

Applying Research-Based Principles for Effective Teaching to Algebra Classrooms

California Algebra Forum II
October 14, 2008
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Begin With Two Facts About Teaching and Learning

1. Teaching matters

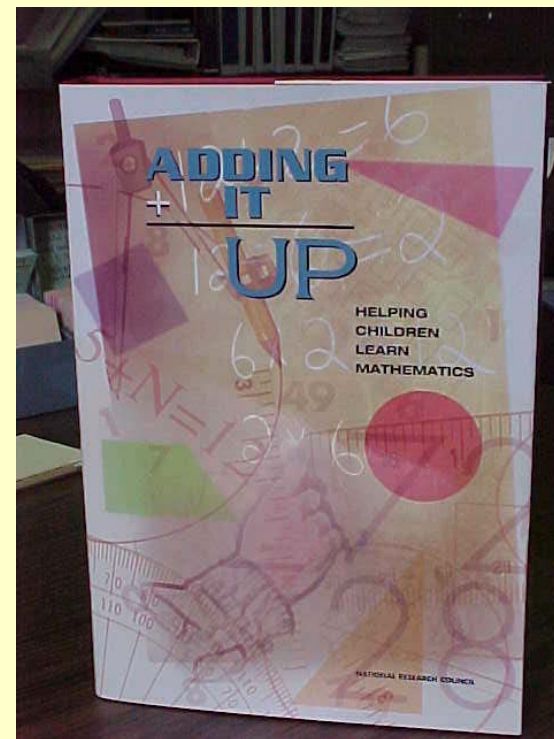
- All educational resources (including curricula) reach students through teaching
 - ◆ Unless teaching changes, students won't know the difference
 - ◆ By teaching, I mean the way teachers interact with students about content
- Teaching is not the same as teachers

The Second Fact About Teaching and Learning

2. Effective methods of teaching depend on what we want students to learn
 - All discussions about research-based findings of effective classroom practices must begin with learning goals
 - Learning goals are value judgments
 - ◆ This inevitably leads to debates, but eventual agreement is essential to improve teaching

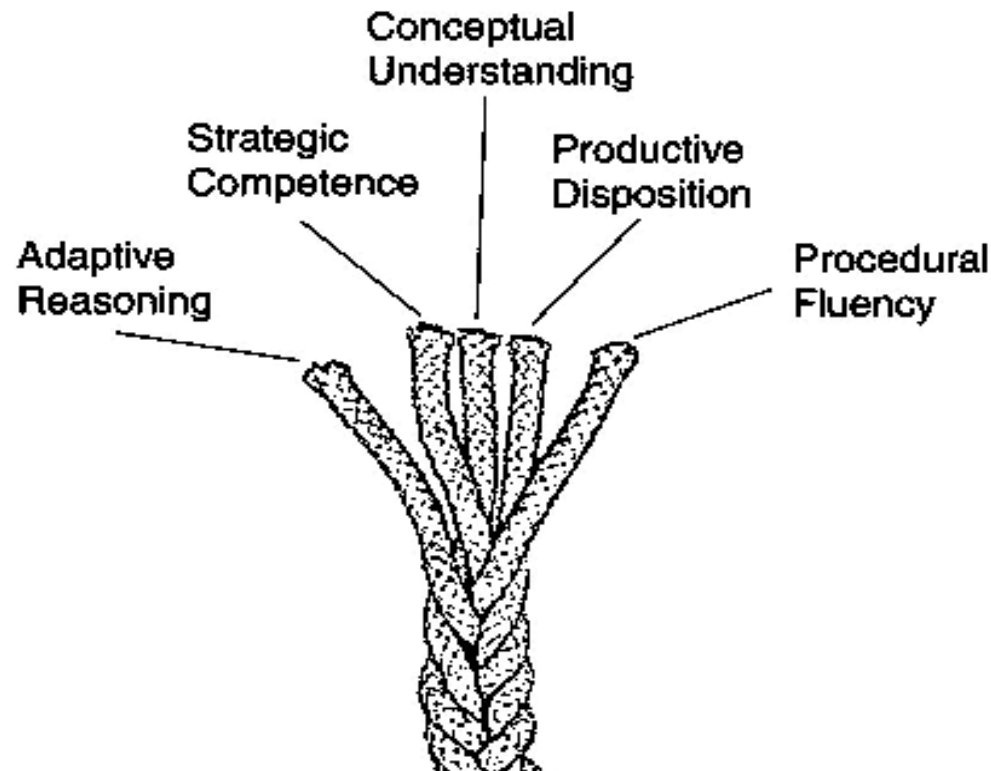
A Statement of Learning Goals

- Consensus statement of learning goals in 2001 National Research Council report *Adding It Up*, confirmed by the National Math Panel.



An Ambitious Learning Goal: Mathematical Proficiency

Intertwined Strands of Proficiency



Adding It Up, p. 117

Two Research-Based Features of Teaching for Mathematical Proficiency

- Make conceptual relationships clear
 - ◆ Attend explicitly, in some way, to relationships among facts, procedures, representations, ideas, etc.
 - T. Carpenter: Engage in relational thinking (Is $57 + 38 = 56 + 39$ true or false?)
 - C. Kieran: See the underlying similarity in different forms (Teacher B: increasingly easy ways to solve the chewing gum problem)

Two Research-Based Features of Teaching For Mathematical Proficiency

- Allow students to do some of the important mathematical work
 - ◆ Teachers pose challenging problems (just beyond the familiar) and allow time for students to work
 - ◆ Problems should engage more than one strand of proficiency
 - See T. Carpenter and C. Kieran for many examples
 - ◆ Major threat is teachers jumping in too quickly and telling students how to find the answer

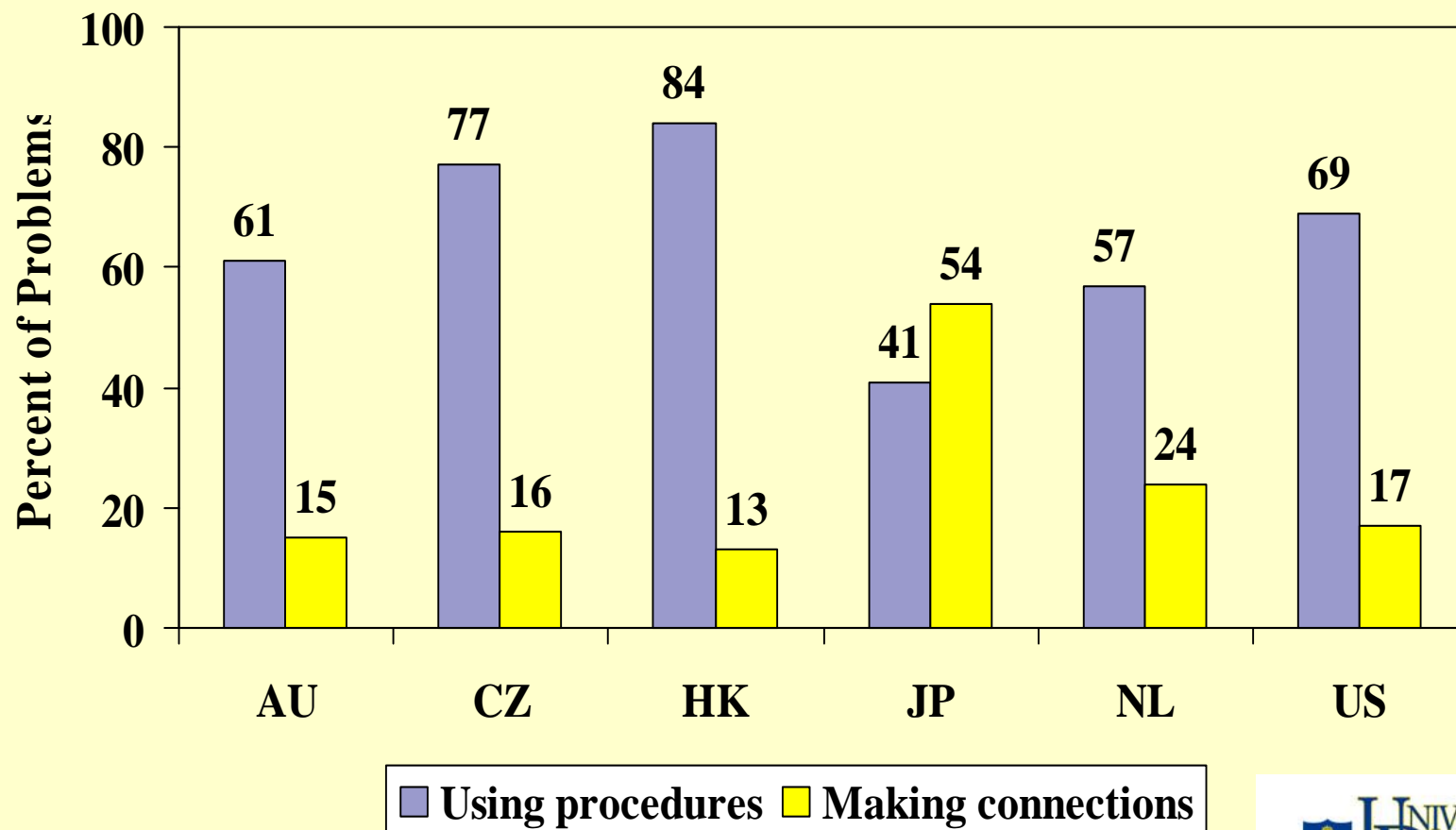
How Are We Doing?

- Does math teaching in the U.S. include the two features that help students achieve mathematical proficiency?
- The TIMSS 1999 Video Study helps answer this question
 - ◆ The study examined about 100 8th-grade math lessons in each of 6 higher achieving countries and the U.S. (Australia, Czech Republic, Hong Kong, Japan, Netherlands, Switzerland)
 - ◆ Videotapes of a random sample of lessons gathered across the year in each country

Types of Problems Presented to Students

- Stating Concepts: recalling or applying definitions or conventions
- Using Procedures: applying learned procedures
- Making Connections: constructing relationships among ideas, facts, or procedures

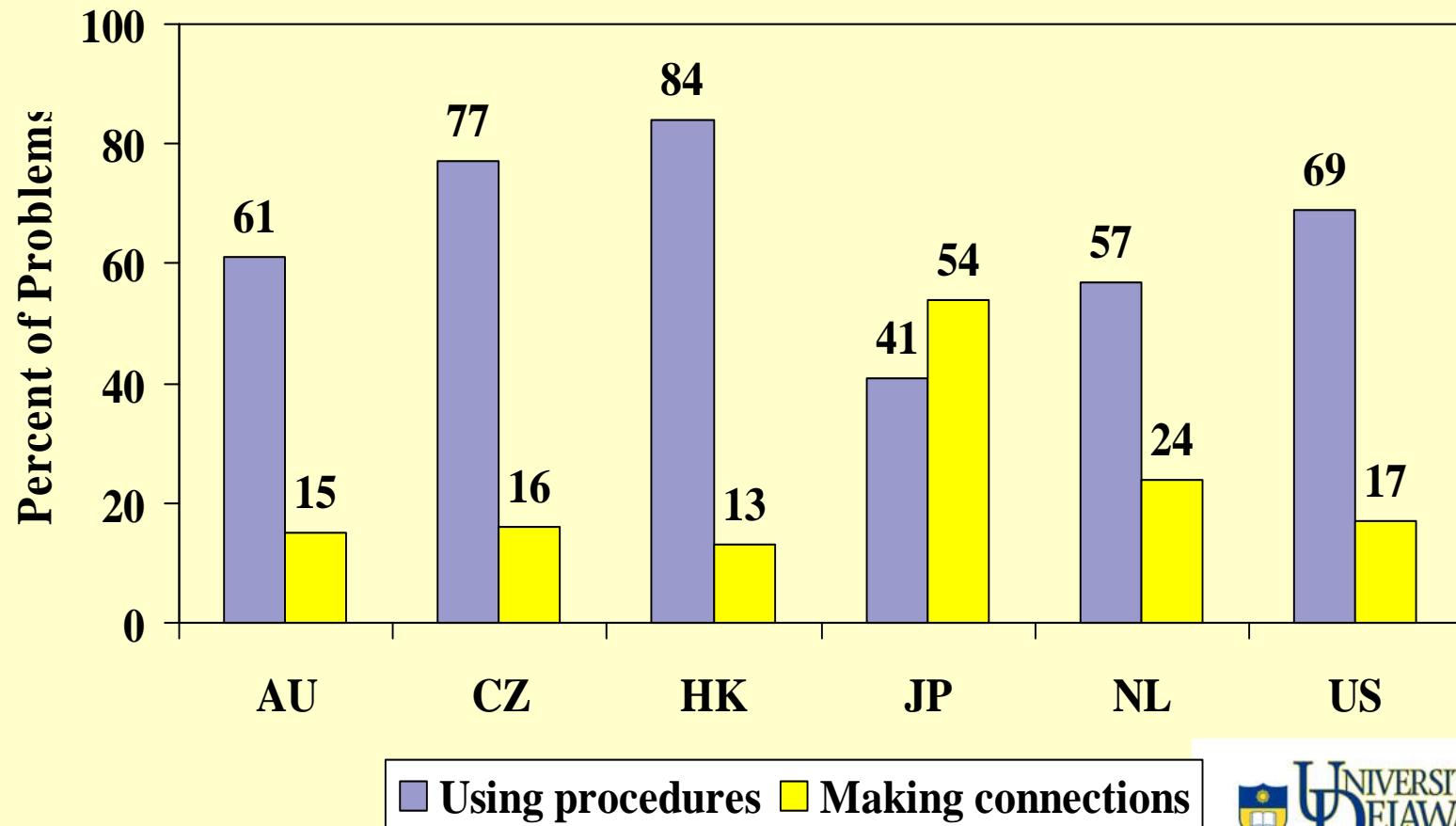
Types of Problems Presented



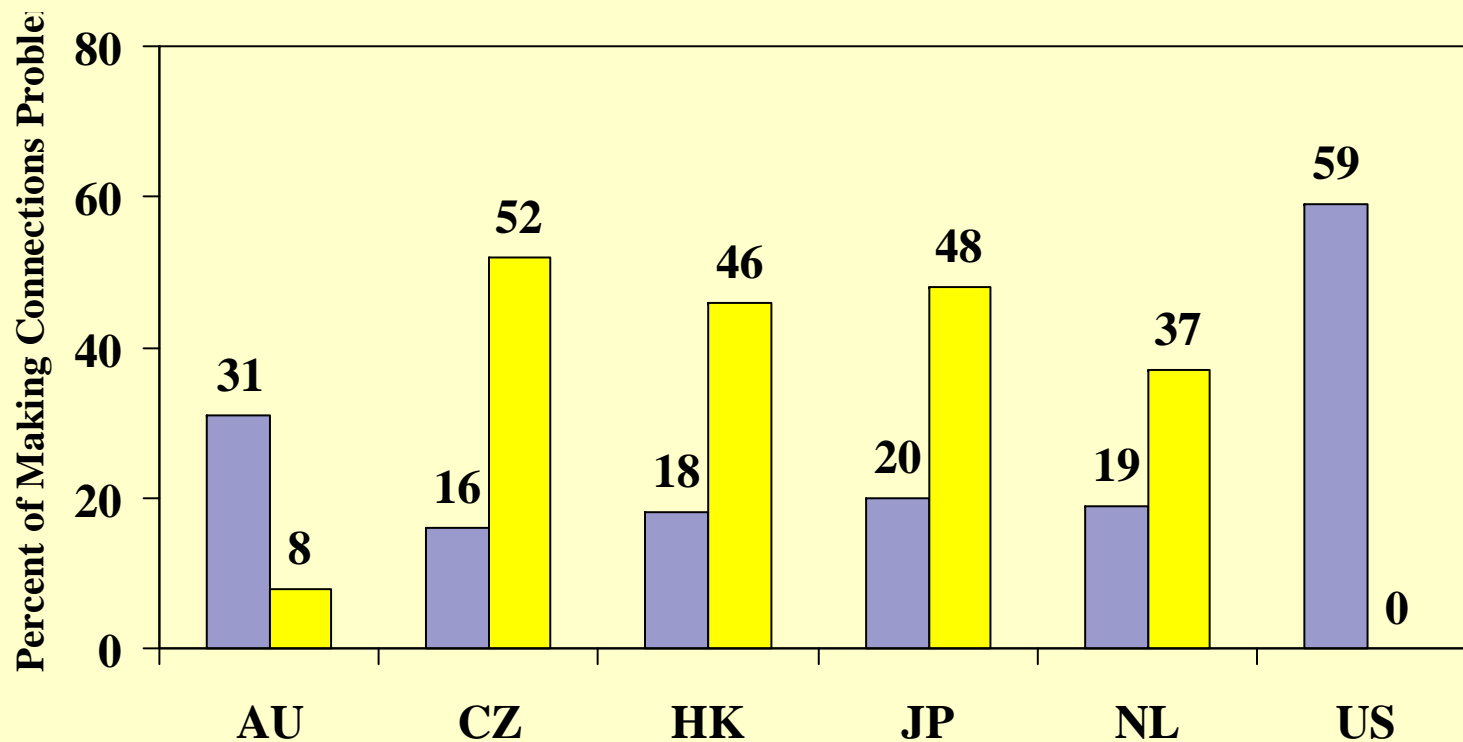
Types of Problems Presented AND Worked On During the Lesson

- Each problem was coded a second time based on how it was worked on and discussed during the lesson.
- This is where teaching really matters.
 - ◆ Problems can be transformed

Again: Types of Problems Presented



How Making Connections Problems Are Worked On During the Lesson



■ Using procedures ■ Making connections

Lessons Learned from Research

- Two features of teaching help students become mathematically proficient
 - ◆ attending to mathematical relationships
 - ◆ allowing students to wrestle with key ideas
- These are two features shared by many higher achieving countries but absent in typical 8th grade classrooms in the U.S. (Not a new finding)
- A preferred curriculum is not enough; teaching transforms curricula.

Teaching Is Hard To Change, But It Is Easier When We Have a Clear Target

- If we want students to develop mathematical proficiency, then
- Teaching needs to incorporate
 - ◆ more direct attention to relationships among concepts, procedures, and facts; and,
 - ◆ more opportunities for students to wrestle with the important mathematical ideas.

How Does Teaching Change?

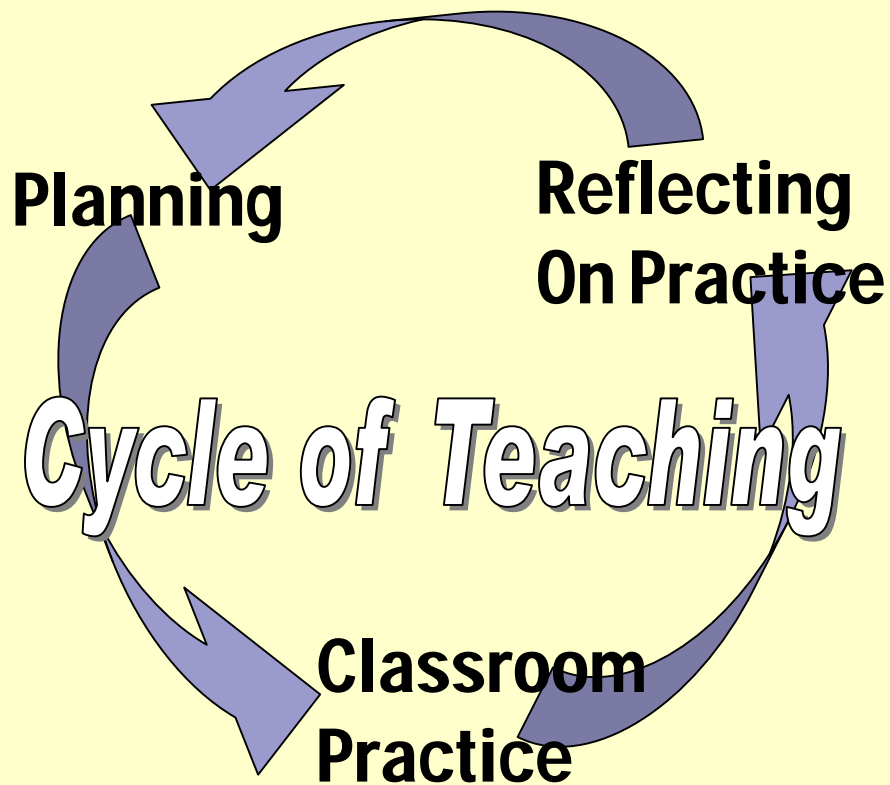
- By being clear about what changes are needed (learning goals for teachers)
- By providing learning opportunities that align with the goals (just as in providing aligned opportunities for students). For teachers' learning, this means
 - ◆ *Not* prescribing rules for better teaching and asking teachers to memorize them
 - ◆ But rather allowing teachers to wrestle with the key ideas involved in teaching for Mathematical Proficiency
- By marshalling the leadership needed to create and sustain these opportunities

Learning Environments Needed To Make Ambitious Changes To Teaching

- *Teachers* must work together to study teaching
- Studying teaching must become part of the routine and culture of the school
- Studying algebra teaching means studying the details of how problems are presented and worked on with students

How does this look, in practice?

The Practice Of Studying Teaching



**Slowing down the
cycle...**

**... and attending to
the planning and
reflecting phases**

Planning and Reflecting On Teaching

- Begin by designing a *few* lessons with great care
- Specify the learning goals clearly and precisely
- Include some algebra problems that challenge students
- Predict students' responses to these problems in order to decide beforehand how to sustain the goal of the problems
- Gather evidence on lesson's effectiveness by assessing students' thinking against the learning goals
- Use the evidence to improve the lesson a little for next time

Won't This Approach Take Years?

- Yes
- The alternatives tried for the past 100 years do not show great promise
- Maybe it's time to take seriously the importance of improving *teaching* and to recognize the hard, relentless work required to do so

Final Words

- When you improve a little each day, eventually big things occur Not tomorrow, not the next day, but eventually a big gain is made. Don't look for the big, quick improvement. Seek the small improvement one day at a time. That's the only way it happens—and when it happens, it lasts.

John Wooden, UCLA

