

Hand in Hand: Lesson Study and Problem Solving in Japan

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Conclusions

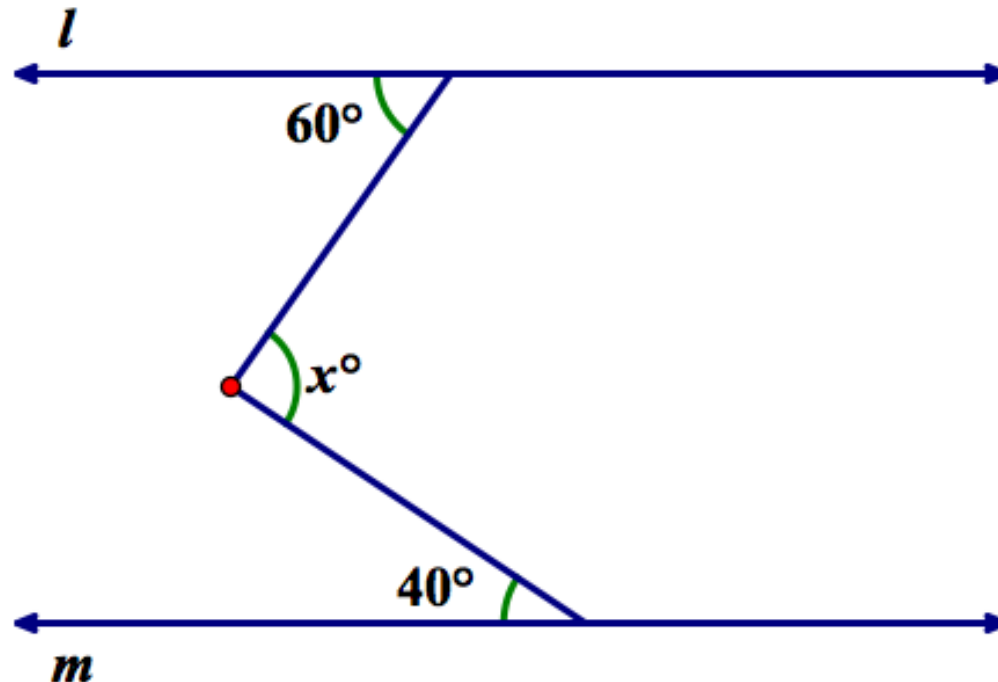
- ▶ Problem solving is just as much a disposition as a skill (or knowledge).
 - ▶ If we want our students to be problem solvers, we must also be problem solvers.
 - ▶ Our problems are about mathematics teaching and learning.
 - ▶ Lesson study is a problem solving process.
 - ▶ Lesson study is useful in polishing our crafts of teaching as well as advancing professionalism in the education community.
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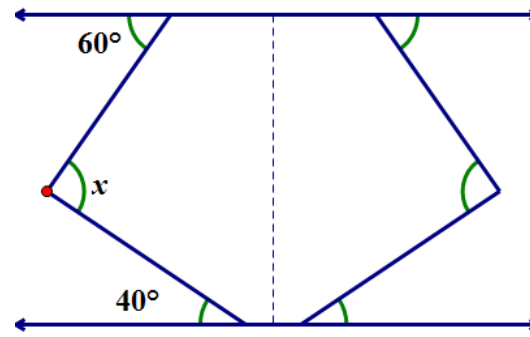
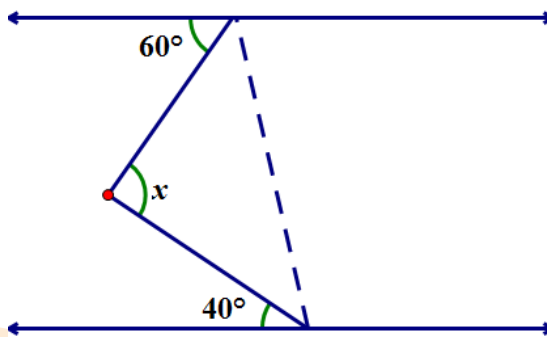
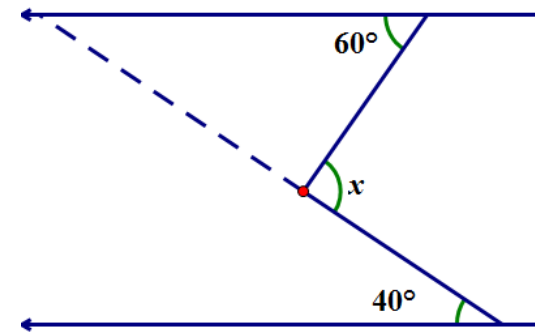
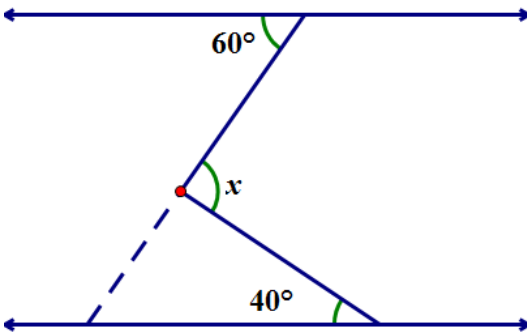
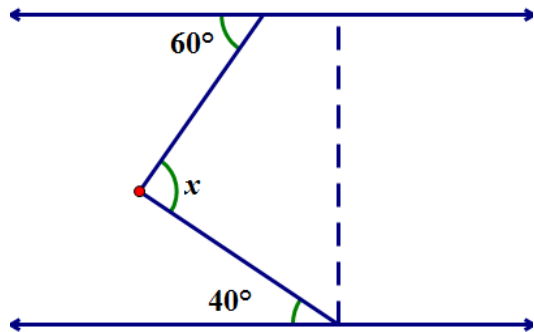
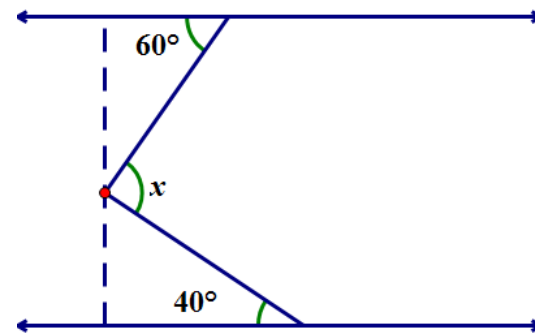
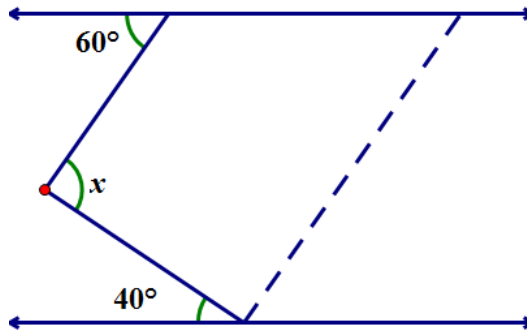
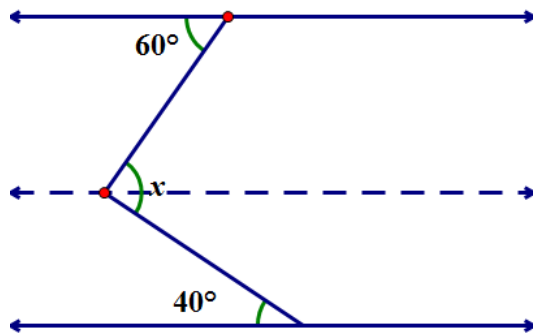
Presentation Outline

- ▶ Mathematics teaching in Japan
 - Some features of Japanese maths lessons
 - Teaching through Problem Solving
 - ▶ Professional development in Japan: Lesson study
 - What is lesson study?
 - *Kyozaikenkyu*: a key for an effective lesson study
 - Why should teachers engage in lesson study?
 - ▶ Implications outside of Japan
 - In the United States
 - In Ireland?
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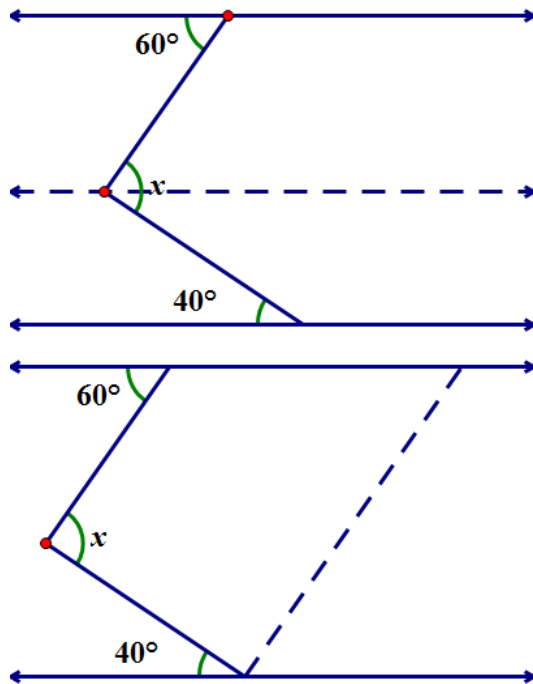
Let's do maths!

- Find as many different ways as you can to find the value of x in the figure below.
Lines l and m are parallel.

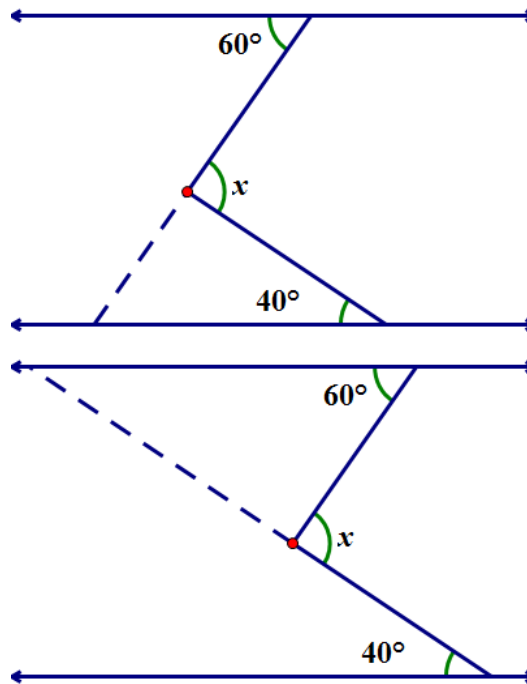




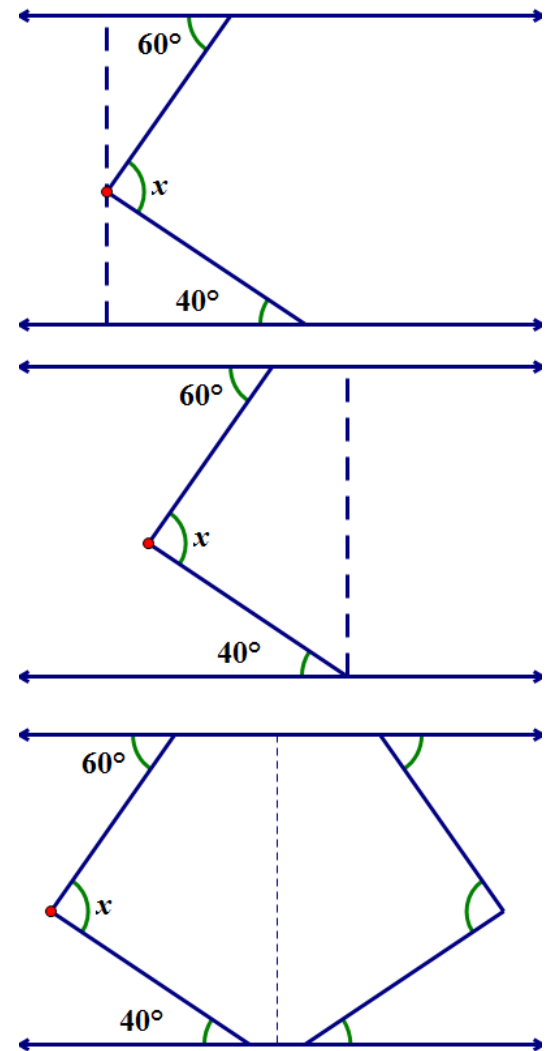
Draw a parallel line.



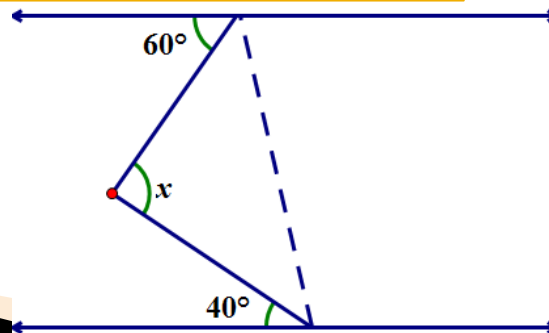
Extend a given line.



Draw a perpendicular line.



Connect two points.

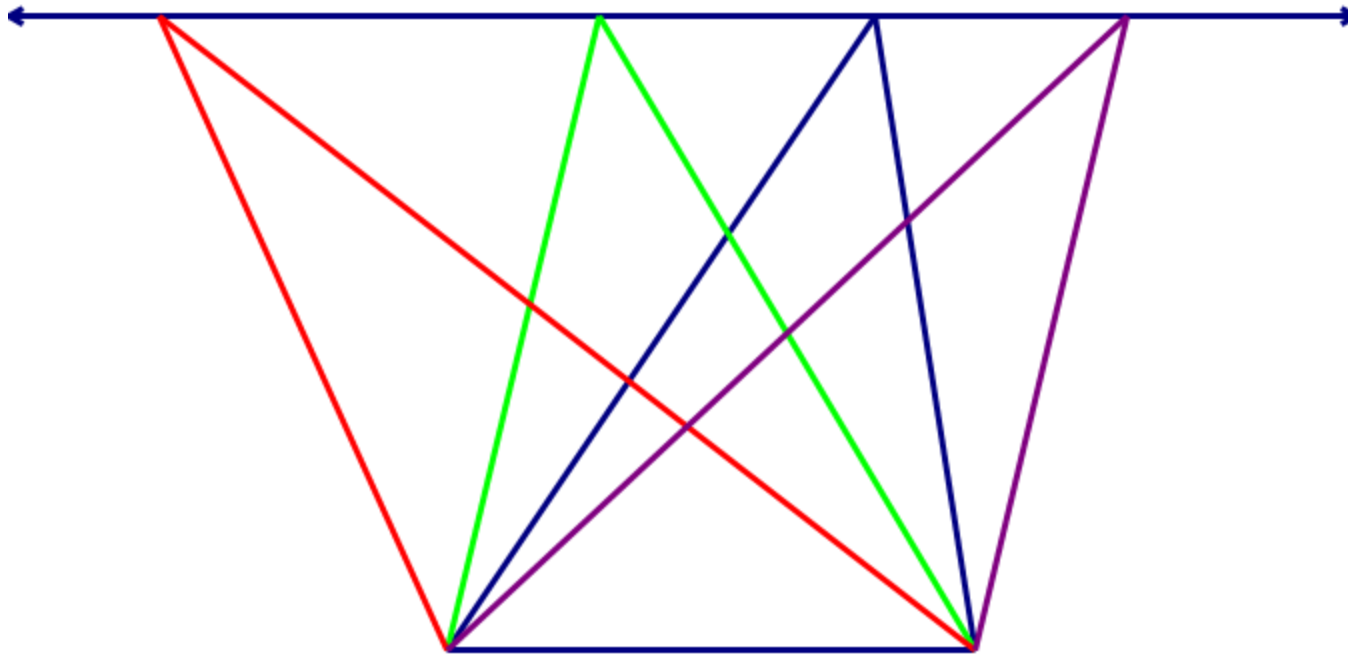


TIMSS Video Study

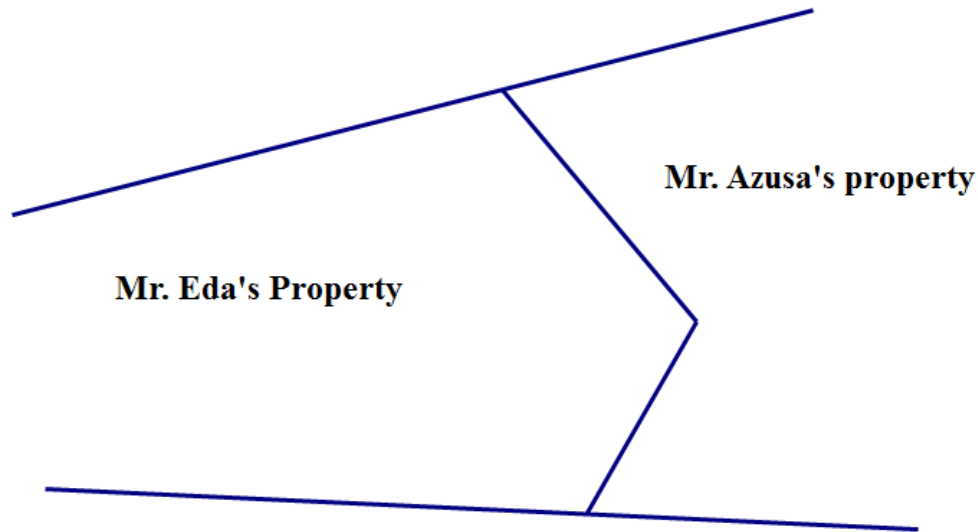
- ▶ Grade 8 (14 years old)
- ▶ Geometry

Previous Day's Work

- ▶ The area of triangle will stay constant when a vertex moves along the line parallel to the base.

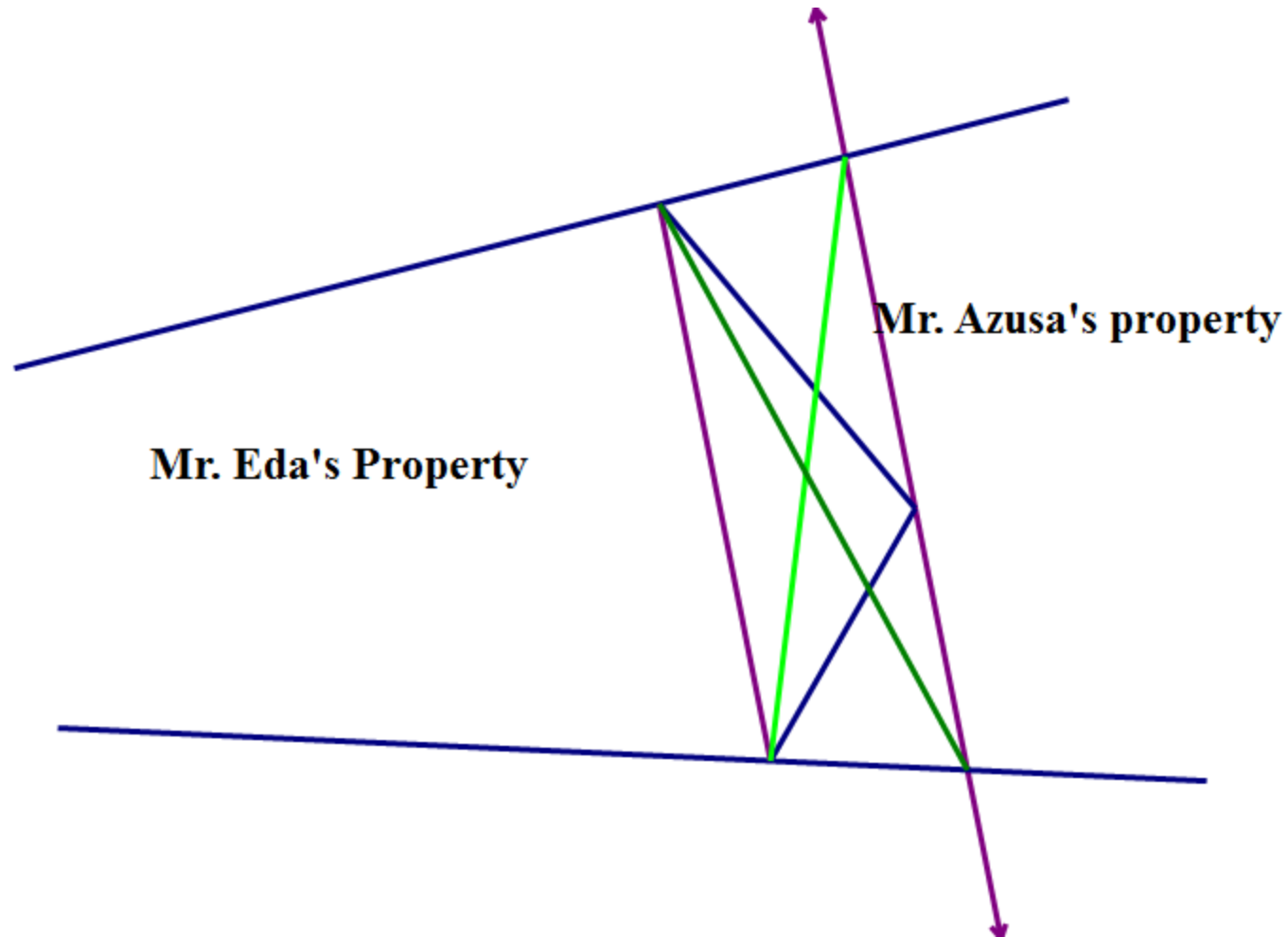


Today's problem 1



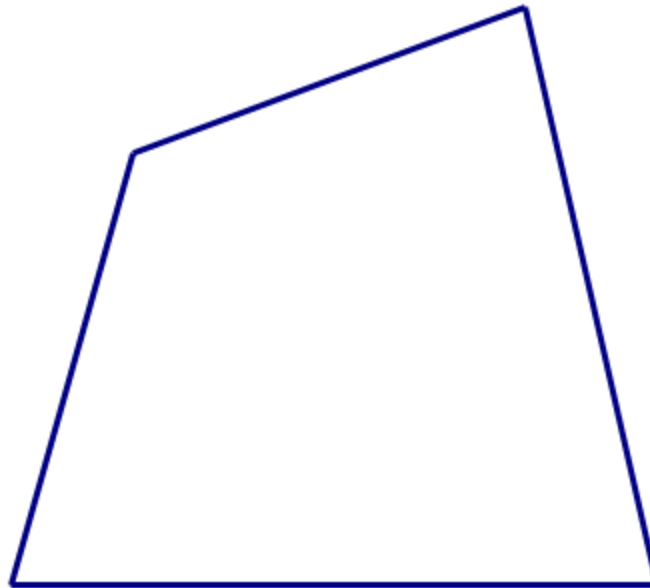
- ▶ Draw a method of changing this shape without changing the area.
- ▶ Draw a new straight boarder so that the sizes of the properties will not change.

Students' solutions

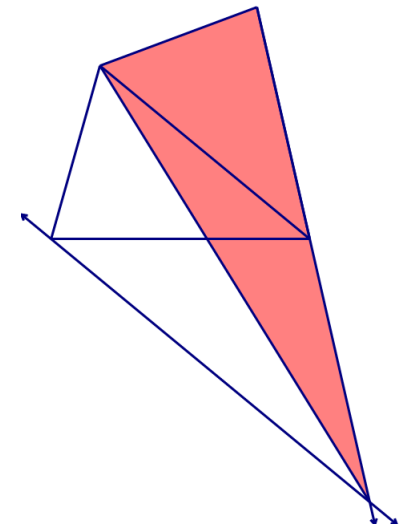
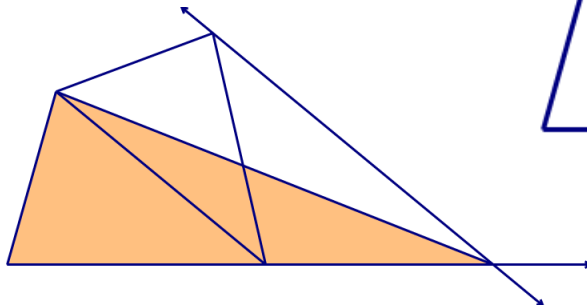
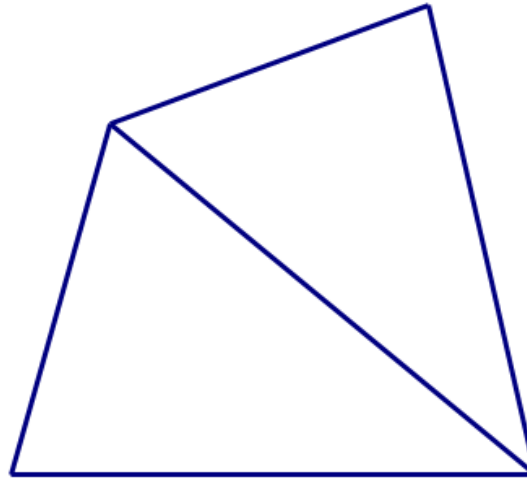
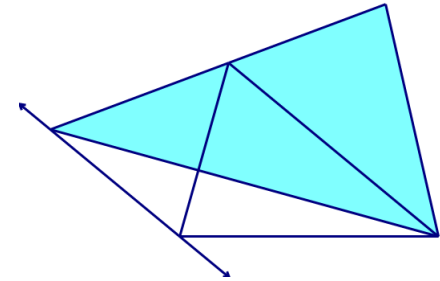
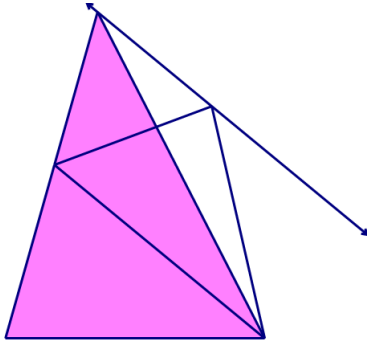


Today's Problem 2

- ▶ Without changing the area, transform the given quadrilateral into a triangle.



Summary of the solutions



Homework

- ▶ Think about ways to transform a pentagon into a triangle without changing its area.

Features of Japanese maths lesson

- ▶ Teaching through Problem Solving (“structured problem solving” – Stigler & Hiebert)
 - ▶ Focus on one problem (or a few problems).
 - ▶ Teacher presents a problem without first demonstrating how to solve the problem.
 - ▶ Comparing and critically analyzing solution strategies is the main component of a maths lesson.
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Problem Solving

- ▶ Problem solving means engaging in a task for which the solution method is not known in advance. (NCTM, *An Agenda for Action*)
 - ▶ An appropriate problem is something students can solve using what they have previously learned.
 - ▶ A productive problem is something that can lead to a new idea by reflecting on its solutions.
- 

Teaching through Problem Solving

- ▶ Solving the problem is not the goal.
- ▶ “A mathematics lesson starts *after* students solve the given problem.”
- ▶ Students’ discussion of solution strategies (carefully guided by the teacher) is the center piece of a maths lesson.

George Polya

How to solve it (1945)

- ▶ One of the most important tasks of the teacher is to help his students.
 - This task is not quite easy; it demands time, practice, devotion, and sound principles.
 - ▶ The student should acquire as much experience of independent work as possible.
 - But, if he is left alone with his problem without any help or with insufficient help, he may make no progress at all.
 - If teacher helps too much, nothing is left to the student.
- 

George Polya (cont.)

- ▶ The teacher should help, but not too much and not too little, so that student shall have reasonable share of the work.
 - ▶ The teacher should leave him at least some illusion of independent work.
 - ▶ The best is, however, to help the student naturally.
- 

George Polya (cont.)

- ▶ The teacher should put himself in the student's place, he should see the student's case, he should try to understand what is going on in the student's mind, and ask a question or indicate a step that could have occurred to the student himself.

George Polya (cont.)

- ▶ The teacher should put himself in the student's place, he should see the student's case, he should try to understand what is going on in the student's mind, and **ask a question or indicate a step that could have occurred to the student himself.**

What are some questions?

- ▶ What do we know and what do we not know?
 - ▶ What do we need to know to find what we do not know?
 - ▶ What do I know that can be helpful?
 - ▶ What's similar about this problem to what I already know, and what's different?
 - ▶ What is changing and what is staying the same?
 - ▶ etc.
- 

George Polya

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How do Japanese teachers develop their craft?

- ▶ Through lesson study.

Lesson Study

- ▶ Lesson study is a professional development activity long favored by Japanese teachers.
 - ▶ Japanese teachers have practiced lesson study for over 100 years.
 - ▶ The center piece of lesson study is the observation and discussion of a carefully designed “research lesson.”
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What makes LS unique?

- ▶ Teacher-centered; Teacher-focused
 - ▶ Focus on students' learning
 - ▶ On-going/continuous
 - ▶ Collaborative
- 



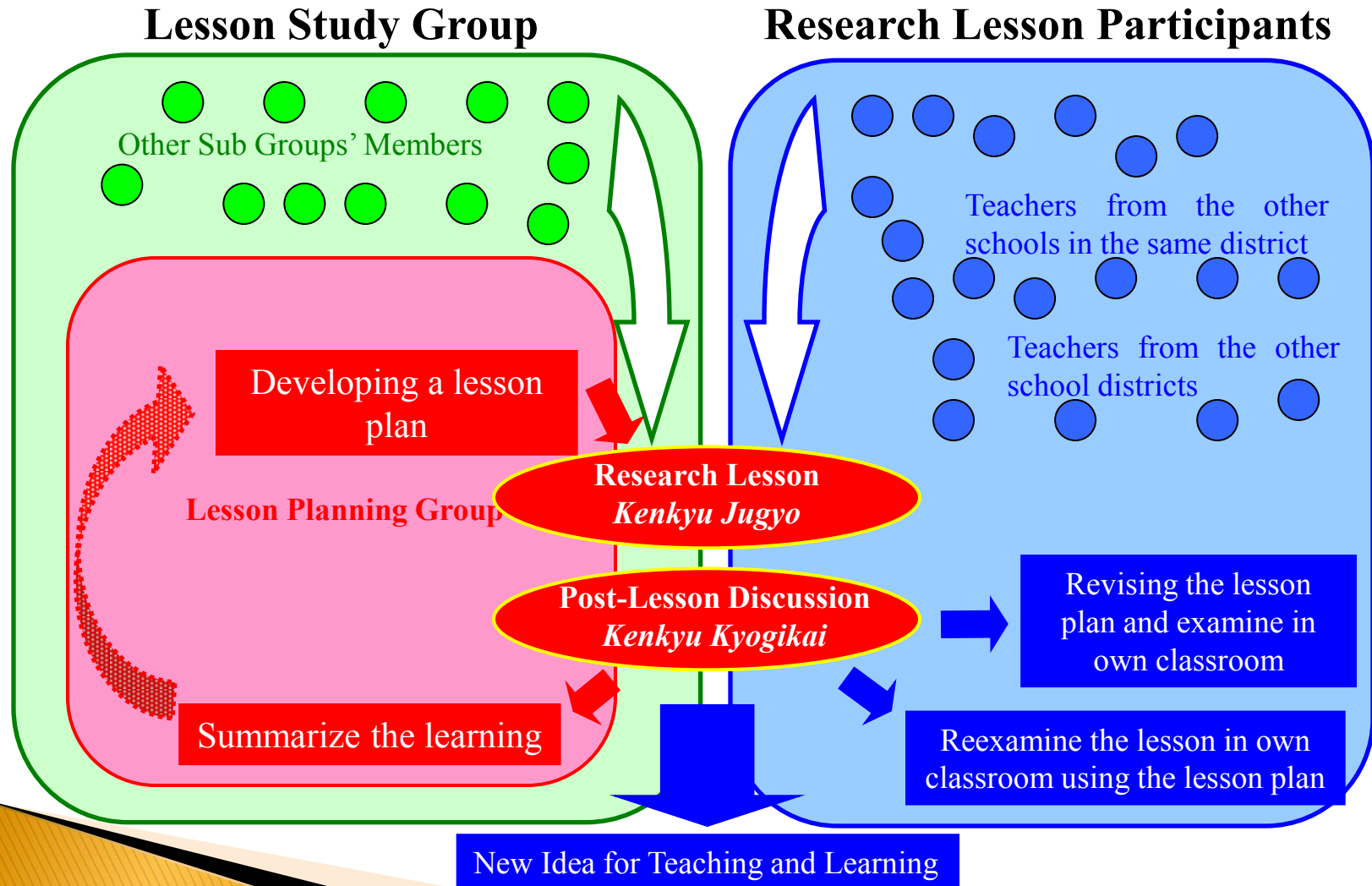
Lesson Study

- ▶ Teachers learning from each other, not from “experts”
- ▶ Teachers learning to teach through teaching and reflecting on own teaching

Basic Cycle of Lesson Study

- ▶ Start with a challenge/issue.
 - ▶ Examine the teaching materials.
 - ▶ Collaboratively develop a lesson plan based on the study of the teaching material – a proposal to tackle the challenge/issue.
 - ▶ Publicly teach the research lesson.
 - ▶ Critically discuss the research lesson by everyone who observed the lesson.
 - ▶ Reflect and summarize the learning.
- 

Basic Lesson Study Cycle



Lesson Study

- ▶ It is not about demonstrating a model lesson or creating the best lesson plan.
 - ▶ It is a problem solving activity:
 - Start with a problem of mathematics (or any other subjects) teaching and learning.
 - Develop a possible plan.
 - Implement the plan – as a public lesson.
 - Look back
- 

Kyozaikenkyu: A key for effective LS

教材研究



What is *kyozaikenkyu*?

教 材研究

“*kyo*”: to teach or
instruct



What is *kyozaikenkyu*?

教 材 研究

“*zai*”: raw materials

What is *kyozaikenkyu*?

教材研究

kenkyu: study or research

教材研究

- ▶ Study of “raw materials for teaching”
- ▶ “Instructional materials” – more than textbooks and other prepared curriculum materials.

Key questions asked during *kyozaikenkyu*

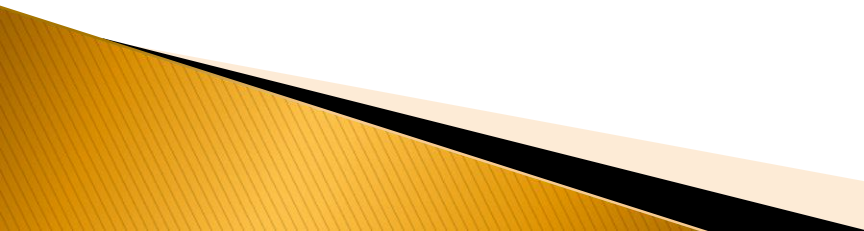
- ▶ What do we want students to understand?

Key questions asked during *kyozaikenkyu*

► What do we want students to understand?

- More than just being able to recite or state area formulae.
- Why these formulae work:
 - Why $\div 2$ in the triangle & trapezoid formulae?
 - What is the height?
 - Can any side be the base?
- Use formulas
 - to find area
 - to develop further formulae
 - to explore changes in measurement & shape

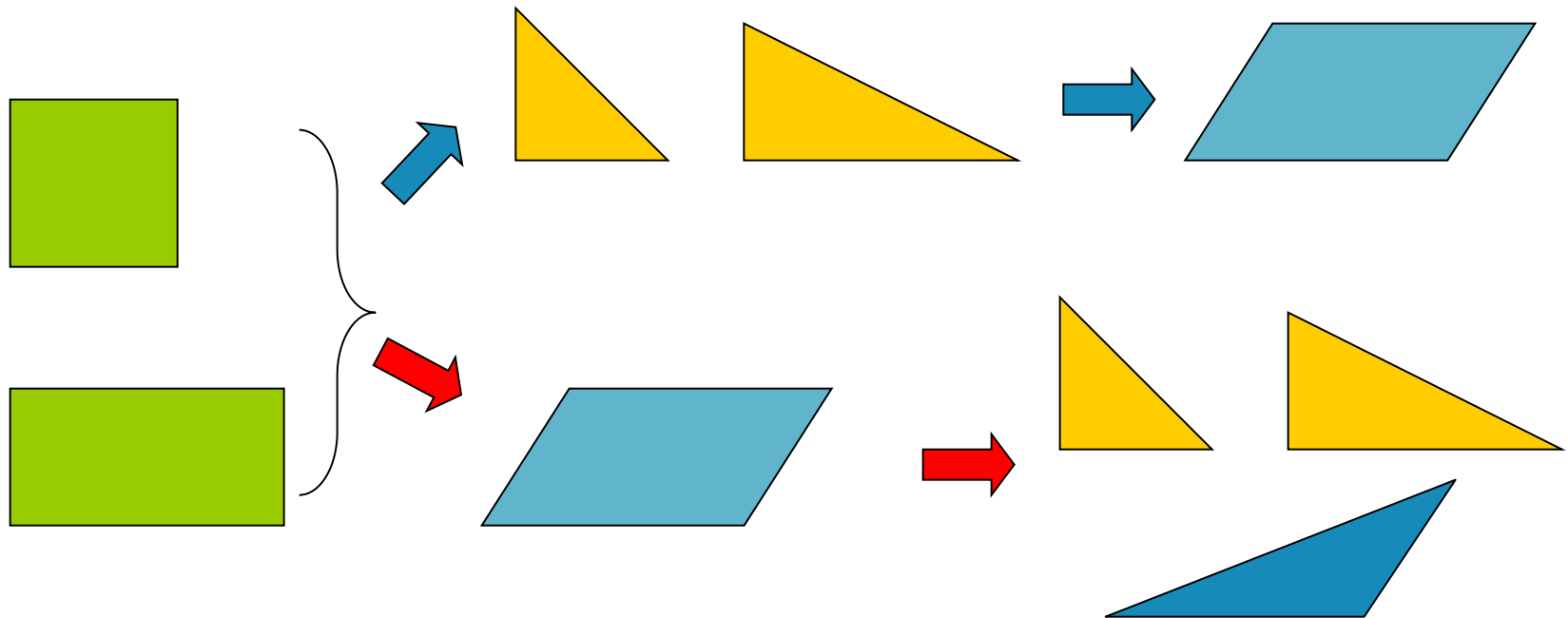
Key questions asked during *kyozaikenkyu*

- ▶ How can students develop the goal understanding?
 - What do students already know that they can use to develop this understanding and how?
 - How do students need to understand this particular idea?
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Key questions asked during *kyozaikenkyu*

- ▶ How is this topic treated in various curriculum materials?

Scope and Sequence of the Area Units: Two Possibilities

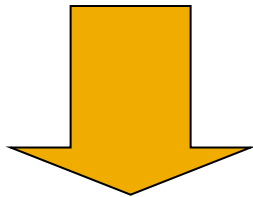


What are advantages and disadvantages of each approach?

- ▶ Triangles first
- ▶ Parallelograms first

Key questions asked during *kyozaikenkyu*

- ▶ How can we teach this particular topic effectively?
 - What are common misunderstandings students have about this topic?
 - What tools/manipulatives can students use to develop their understanding?



Developing learning tasks

Japanese saying

To teach one, you need to learn ten.

After you learn ten, you must discard nine.



Why lesson study?



Three Levels of Teaching

(Sugiyama, 2008)

- ▶ **Level 1:** Teachers can tell students important basic ideas of mathematics such as facts, concepts, and procedures.
 - ▶ **Level 2:** Teachers can explain the meanings and reasons of the important basic ideas of mathematics in order for students to understand them.
 - ▶ **Level 3:** Teachers can provide students opportunities to understand these basic ideas, and support their learning so that the students become independent learners.
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- ▶ Knowing the content that is written in the textbooks is the most important foundation to be a (level 2) teacher, however it is not enough to be an effective (level 3) teacher.
 - ▶ Teaching through problem solving is a type of level 3 teaching.
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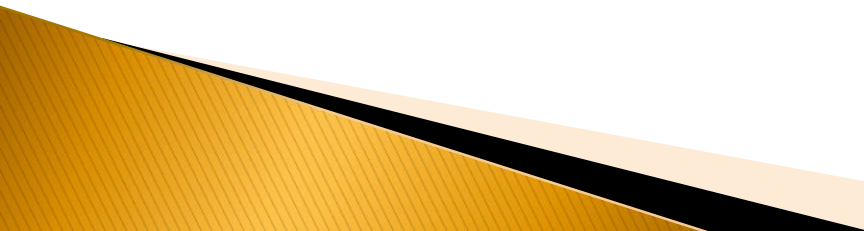
Professional Learning

- ▶ No teacher education program can prepare Level 3 teachers.
- ▶ All teachers – prospective, novice, or experienced – need on-going opportunities to continue growing toward Level 3 teaching throughout their careers.

Two Phases of Professional Learning (Takahashi, 2011)

- ▶ Phase 1: Professional learning focused on developing the knowledge base for teaching mathematics (content, pedagogy, and children).
 - ▶ Phase 2: Professional learning focused on developing expertise for teaching mathematics
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Phase 1 Professional Learning

- ▶ Teachers learning through reading books and resources, participating in workshops, watching videos, etc.
 - ▶ Preservice teacher education is primarily Phase 1 Professional Learning.
 - ▶ Having the sound knowledge base is necessary for successful mathematics teaching, but it is not sufficient for Level 3 teaching.
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Phase 2 Professional Learning

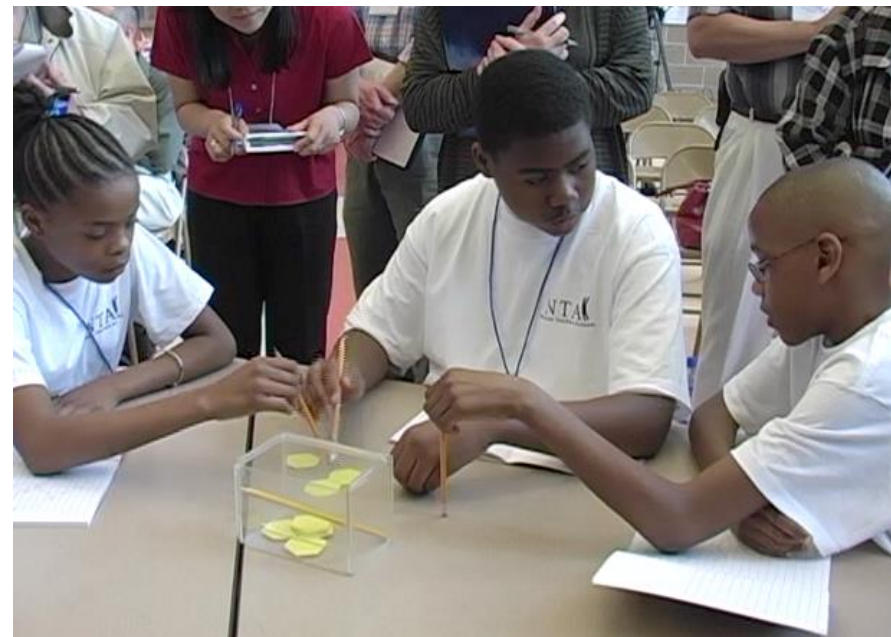
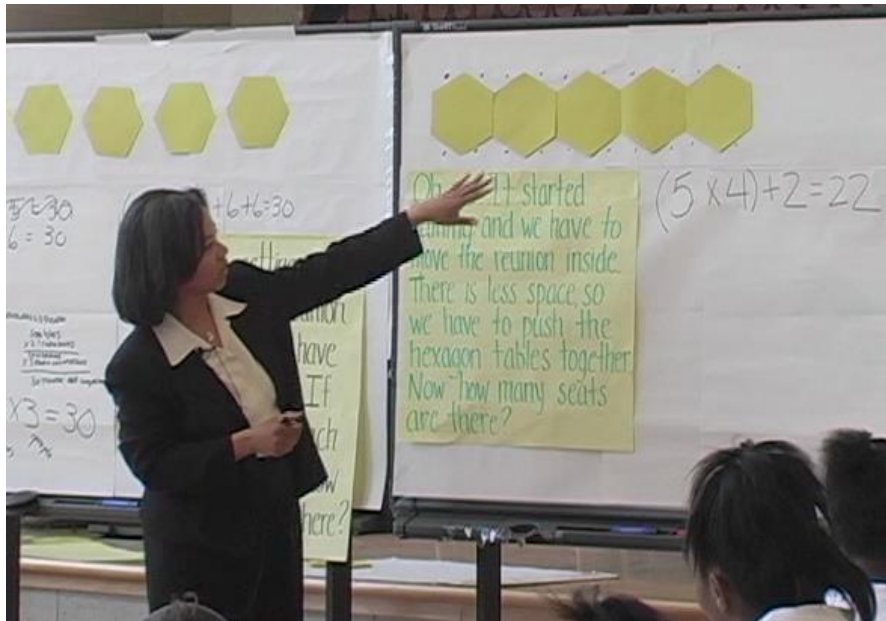
- ▶ Expertise for mathematics teaching practices must be learned through reflection on practices.
 - ▶ Teachers should plan a lesson carefully, teach the lesson based on the lesson plan, and reflect upon the teaching and learning based on the intention of the lesson plan.
 - ▶ Reflecting on own lessons is limited.
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Phase 2 Professional Learning

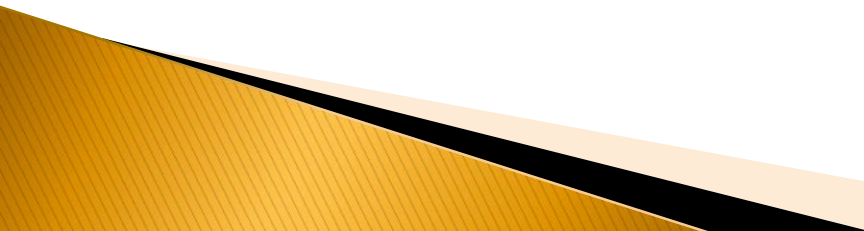
- ▶ Lesson Study is used as the primary mechanism for Phase 2 Professional Learning by Japanese teachers.

Implementing Lesson Study: US

- ▶ Lesson study was introduced in 1999/2000.
- ▶ Lesson study organizations:
 - Chicago Lesson Study Group:
<http://www.lessonstudygroup.net/index.php>
 - Lesson Study Group at Mills College:
<http://www.lessonresearch.net/>
 - William Paterson University:
<http://www.wpunj.edu/coe/lessonstudy/>



Challenges

- ▶ Time
 - ▶ Lesson study leadership capacity
 - LS often facilitated by non-teachers (e.g., university faculty, professional development providers, district curriculum coordinators, etc.)
 - Developing skillful moderators of post-lesson discussion
 - Developing high-quality outside commentators
 - ▶ LS often conducted with fixed-time financial supports
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Lesson Study: Is it *nice to have*, or is it *must have*?

- ▶ To improve teaching practice, we must carefully examine our own teaching practice, and LS provides a useful mechanism.