



Learning to See Students' Opportunities to Learn

Leadership Coaching Lab

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Learning Goal for This Session

- Work toward developing a research-based process for identifying, critiquing, and improving students' opportunities to understand and reason sensibly about mathematics
- Why is this important?

What Counts as a Learning Opportunity to Understand and Reason?

- The TIMSS video study examined about 100 8th–grade math lessons in each of 6 higher achieving countries plus the U.S. (Australia, Czech Republic, Hong Kong, Japan, Netherlands, Switzerland)
- Of the 75 indicators of teaching that were assessed, 1 was clearly shared by the high achieving countries.

Types of Problems Presented to Students

- Relevant finding is based on classifying all problems presented during the lessons into one of three categories.
 - ◆ *Recalling Facts* (RF): recalling or applying facts, definitions, or conventions
 - ◆ *Using Procedures* (UP): applying learned procedures
 - ◆ *Making Connections* (MC): constructing relationships among ideas, facts, or procedures
- We will focus on UP and MC

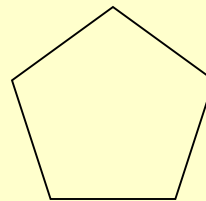
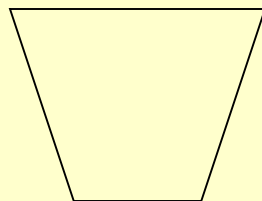
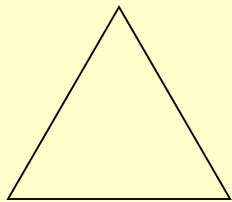
Examples: Making Connections

- Solve these two equations and describe what is different about their solutions

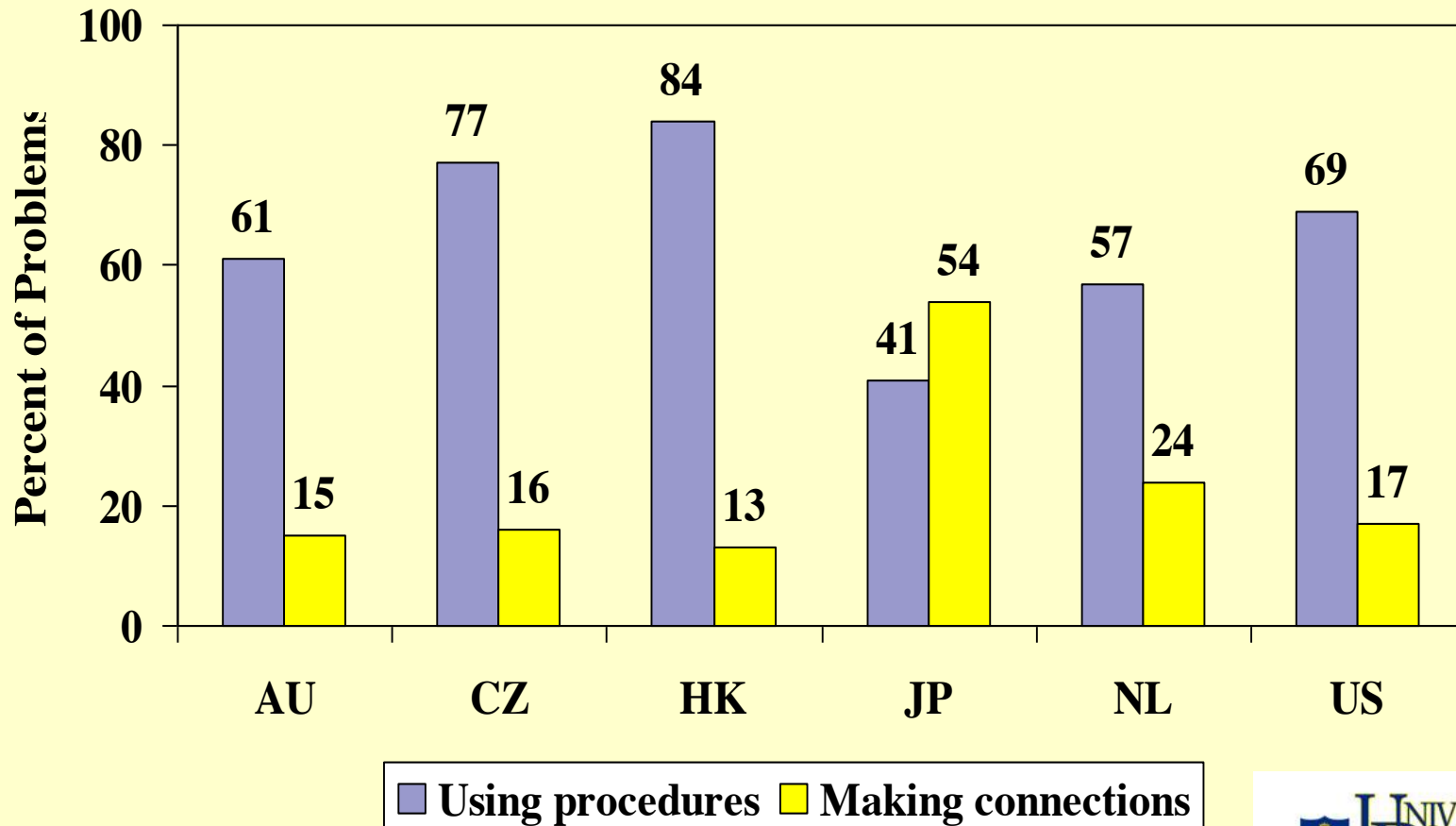
$$2x + 4 = x + 6$$

$$2x + 10 = 2(x + 5)$$

- Find a pattern for the sum of the interior angles of a polygon



Types of Problems Presented



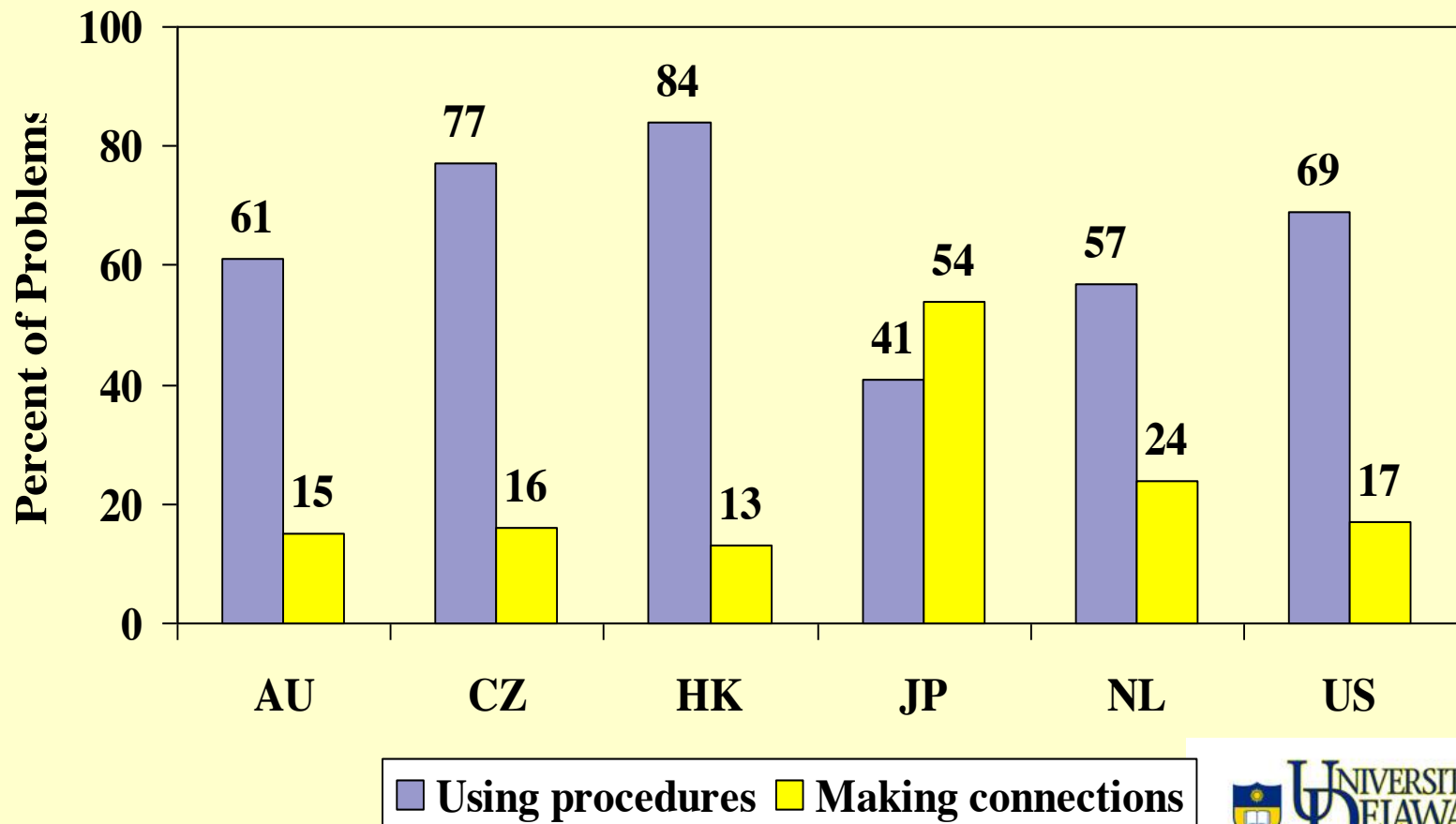
Types of Problems Presented AND Worked On During the Lesson

- Each problem was coded a second time based on how it was worked on and discussed during the lesson.
- This is where students' opportunities to learn can be found. This is where teaching really matters. Actual learning opportunities do not always align with the kinds of problems presented.

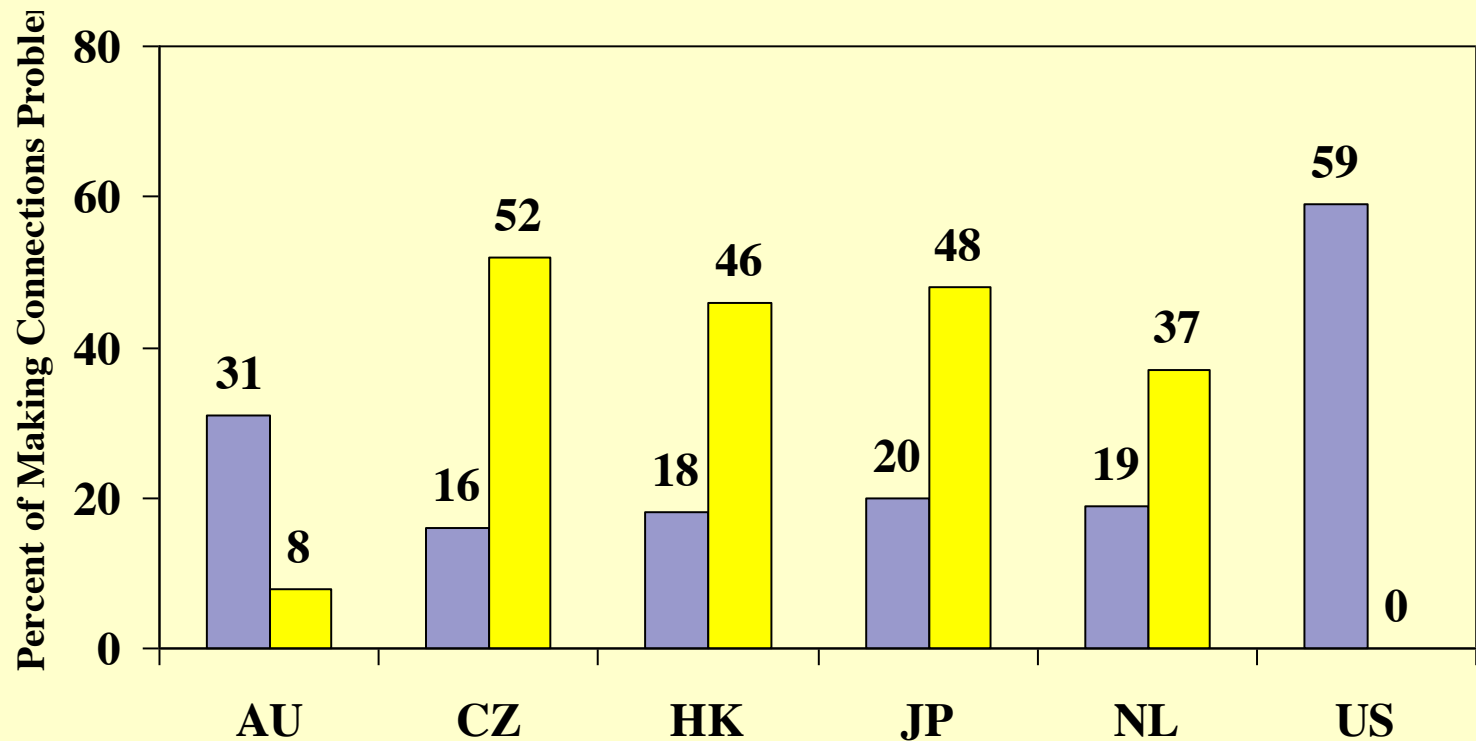
Example: Transforming a Problem From Making Connections \Rightarrow Using Procedures

- Problem: Find a pattern for the sum of the interior angles of a polygon
- Worked on as Making Connections
 - ◆ Measure the sum of the angles for 3-, 4-, and 5-sided polygons; predict for 6-sided polygons; for n-sided polygons; develop a general formula
- Worked on as Using Procedures
 - ◆ Present formula [Sum = $180(n - 2)$] and ask students to practice

Again: Types of Problems Presented



How Making Connections Problems Were Worked On During the Lesson



■ Using procedures ■ Making connections

Finding: Key Learning Opportunities Found in Working on MC Problems

AS MC Problems

- What kind of teaching ensures these learning opportunities?
 - ◆ Students do some of the important mathematical work
 - ◆ Students present, or hear, the key mathematical connections that generate understanding

Doing Important Mathematical Work

Allowing time for students to work on mathematics problems that . . .

- ◆ Capture the key mathematical point (the learning goal) of the lesson
- ◆ Are just beyond problems students have worked before (this creates the need to do mathematical work)

Making Mathematical Connections

Orchestrating a purposeful class discussion that . . .

- ◆ Focuses on the key mathematical relationships that enable students to achieve the learning goal
- ◆ Prepares students to *hear* these relationships
 - Doing mathematical work often is good preparation

“Key Relationships Enable Students to Achieve the Learning Goal”

- Recall our primary learning goals: Understand and reason sensibly about mathematics
 - ◆ The basis for understanding and reasoning about mathematics is making connections among facts, procedures, and concepts
 - ◆ That means learning goals, even for individual lessons, must consider what relationships or connections students should have an opportunity to create

Review – Part 1

- Try not to discuss learning opportunities without specifying what they are for: What are the learning goals?
- Key learning goals are to help students understand and reason about mathematics. Why?
- These learning goals can be written in terms of what mathematical relationships students should create.
- To provide these learning opportunities
 - ◆ Students must do some of the mathematical work, and
 - ◆ The key relationships must be made explicit

End of Part 1.
Break Time!

Part 2

Getting Good at Seeing Opportunities to Learn

- Recall our goal: Work toward developing a research-based process for identifying, critiquing, and improving students' opportunities to understand and reason about mathematics
- Watch lots of classroom lessons and talk about what you see with colleagues
- A good way of doing this is to watch video clips of classroom lessons.

Activity: Analyzing Video Clips

- View and analyze two video clips
- Clips come from an instrument developed by Nicki Kersting (University of Arizona) that we used in our research on ETE graduates
- Learning goal: Students will understand the key ideas underlying topic X.

Video Clip #1

- Clip #1: Subtraction of Fractions
- Learning goal: Students will understand the key ideas underlying subtraction of fractions.
- Task: Describe how the teacher and students interact around the mathematical content.
- Process:
 - ◆ View the clip twice.
 - ◆ Think and write an individual response.
 - ◆ Discuss observations with a neighbor.
 - ◆ Whole-group discussion

The Power of Seeing Student Learning Opportunities in Video Clips

- Kersting asked 5th – 7th grade teachers to watch and analyze video clips of fraction lessons.
- Teachers who suggested ways to improve students' learning opportunities also...
 - ◆ Taught their own fraction lessons with more attention to the two features identified earlier
 - ◆ Taught lessons in which their students' learned more

Our Research on ETE Graduates

- We found that pre-service teachers who acquired a deeper understanding of the mathematics featured in the video clips...
 - ◆ Analyzed the mathematics in the video clips more appropriately
 - ◆ Suggested better improvements for students' learning opportunities

Research Design

- Compared graduates' knowledge, skills, and teaching practices in 4 math domains:
 - ◆ 3 target topics developed in the program
 - Multiplication of two-digit whole numbers
 - Subtraction of fractions
 - Division of fractions

vs.

- ◆ 1 control topic not developed in the program
 - Finding the mean (of a small set of whole numbers)

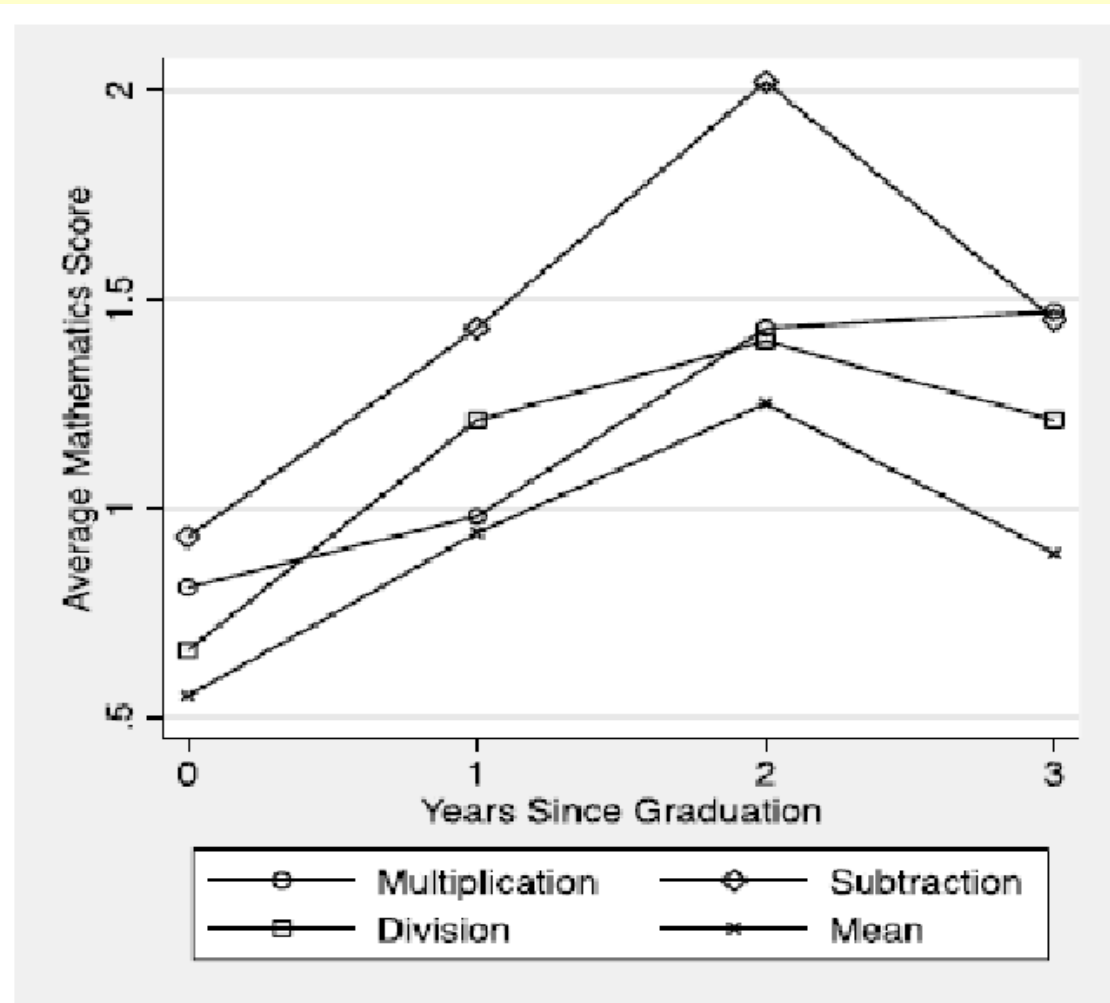
Research Design

- At graduation, and each summer after graduation, ETE graduates analyzed 4 video clips, one on each of the 4 math topics
- Responded to the Kersting prompt:
 - ◆ Describe how the teacher and students interact around the mathematical content.
- Coding rubric with 2 scales:
 - ◆ Describing and critiquing the mathematics
 - ◆ Critiquing the learning opportunities and suggesting improvements aligned with 2 teaching principles

Findings: Mathematics Scale

Years since graduation	Pairwise Comparisons
At graduation	Multiplication > Mean
1 year after graduation	Subtraction > Mean
2 years after graduation	Subtraction > Mean
3 years after graduation	All 3 target topics > Mean

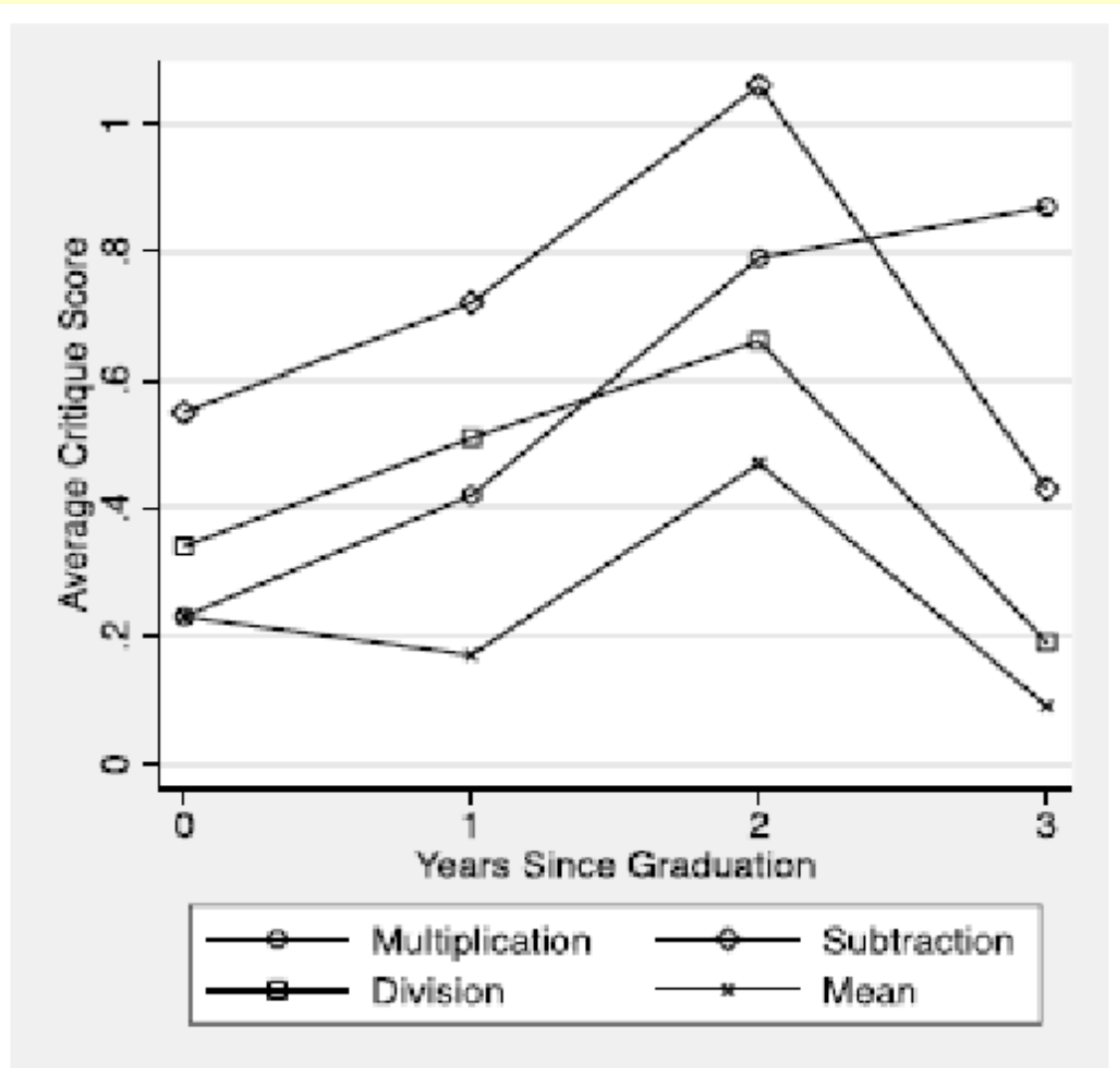
Mathematics Scale – Changes Over Time



Findings: Critiquing Scale

Years since graduation	Pairwise Comparisons
At graduation	No significant differences
1 year after graduation	Subtraction > Mean Division > Mean
2 years after graduation	Subtraction > Mean
3 years after graduation	Multiplication > Mean Subtraction > Mean

Critique Scale – Changes Over Time



Summary of Findings

- ETE graduates scored significantly higher on topics developed in the ETE program than on a topic not developed in the program
- Improvements in participants' performance over time suggest they are learning from teaching.
- Effects are apparent even 6 years after participants began studying the material.

Video Clip #2

- Clip #2: Multiplying Two-digit Whole Numbers
- Learning goal: Students will understand the key ideas underlying subtraction of fractions.
- Task: Describe how the teacher and students interact around the mathematical content.
- Process:
 - ◆ View the clip twice.
 - ◆ Think and write an individual response.
 - ◆ Discuss observations with a neighbor.
 - ◆ Whole-group discussion

Concluding Remarks

- The key is the **learning opportunities** provided to students to help them achieve the learning goal.
- If the learning goal involves conceptual understanding, the opportunities should involve
 1. Students doing mathematics
 2. Explicit, accessible, discussions of the conceptual relationships.

Concluding Remarks

- Pedagogical moves are a means to the end (learning opportunities for students), not the end in themselves.
- Different pedagogical moves can lead to the same opportunities, and the same pedagogical move can lead to different learning opportunities. So, keep your eye on the learning opportunities.

Concluding Remarks

- One way to get good at identifying potential learning opportunities and seeing how to improve them is by practicing.
- A good way to practice is by analyzing video clips of classroom instruction with colleagues.
- The rubric we developed provides a simple, research-based framework for keeping your eye on the *mathematical learning opportunities*.

Concluding Remarks

- **None** of this matters without being clear about the learning goal(s).
- The learning goals should drive the entire process.

Resources

- Research studies on analyzing video clips of classroom lessons
 - ◆ Hiebert, J., Miller, E., & Berk, D. (in press). Relationships between mathematics teacher preparation and graduates' analyses of classroom teaching. *Elementary School Journal*.
 - ◆ Kersting, N., et al. (2012). Measuring useable knowledge: Teachers' analyses of mathematics classroom videos predict teaching quality and student learning. *American Educational Research Journal*, 49, 468-489.
- Review of research on opportunities to understand mathematics
 - ◆ Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371-404). Charlotte, NC: Information Age Publishing.
- TIMSS Video Study (1999)
 - ◆ <http://nces.ed.gov/timss>