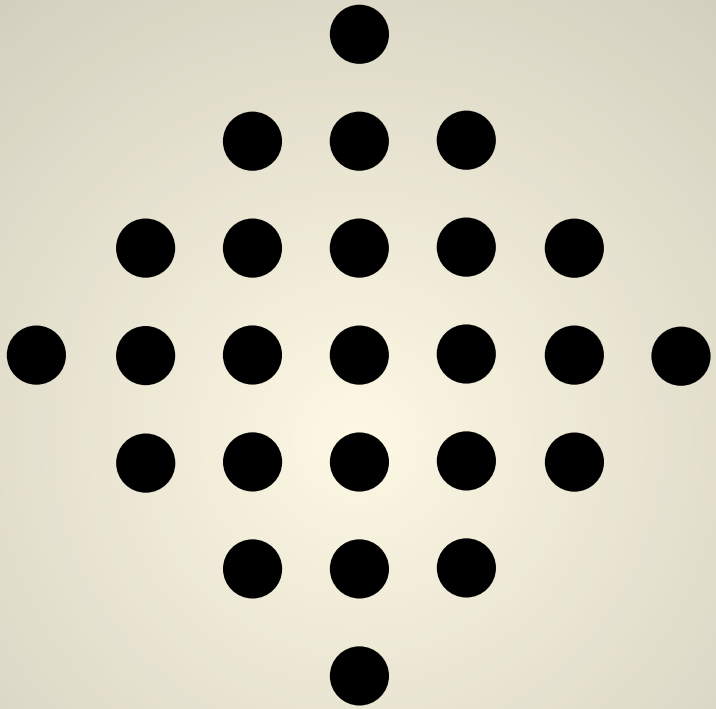
LONGMANS, GREEN, AND CO.
91 AND 93 FIFTH AVENUE, NEW YORK
LONDON, BOMBAY, AND CALCUTTA
1908

Some pupils are tempted to evade precisely that portion of the work which gives the benefit, by memorizing the results of the work of others. This temptation is great to some pupils, and perhaps no other subject can become so barren and dreary as mathematics so studied. Ten pages of mathematics *understood* are better than a hundred memorized and not understood, and one page actually worked out independently is better than ten pages clearly but passively understood. The question is not *how much?* but *how?* The object is mastery, attainment of the spirit of the subject, and not to train the memory, or to ingest a large bulk of mathematical fact and formulas.

Memorizing.

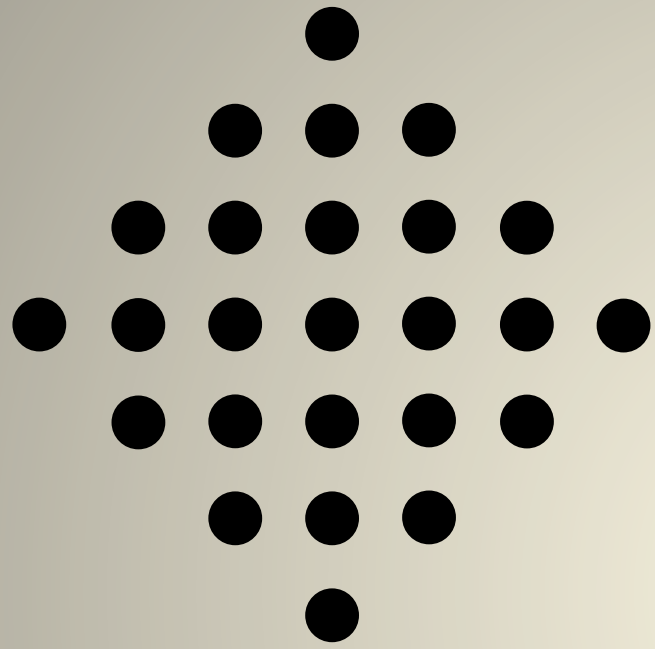
(J.W.A. Young, 1908, p.38)

How many marbles are there in the picture below?



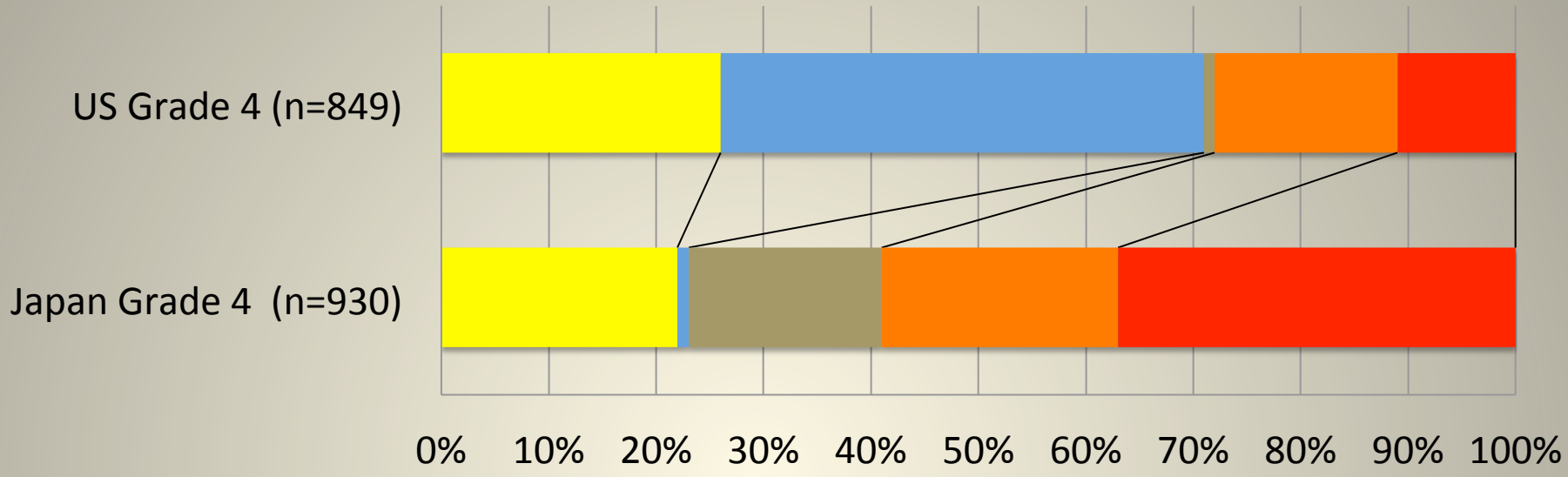
Find the answer in as many different ways as you can. Write your ways of finding the answer and write your answer

Nagasaki (1990) in Fujii, T. (1993). Japanese Students' Understanding of School Mathematics; Focusing on Elementary Algebra. In G. Bell (Ed.), Asian Perspectives on Mathematics Education (pp. 70-89). Lismore, Australia: The Northern Rivers Mathematical Association.



- Category 1 (words/verbal explanation) Counting one by one, count by lining, count from the top
- Category 2 (words/verbal explanation) addition: sum up, by adding the marbles
- Category 3 (verbal explanation) multiplication: taking them into groups, count by fives
- Category 4 (explanation with mathematical expression) addition: 1+3+5+7+5+3+1, 4+3+4+3+4+3+4
- Category 5 (explanation with mathematical expression) multiplication: 5x5, 4x4+3x3, 3x8=24 24+1

Ways of Solution in Word Explanations (%)

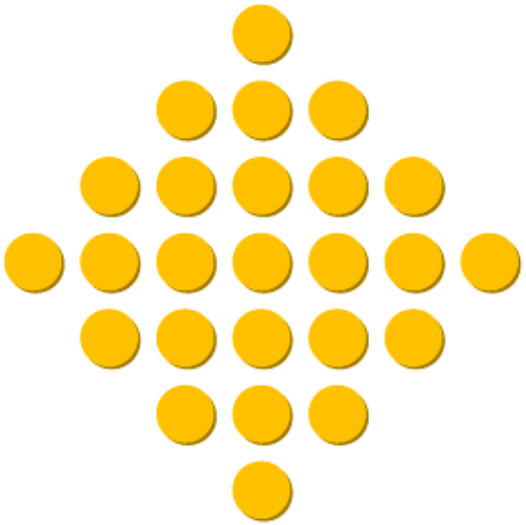


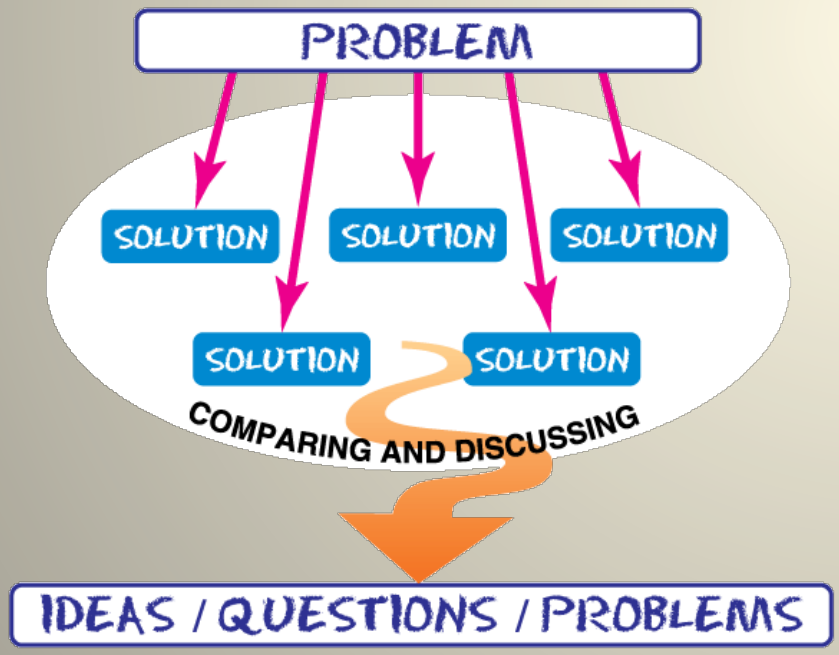
	Japan Grade 4 (n=930)	US Grade 4 (n=849)
Verbal Counting	22	26
Verbal Addition	1	45
Verbal Multiprication	18	1
Math Expression Addition	22	17
Math Expression Mlutiplication	37	11

Nagasaki (1990) in Fujii, T. (1993). Japanese Students' Understanding of School Mathematics; Focusing on Elementary Algebra. In G. Bell (Ed.), Asian Perspectives on Mathematics Education (pp. 70-89). Lismore, Australia: The Northern Rivers Mathematical Association.

5

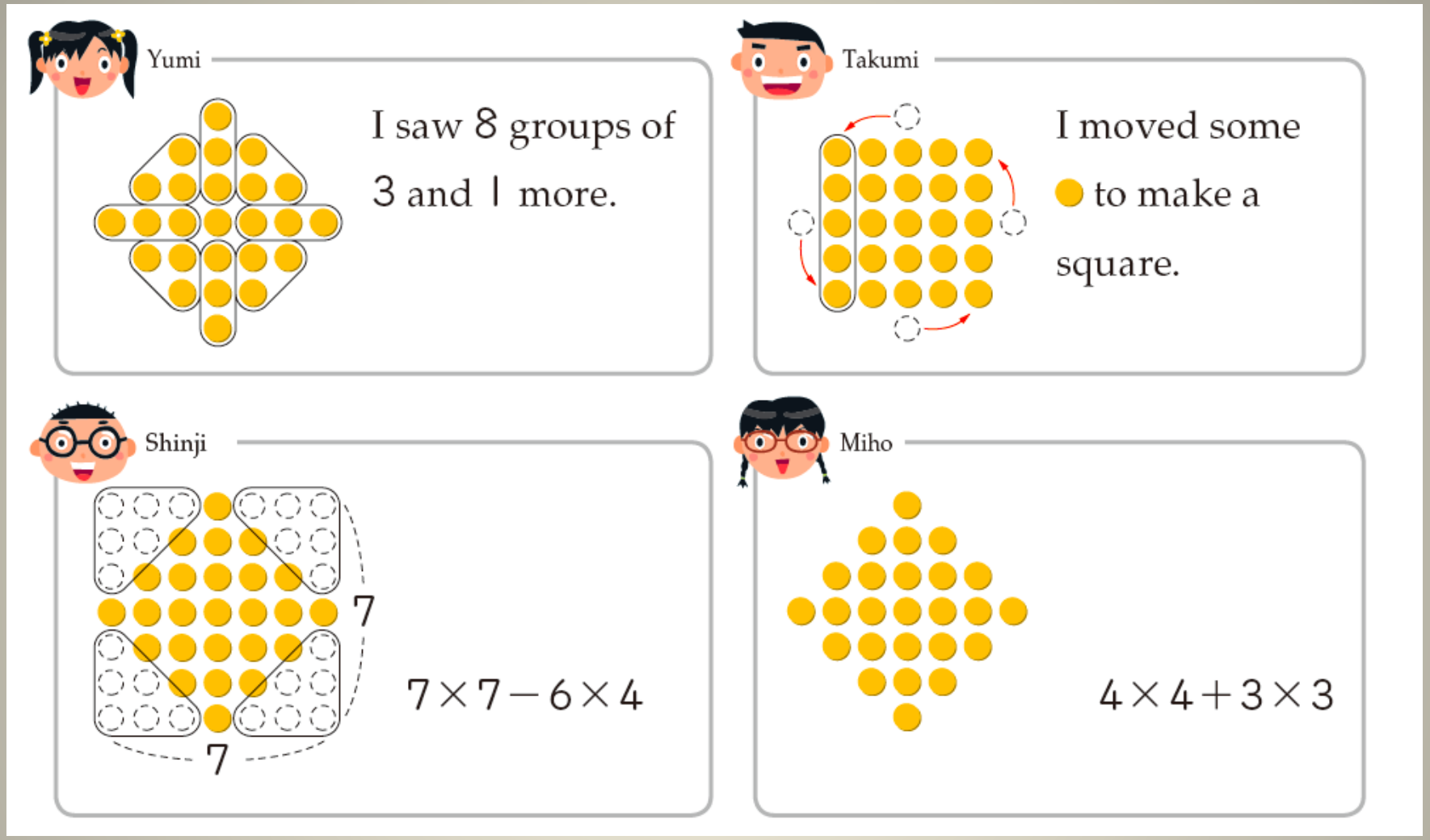
How many ● are there? Write how to calculate the total number in one math sentence, and then find the answer.





Mathematics International, Tokyo Shoseki, Grade 4 B, p. 13)

1. Represent
2. and solve



1) Write one math sentence for Yumi's method and one for Takumi's method.
2) Explain Shinji's idea.
3) Look at the math sentence Miho wrote. Explain her idea using diagrams and words.

- Although researchers have been emphasizing problem solving, we still do not see many mathematics classes using problem solving as an integral part of mathematics teaching and learning.

- In order to improve the teaching of math in the United States, we need to engage students in exploring mathematical relationships and wrestling with key mathematical ideas. Unfortunately, it's not possible to achieve this goal simply by identifying best practices. (Closing the Teaching Gap, 2009)

Beliefs about teaching and learning mathematics

Reprint from *Principles to Actions p.11* (NCTM, 2014)

Unproductive beliefs	Productive beliefs
Mathematics learning should focus on practicing procedures and memorizing basic number combinations.	Mathematics learning should focus on developing understanding of concepts and procedures through problem solving, reasoning, and discourse.
Students need only to learn and use the same standard computational algorithms and the same prescribed methods to solve algebraic problems.	All students need to have a range of strategies and approaches from which to choose in solving problems, including, but not limited to, general methods, standard algorithms, and procedures.
Students can learn to apply mathematics only after they have mastered the basic skills.	Students can learn mathematics through exploring and solving contextual and mathematical problems.
The role of the teacher is to tell students exactly what definitions, formulas, and rules they should know and demonstrate how to use this information to solve mathematics problems.	The role of the teacher is to engage students in tasks that promote reasoning and problem solving and facilitate discourse that moves students toward shared understanding of mathematics.
The role of the student is to memorize information that is presented and then use it to solve routine problems on homework, quizzes, and tests.	The role of the student is to be actively involved in making sense of mathematics tasks by using varied strategies and representations, justifying solutions, making connections to prior knowledge or familiar contexts and experiences, and considering the reasoning of others.
An effective teacher makes the mathematics easy for students by guiding them step by step through problem solving to ensure that they are not frustrated or confused.	An effective teacher provides students with appropriate challenge, encourages perseverance in solving problems, and supports productive struggle in learning mathematics.

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- Listening to experts during special professional development days does not translate into improved teaching. Effective teacher learning must be built into teachers' daily and weekly schedules. Schools must become the places where teachers, not just students, learn.

(Closing the Teaching Gap, 2009)

For Level 3 teaching

- In order to develop expertise for Level 3 teaching, learning by reading, listening, and seeing may not be sufficient.

Two Major Types of Professional Development

- Phase 1 professional development focuses on developing the knowledge for teaching mathematics,
  - through reading books and resources, listening to lectures, and watching visual resources such and video and demonstration lessons.
- Phase 2 professional development focuses on developing expertise for teaching mathematics
  - teachers should plan the lesson carefully, teach the lesson based on the lesson plan, and reflect upon the teaching and learning based on the careful observation. Japanese teachers and educators usually go through this process using Lesson Study

A framework for developing programs and resources for mathematics teacher education

<table>
<tr><th></th><th>For becoming level 1 Teacher</th><th>For becoming level 2 Teacher</th><th>For becoming Level 3 Teacher</th></tr>
<tr><td>Phase 1 Professional Development</td><td rowspan="2">Reviewing the contents for teaching
•Workbooks
•Online courses
•Developing lesson plans</td><td rowspan="2">Undergraduate courses for prospective teachers
•Books/resources
•Classroom videos
•Classroom observation</td><td>Undergraduate courses for prospective teachers
•Books/resources
•Classroom videos
•Classroom observation</td></tr>
<tr><td rowspan="2">Phase 2 Professional Development</td><td rowspan="2">Lesson Study

Design, Teach, Observe, and Reflect
Establishing shared knowledge for Level 3 teaching</td></tr>
<tr><td>Find effective ways of presenting ideas and procedure through Lesson Study</td></tr>
</table>

Can Lesson Study Make An Impact on Student and Teacher Learning?

A recent randomized controlled trial **demonstrated a significant impact of lesson study** supported by mathematical resource kits on both U.S. teachers' and students' mathematical knowledge

> Teachers randomly assigned to lesson study conditions reported their professional learning to be of significantly higher quality than did educators randomly assigned to self-chosen professional learning, on indicators such as "Encouraged my active participation," "Valued my opinion, experience, and contributions" and "Included intellectual rigor, constructive criticism, and challenging of ideas" (Lewis & Perry, under review-b).

- **This is one of only two mathematics professional learning interventions (of 643 studied) identified by the What Works Clearinghouse to meet scientific criteria and demonstrate impact on students' mathematical proficiency (Gersten, Taylor, Keys, Rolfhus, & Newman-Gonchar, 2014).**

However…..

- Although many schools and teachers have tried to use ideas from Lesson Study in various ways, only a few cases have been documented in which there was strong evidence of impact on teaching and learning (e.g., Gersten, Taylor, Keys, Rolfhus, & Newman-Gonchar, 2014; Lewis, Perry, Hurd, & O'Connell, 2006).
- Why Lesson Study has been less consistently impactful outside of Japan?
- There are important aspects of *jugyou kenkyuu* that are getting "lost in translation" and can be fixed.

Interesting Cases (1)

One school district decided to try Lesson Study in one day. In the morning, a team of teachers came together to spend 30 minutes planning a lesson. They taught the lesson with students and reported what they observed. That afternoon, they modified the lesson plan in 30 minutes and taught the revised lesson.

- Although this one-day process seems to include all the components of Lesson Study that are described in journal articles and resources, this is far from *jugyou kenkyuu*. The typical duration of one *jugyou kenkyuu* cycle in a Japanese elementary school is more than 5 weeks (Murata & Takahashi, 2002) – it is certainly never done in just one day. Moreover, re-teaching a research lesson is not a common practice in *jugyou kenkyuu* (Fujii, 2014).

Interesting Cases (2)

After a public research lesson and post-lesson discussion, the team members commented that "we did not learn much from the research lesson and the discussion because we have already done six lesson study on this lesson."

- This team thought that the purpose of Lesson Study was to reteach a lesson until perfecting the lesson. The true purpose of *jugyou kenkyuu*, however, is to establish shared knowledge for teaching and learning among professionals, and not perfecting a lesson plan. In fact, Japanese teachers share the belief that there is no perfect lesson plan available. For Japanese teachers, the lesson plan is a plan for contingency and not a script for teaching the topic (Lee & Takahashi, 2011).

What should be consider in order to conduct Lesson Study effectively?

Five Lesson Study pilot programs for inservice teachers in the U.S. concluded that Lesson Study has the potential to help teachers gain insights into how students learn, and to reflect on their own teaching practice.

- Hart, L. C., Alston, A., & Murata, A. (Eds.). (2011). Lesson Study Research and Practice in Mathematics Education. Now York: Springer.

Important conditions to make Lesson Study effective in U.S. schools.

- Fujii, T. (2014). Implementing Japanese Lesson Study in Foreign Countries: Misconceptions Revealed. Mathematics Teacher Education and Development, 16(1).

  Misconceptions

  1) Lesson Study is a form of workshop;
  2) the focus of consideration at a research lesson is the teacher rather than teaching;
  3) Lesson Study is an isolated activity;
  4) structured problem-solving means having students solve a task; and
  5) a research lesson should always be re-taught.

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- Lee, Y, & Takahashi, A. (2011). Lesson plans and the contingency of classroom interactions. Human Studies, 34(2), 209-227. doi: 10.1007/s10746-011-9181-1
- Lewis, C., Perry, R., Hurd, J., & O'Connell, M. P. (2006). Lesson Study Comes of Age in North America. Phi Delta Kappan, 88(04), 273-281.
  1) Cross-site learning about lesson study
  2) Diverse ecology of lesson study
  3) Pass way linking lesson study to textbook
  4) Provision for "inside-out"reform

Case Studies to Examine Lesson Study in Japan

Project IMPULS, International Mathematics-Teacher Professionalization Using Lesson Study, was established in Tokyo Gakugei University to conduct case studies to understand the mechanism of Lesson Study in Mathematics education.

- Takahashi, A. (2014a). The Role of the Knowledgeable Other in Lesson Study: Examining the Final Comments of Experienced Lesson Study Practitioners. Mathematics Teacher Education and Development, 16(1).
- Takahashi, A. (2014b). Supporting the Effective Implementation of a New Mathematics Curriculum: A case study of school-based lesson study at a Japanese public elementary school. In I. Y. Li & G. Lappan (Eds.), Mathematics curriculum in school education (pp. 417-441). New York: Springer.
- Takahashi, A., & McDougal, T. (2014c). Implementing a New National Curriculum: A Japanese Public School's Two-Year Lesson-Study Project. In A. R. McDuffie & K. S. Karp (Eds.), Annual Perspectives in Mathematics Education (APME) 2014: Using Research to Improve Instruction: National Council of Teachers of Mathematics.

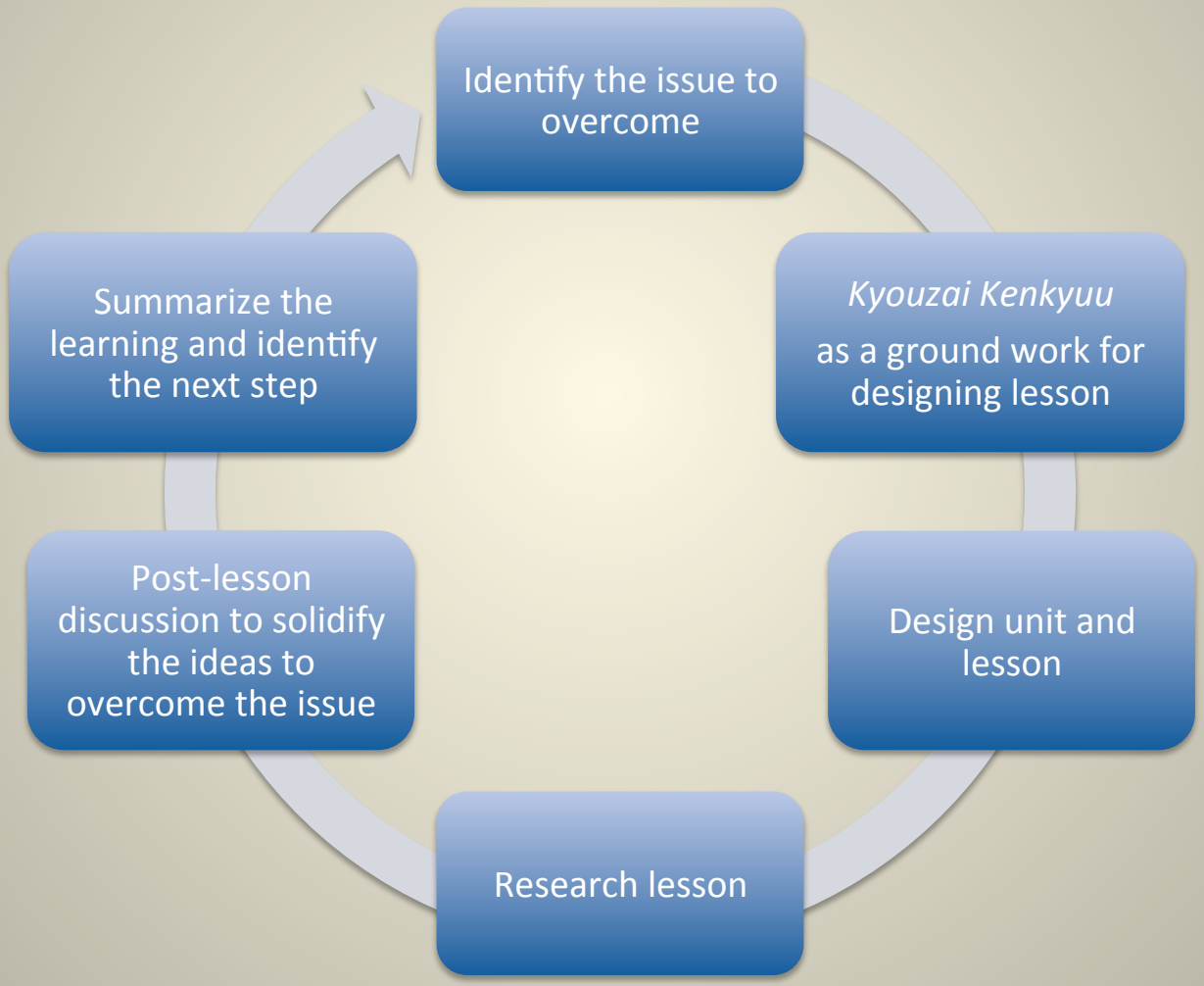
A Proposal

- Lesson Study is not an end in itself, but a process for accomplishing specific teaching-learning goals.
- Based on research findings and our own experience of Lesson Study outside Japan, we hypothesize that certain institutional structures and practices are important for maximizing the impact of Lesson Study.
- In order to differentiate these collective structures and practices from other, less-effective implementations of Lesson Study, we have coined a new term:

Collaborative Lesson Research (CLR).

Takahashi, A., & McDougal, T (under review) Collaborative Lesson Research: Maximizing the impact of Lesson Study. ZDM Mathematics Education Issue 2016 – 3.

CLR cycle to impact on student learning of mathematics



LESSON STUDY ALLIANCE

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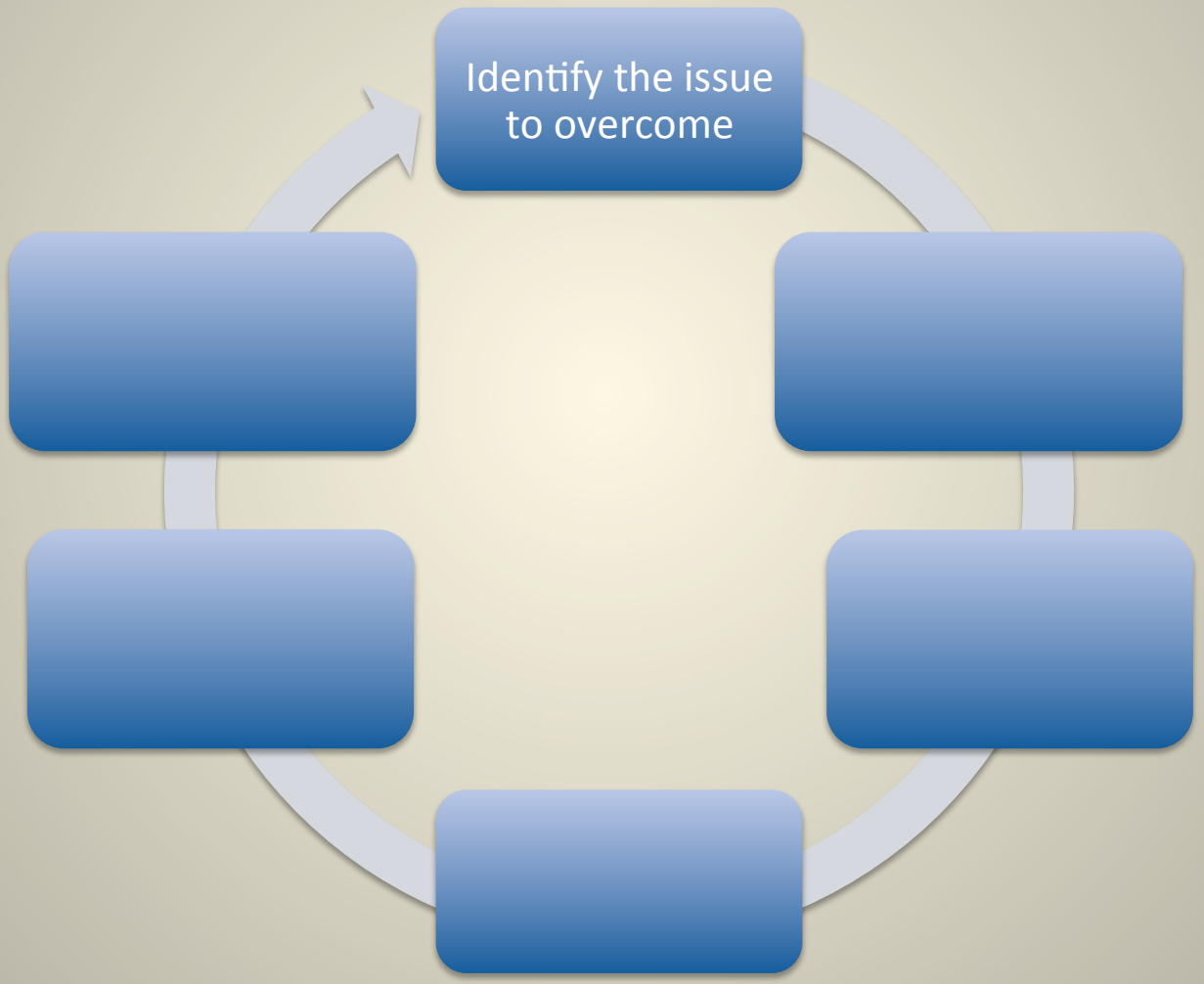
http://www.LSAlliance.org

Collaborative Lesson Research (CLR) for Maximizing the impact of Lesson Study

We define Collaborative Lesson Research (CLR) has having the following components:

1. Research theme
2. Research rationale
3. *Kyouzai kenkyuu* (curriculum and content study)
4. A research hypothesis
5. A research lesson plan
6. A live *research lesson*
7. A post-lesson discussion
8. A knowledgeable other
9. A written reflection
10. Contribution to the professional community

CLR cycle to impact on student learning of mathematics

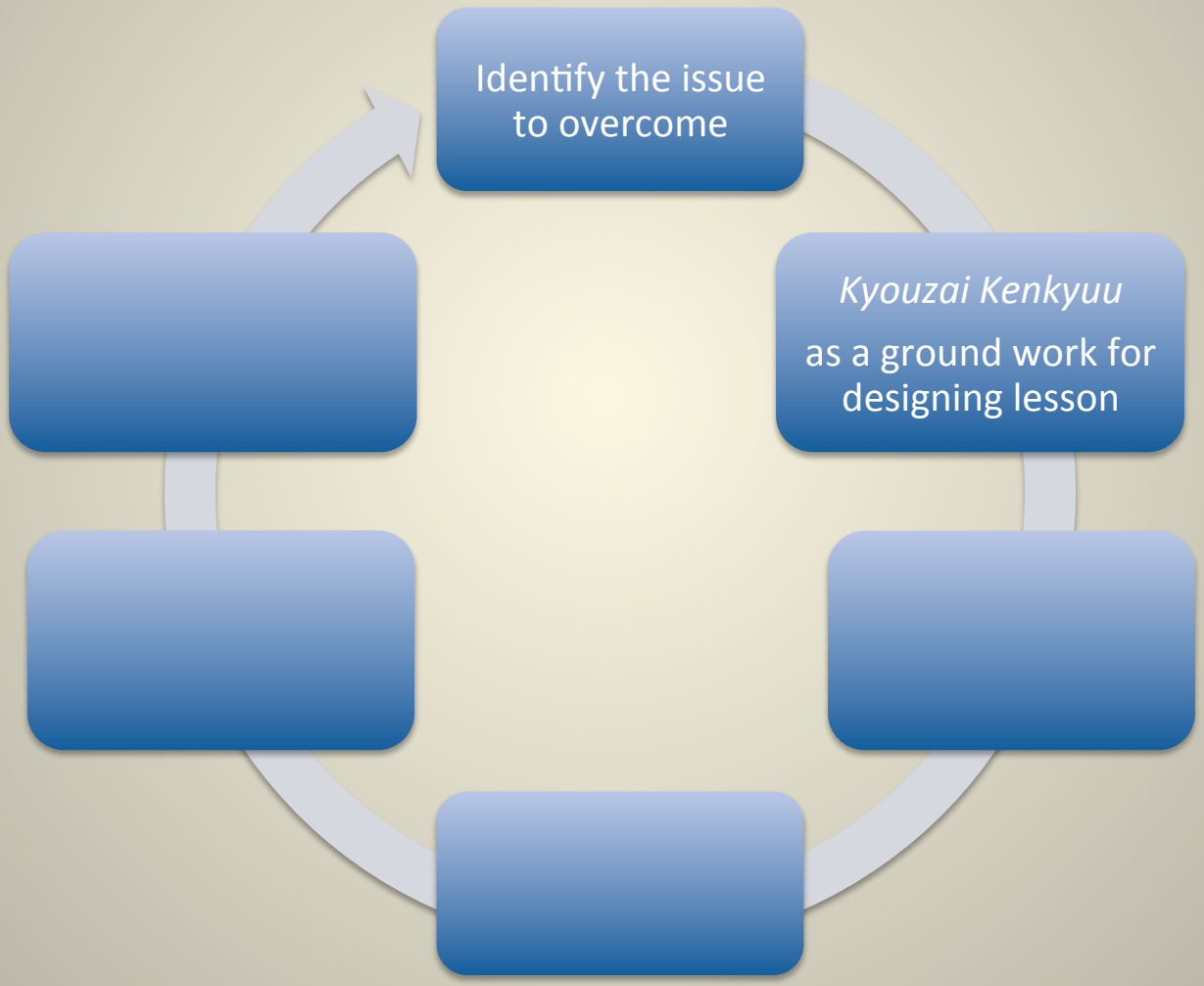


Identify the issue to overcome

Students have difficulty communicate each other, cannot explain their ideas/solutions in math classes.

- Prieto Math and Science Academy, Chicago
  - Using note-taking as a framework for communicating about mathematics
- O'Keeffe School of Excellent, Chicago
  - Supporting students' ability to explain their mathematical thinking and the thinking of their peers using 'evidence-based strategies' used in literacy

Lesson Study cycle to impact on student learning of mathematics



Kyouzai kenkyuu
教材 研究

Japanese teachers usually conduct ground works before actually design lesson. This investigation called '*Kyouzai kenkyuu*' in Japanese means studying:

(a) a variety of teaching and learning materials, such as curricula, textbooks, worksheets, and manipulatives;

(b) a variety of teaching methods;

(c) the process of student learning which includes student's typical misunderstandings and mistakes; and

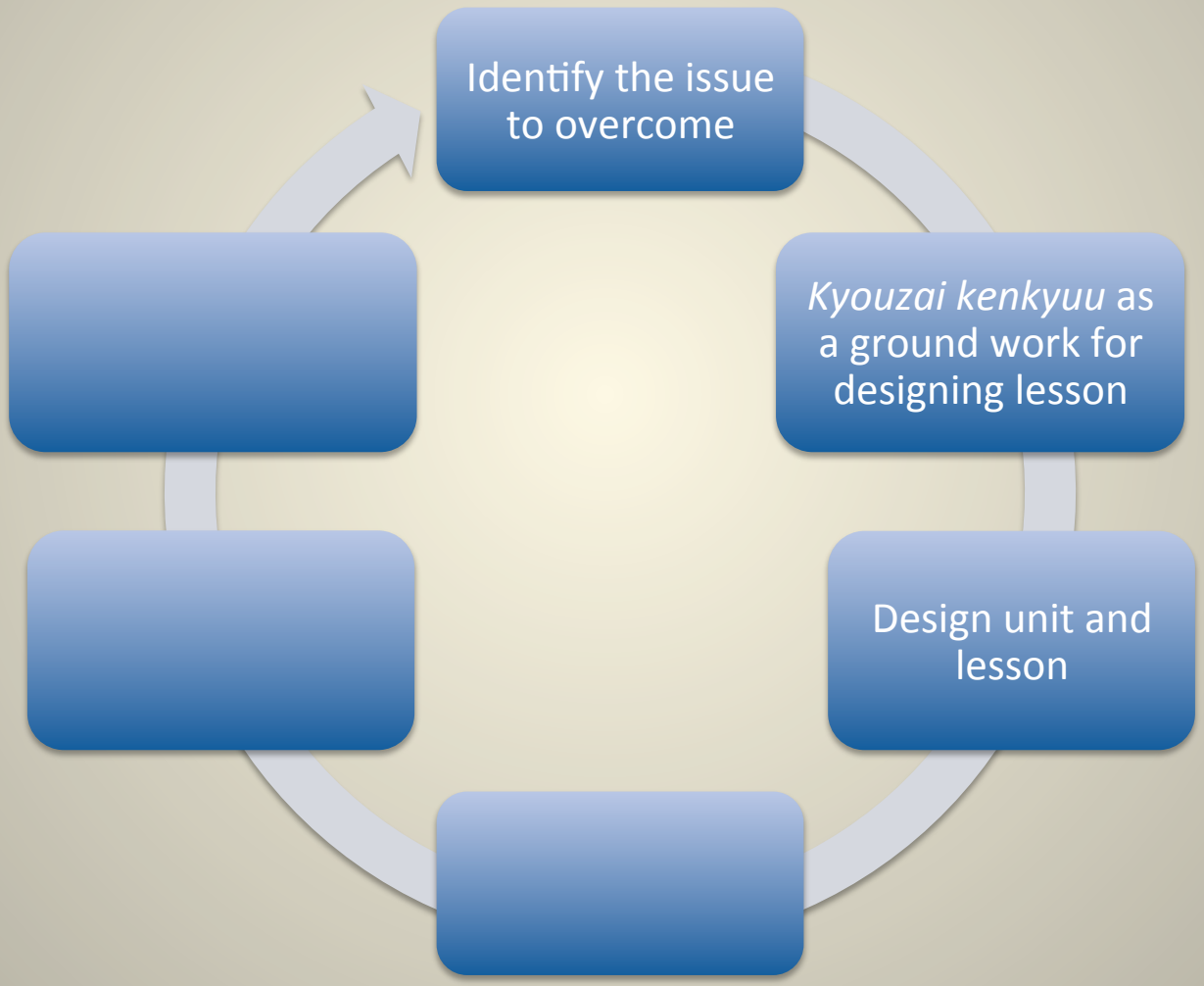
(d) research related to the topic.

Teachers often begin *Kyouzai kenkyuu* by comparing various teacher's guides published by textbook companies.

A Schedule for Designing Lesson

- The First Meeting (5 weeks before)
  - Identifying Your Research Goal/Theme
  - Deciding on a Topic to Investigate
- The Second Meeting (4 weeks before)
  - Investigate a Variety of Materials to Develop a Lesson Plan for a Research Lesson (*Kyouzai Kenkyuu*)
- The Third Meeting (3 weeks before)
  - Developing a Research Lesson and Writing a Lesson Plan
- The Fourth Meeting (2 weeks before)
  - Complete the first draft of lesson plan
- The Fifth Meeting (a weeks before)
  - Complete the final draft and prepare for the lesson
- Research Lesson and Post-Lesson Discussion

CLR cycle to impact on student learning of mathematics



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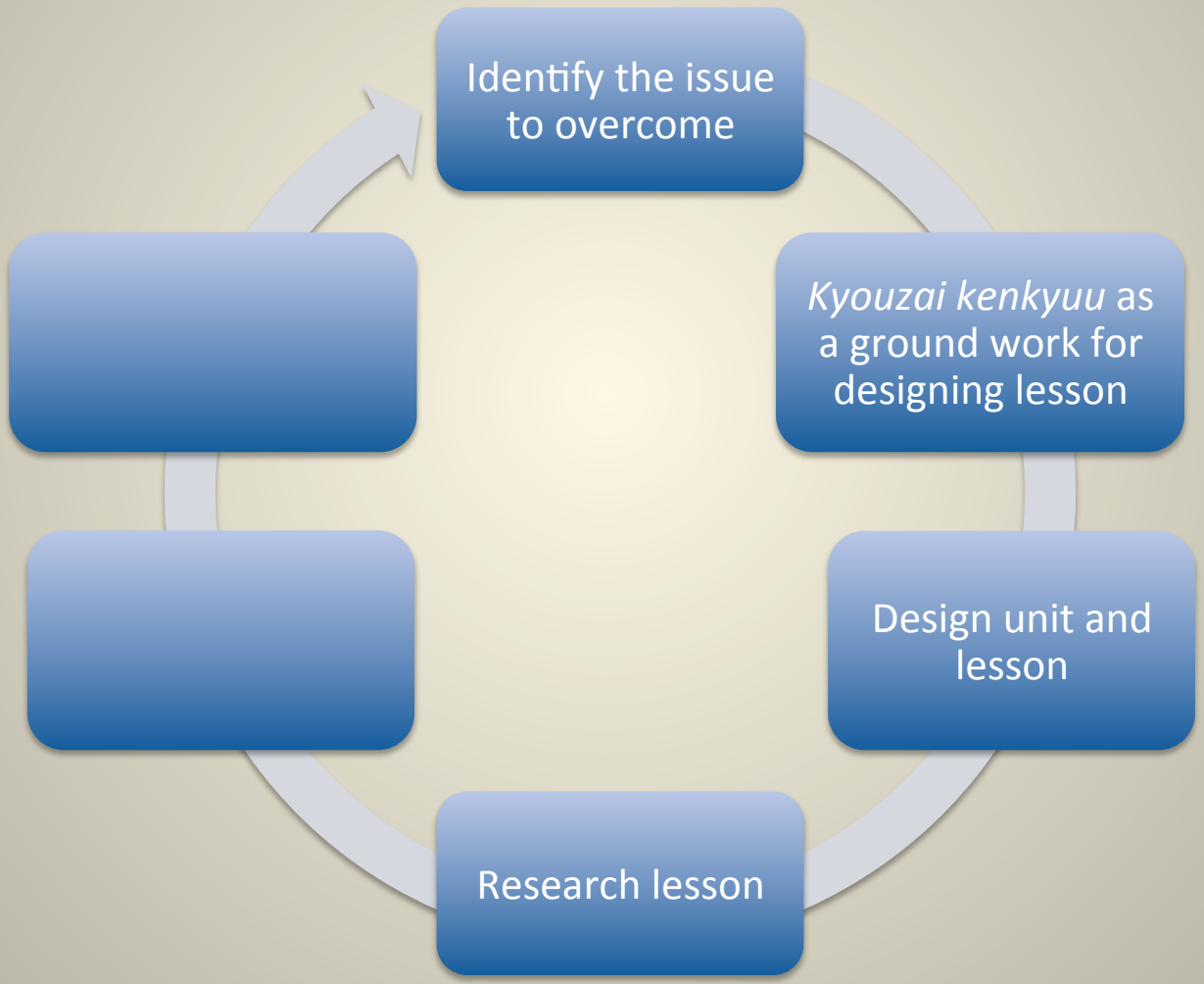
Guiding questions for high-quality research lesson plan
(Takahashi, 2014a)

- Does the lesson plan provide sufficient information for the teacher to understand the task and the flow of the lesson?
- Does the lesson plan provide sufficient information about how the planning team decided to teach the lesson as described by the plan?
- Do the objectives of the lesson plan clearly address the Course of Study?
- Are the tasks appropriate for the students given the date of the lesson?
- Are the key questions clear? Will they encourage students to think mathematically and help them complete the task independently?
- Does the lesson plan include reasonable anticipated student responses and indicate how the teacher will help students overcome any misunderstandings?
- Does the lesson plan include a plan for formative assessment and a plan to accommodate individual student differences during the lesson?

CLR cycle to impact on student learning of mathematics



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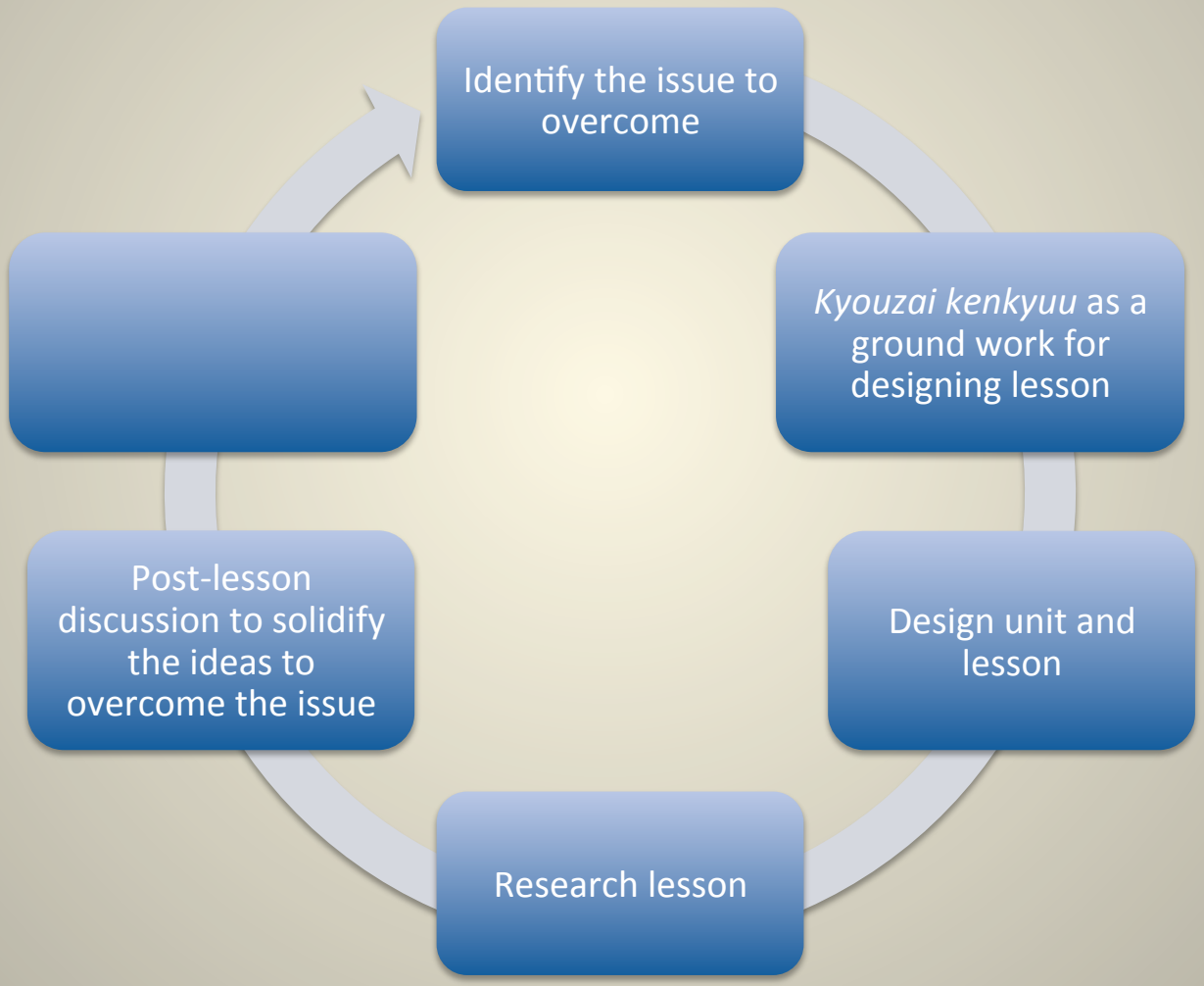
CLR cycle to impact on student learning of mathematics



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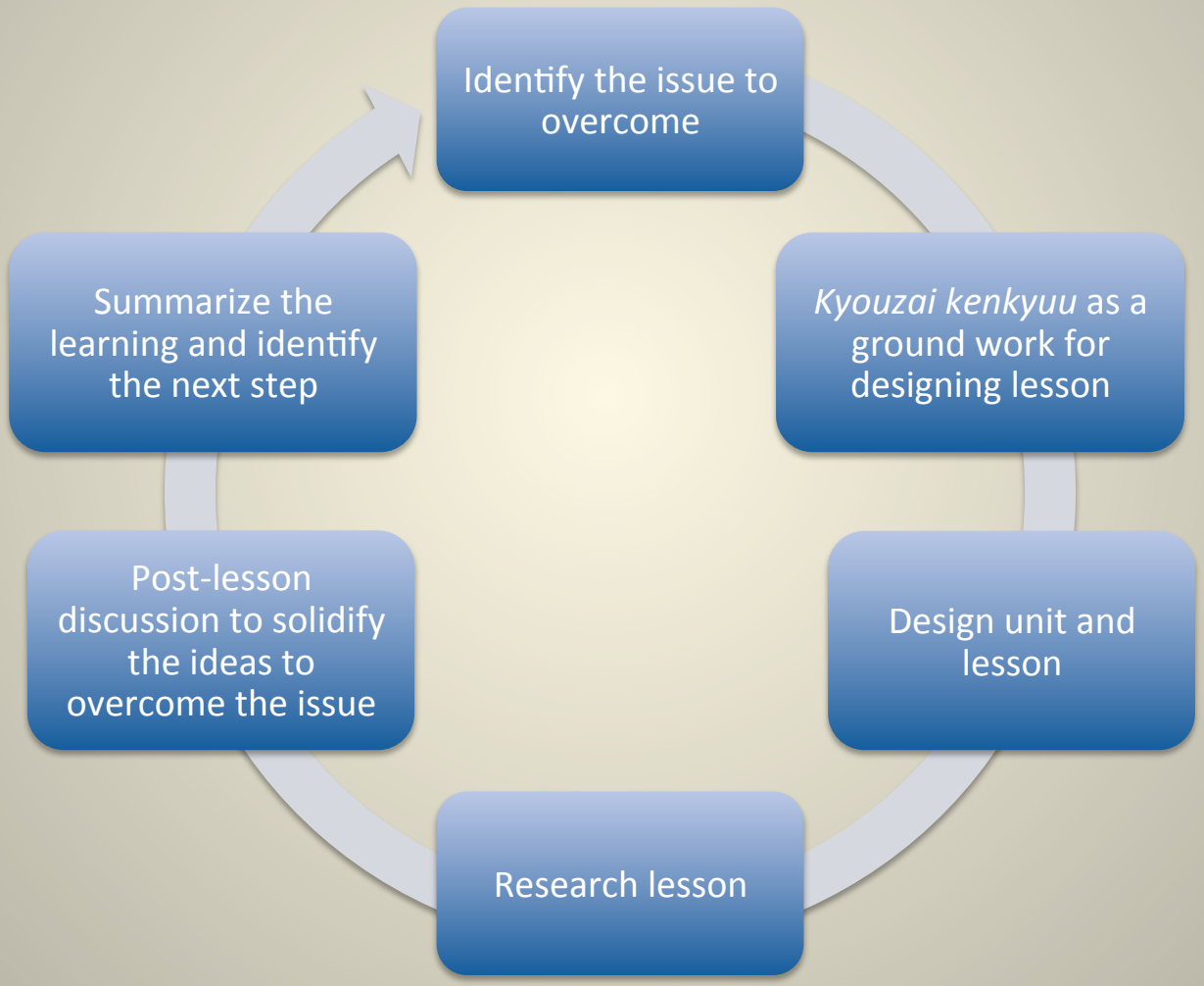
Effective Final Comments
(Takahashi, 2014b)

Effective final comments;

- bring new knowledge from research and the curriculum,
- show the connection between the theory and the practice,
- help teachers learn how to reflect on teaching and learning,
- include ideas and concrete examples to help the school and the teachers advance the school's research, and
- highlight the joy of collaborative study and of making the school a place for the staff to work together on the research theme.

CLR cycle to impact on student learning of mathematics



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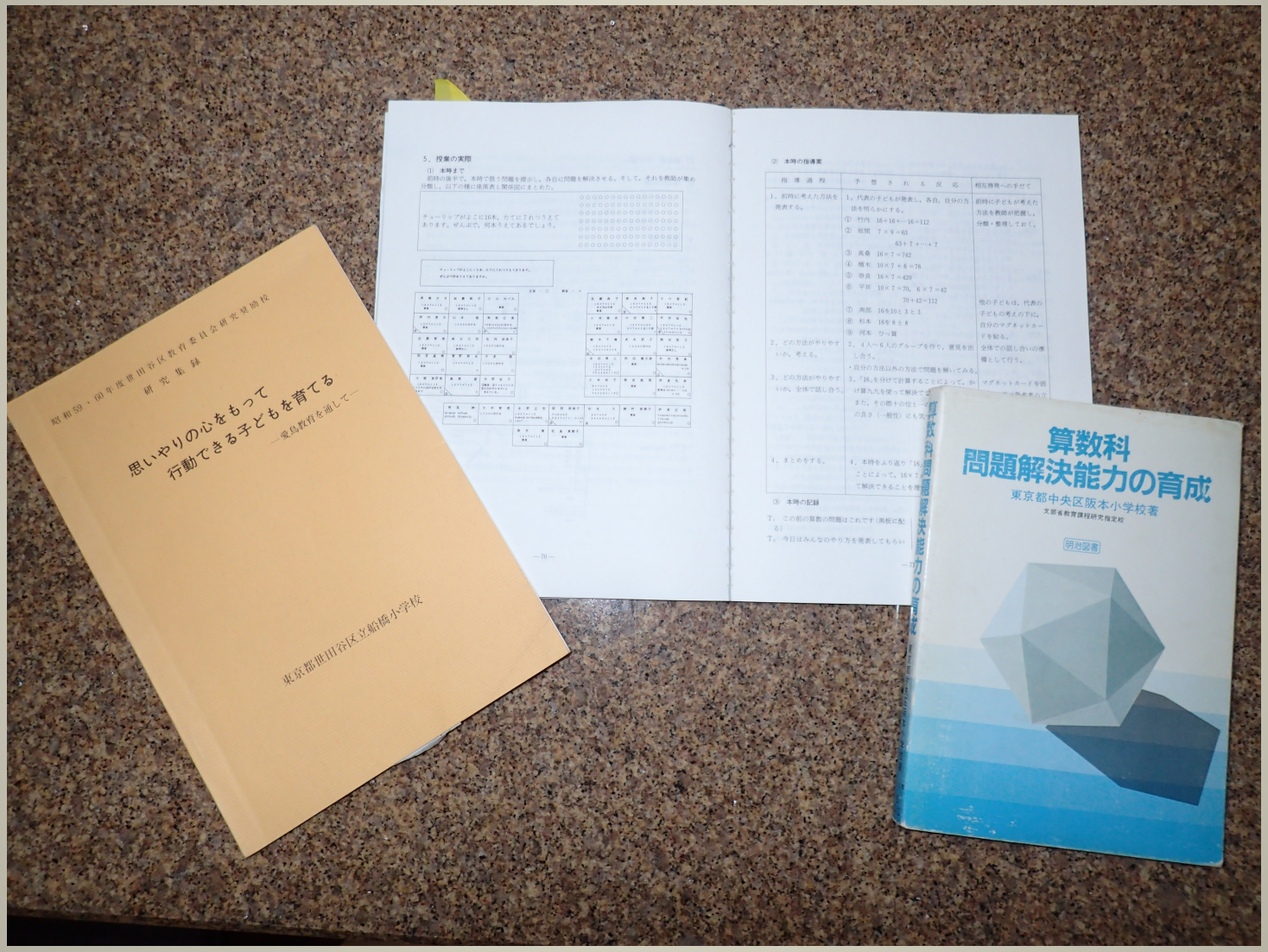

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A New Project based on our learning

To test our hypothesis, we started the following projects to developing school-wide CLR as a means to enact the curriculum that emphasize problem solving.

- In the U.S.

  Funded by the Bill & Melinda Gates Foundation, Mills College and Lesson Study Alliance with the support of Project IMPULA are supporting total 15 schools in three urban school districts, Chicago, Oakland, and San Francisco, to pilot the school-wide CLR.

- In Qatar

  Funded by the Qatar Petro Chemical Company, Project IMPULS and Lesson Study Alliance are supporting Qatar University to implement school-wide CLR in four independent schools in Doha.

How can school-wide CLR be built?

We hope to implement school-wide lesson study by engaging in three major strands of work:

- building the school-wide lesson study at the sites in three districts,
- documenting the work through video and print materials that can be put online for other sites to use, and
- ongoing formative evaluation of the school-wide lesson study so that we identify problems and craft solutions in a timely fashion.

We believe that through these elements, we can better understand school-wide lesson study and also begin to disseminate our work.

Data	Description	Purpose/Use
Video and artifacts of lesson research	Artifacts include lesson plans, student work, tasks, and written reflection on lesson research cycle	Understand how lesson research cycles are conducted and perceived by teachers, how materials are used, and nature of instruction. Information will be used to improve materials and process, as well as to document process for future sites.
Surveys Beginning and end of school year at program and comparison sites. Additional administrations of a 5-minute subset of items 2 times during school-year at program sites only.	Published survey items on collective responsibility, expectations for student achievement, feasibility of standards, perceived quality of professional learning, etc.	Understand educators' attitudes and experience of professional learning, and track any changes over time. Information will be used formatively and summatively, to improve the work and understand its impact.
Interviews	Fuller information on experience of professional learning.	Interviews will allow more open-ended explication of how collaborative lesson research is experienced.
Student Achievement Data	District-collected student achievement and demographic data	Track student achievement at participating sites and comparison sites, to understand impact of work.

Resources to Support School-wide CLR

- Map of Research Conception for School-wide Collaborative Lesson Research
- Research Lesson Plan Template
- LessonNote: Tablet Based Lesson Observation Tool

  LessonNote is a free App for iPad and iPad mini.

  You can obtain from Apple App Store.

  http://www.lessonnote.com

Update of the Project will be on Facebook pages

- Impuls-tgu
- Lesson study alliance
- Lesson study mills
- LessonNote