WHY IS SKILLFUL MATHEMATICS TEACHING SO IMPORTANT AND (HOW) COULD THE U.S. SUPPLY IT AT SCALE?

Deborah Loewenberg Ball

Hugo Rossi Lecture Series • The University of Utah

November 3, 2014 • Salt Lake City, UT

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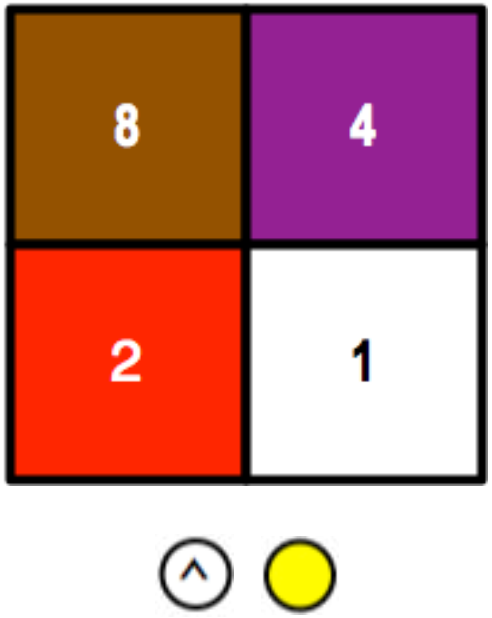
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What does it mean to be "mathematically skillful"?

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WHAT IS THIS PROBLEM ASKING, AND WHAT IS INVOLVED IN TRYING TO SOLVE IT?



Using exactly one positive and one negative checker, find all the numbers that can be represented on this minicomputer board.

Prove your answer and explain why.

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A CORE CHALLENGE OF TEACHING MATHEMATICS

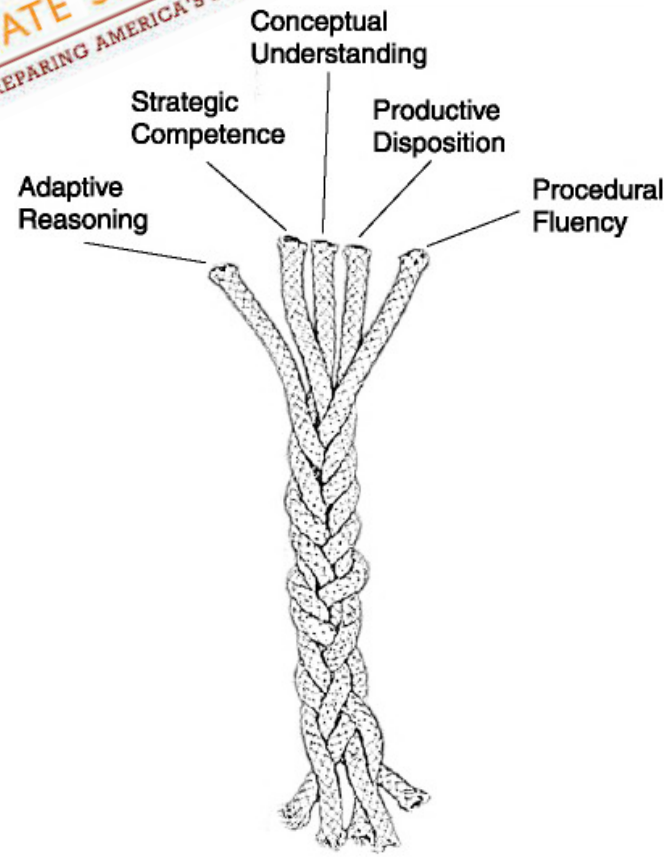
- Teaching complex mathematical knowledge and skill
- Teaching all students

What does this involve?

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STRANDS OF MATHEMATICAL PROFICIENCY



- ***Conceptual understanding*** - comprehension of mathematical concepts, operations, and relations
- ***Procedural fluency*** - skill in carrying out procedures flexibly, accurately, efficiently, and appropriately
- ***Strategic competence*** - ability to formulate, represent, and solve mathematical problems
- ***Adaptive reasoning*** - capacity for logical thought, reflection, explanation, and justification
- ***Productive disposition*** - habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy

Kilpatrick, J., J. Swafford, and B. Findell. (2001). *Adding It Up: How Children Learn Mathematics*. Washington, DC: National Academy Press.

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THE COMMON CORE:
WHAT IS ENTAILED IN BEING MATHEMATICALLY SKILLFUL?

CONCEPTS AND PROCEDURES

- Understanding of operations (+, x)
- Fluency with whole number computational skills (+, x)
- Multi-digit computation
- Understanding of mathematical structure

MATHEMATICAL PRACTICES

- Making sense of and interpreting problems
- Representing mathematical ideas in strategic ways
- Persevering with complex mathematical problems
- Constructing mathematical arguments
- Looking for and using regularity in mathematical reasoning
- Looking for and making use of mathematical structure

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WHAT DOES IT MEAN TO TEACH FOR MATHEMATICAL SKILLFULNESS?

- Set goals that combine strands of proficiency and that wrap the mathematical practices together with the mathematical "content"
- Develop students' learning opportunities through:
  - The careful choice of mathematical tasks
  - The way that a mathematical task is framed, set up, and used
  - How the classroom environment is shaped for productive collective learning

And many other things that we will get back to ….

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TEACHING AS A COMPLEX BALANCING ACT

Teaching all students to become mathematically skillful entails balancing three traditional dualities:

1. Focus on mathematical concepts and procedures *and* mathematical practices
2. Teach in ways that are both teacher-directed *and* student-centered
3. Work to fill students' gaps *and* to accelerate their capabilities with complex mathematical work

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① FRAMING THE LARGER CONTEXT

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PAUSE: WHAT IS THE ROLE OF PUBLIC RESEARCH UNIVERSITIES?

- To produce people who will play roles, solve problems, and be the society of the next generations
- To develop knowledge and creativity to tackle pressing problems, contribute to a democratic society, and enhance the quality of life
- To engage in the broader environment as leaders and collaborators, using the resources of the university's people, skills, and work

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OUR TIME: 2014, AND 40 YEARS AGO

- Dramatically growing class divide in the U.S. (Goldin & Katz, 2009, Putnam, forthcoming)
- Increased racial segregation
- Rapidly changing demographic in the country, led by rapid changes in the school-age population (race, ethnicity, language)
- Changed relationships among class, schooling, work
- Building rhetoric about international comparisons

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BUT LOOK WHAT HAS NOT CHANGED

- Strong non-professional governance of and influence on education
- School funding and local control of education
- Using substantially similar policy strategies to improve outcomes
- Modal school curricula and instructional practices
- Teacher education and professional development

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RAISING UP TEACHING AS THE #1 POLICY IMPERATIVE OF OUR TIME

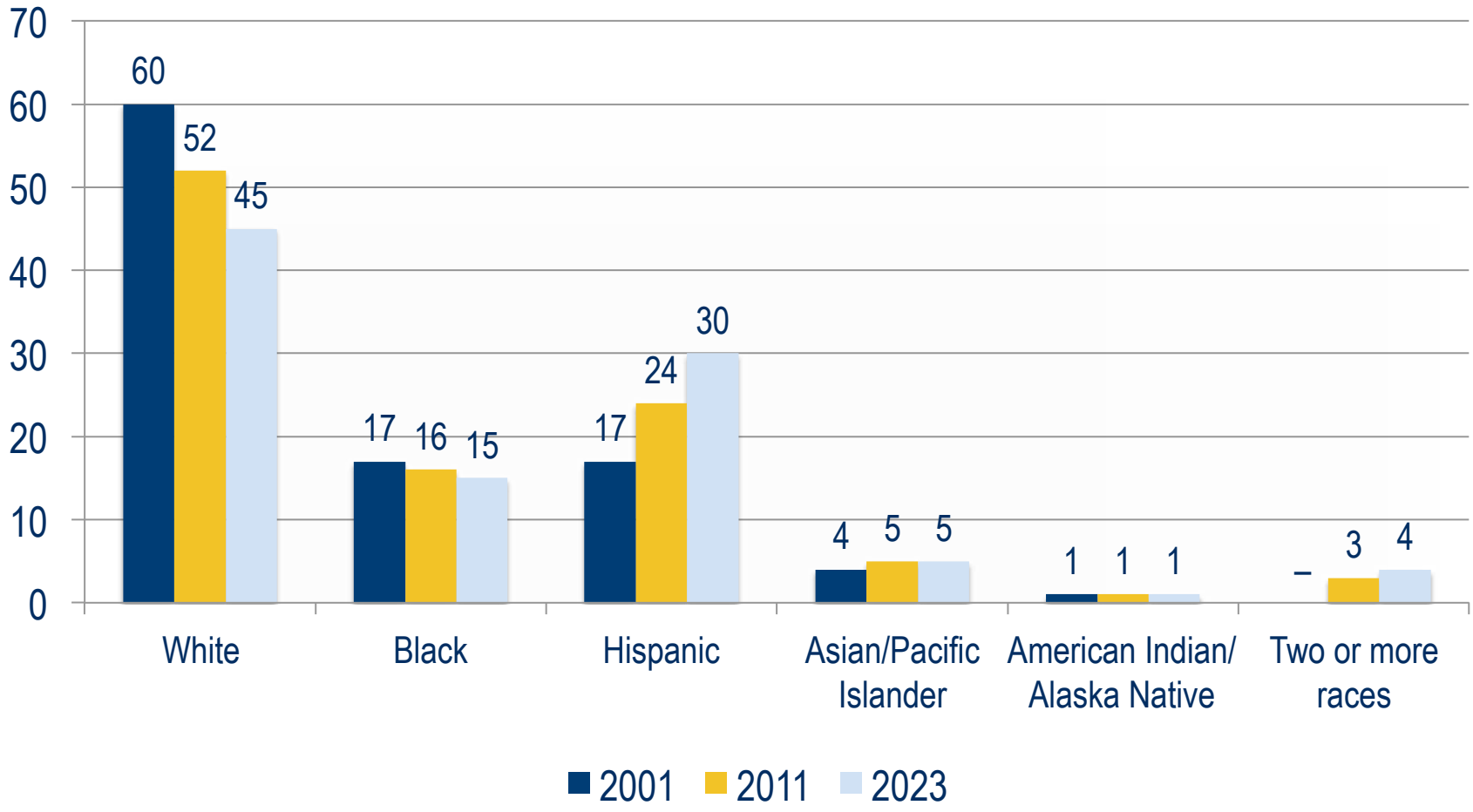
- 74,000,000 children in U.S.
- Schooling: Our society's commitment to individuals' lives and to the future of our society
- Evidence of the power of skillful teaching
- Overwhelming lack of public respect for the work of teaching

→ **This is a public policy problem of vital moral, practical, and political urgency.**

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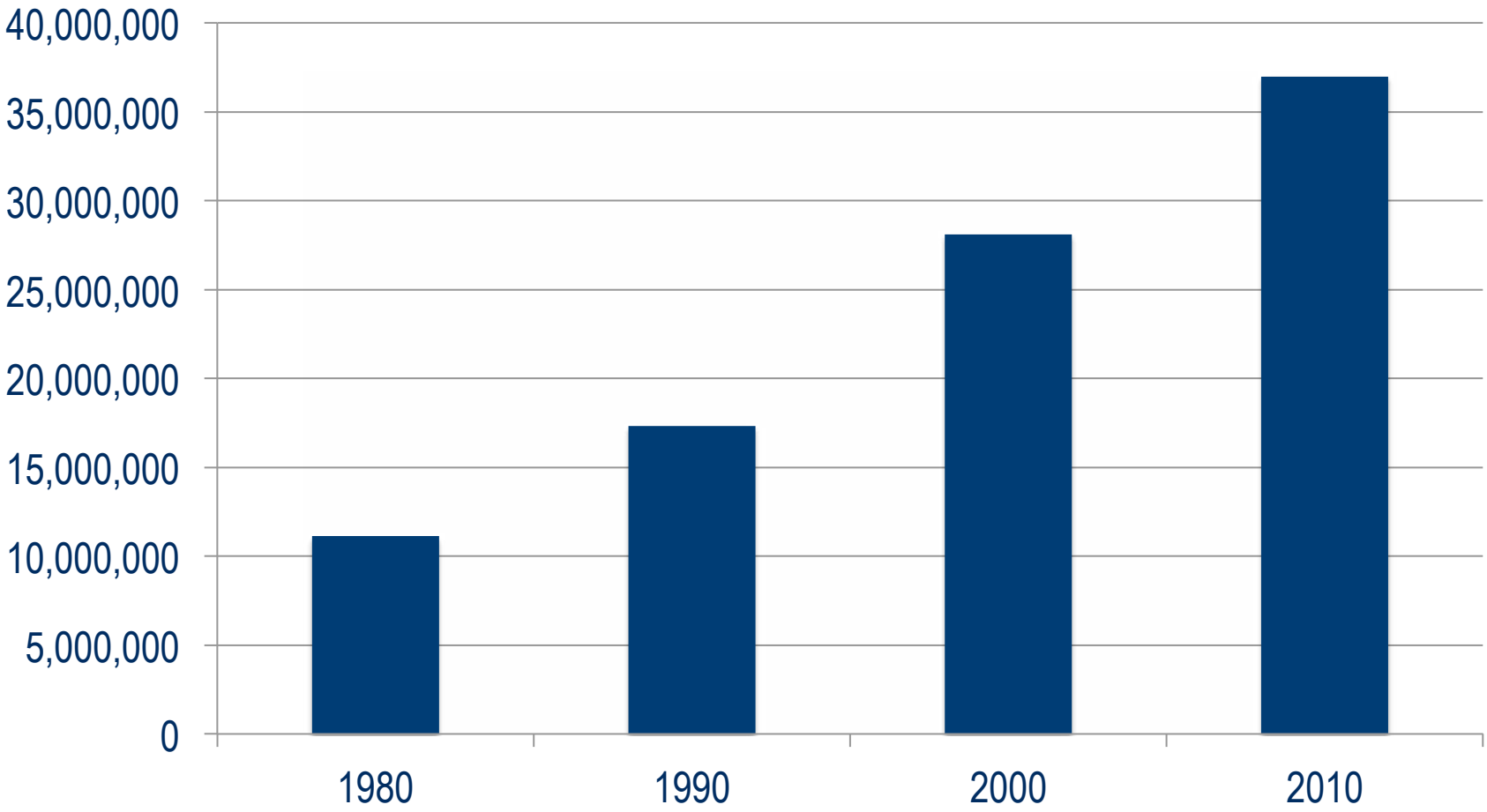
CHANGING DEMOGRAPHICS OF PUBLIC SCHOOLS



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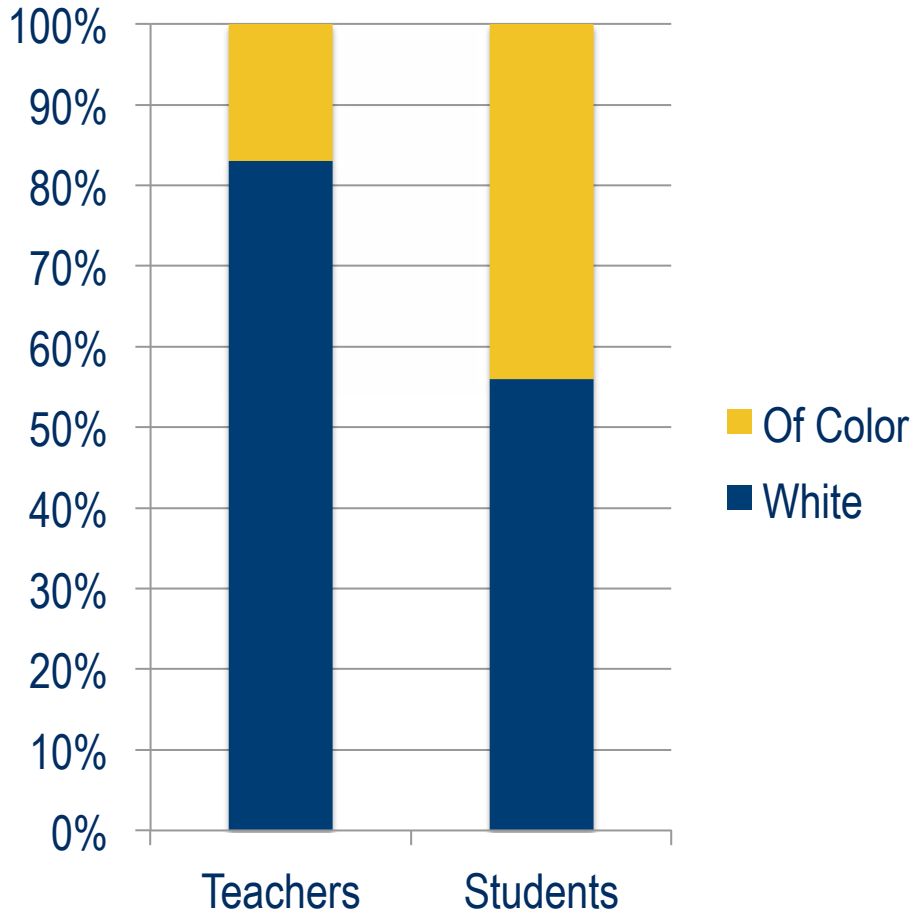
SPANISH SPEAKING IN THE HOME



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DEMOGRAPHIC DIVIDE: K-12 TEACHERS AND STUDENTS

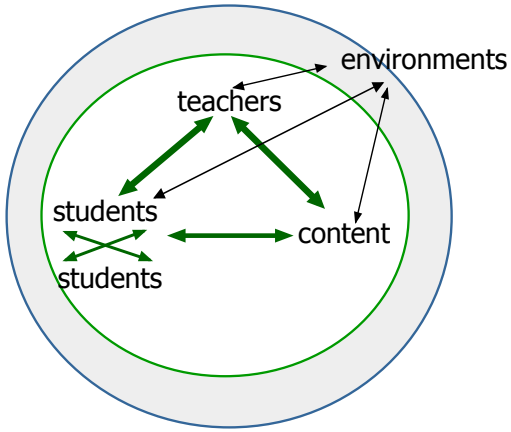


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EVIDENCE THAT TEACHING MATTERS

- Teaching "effects": Having skillful teaching 2–3 years in a row in school—or not—can make enormous significant differences in students' levels of achievement
- Policies affect students by permeating the classroom—for better or for worse



(Lampert, 2001)

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WHY SHOULD PUBLIC RESEARCH UNIVERSITIES HAVE SCHOOLS OF EDUCATION?

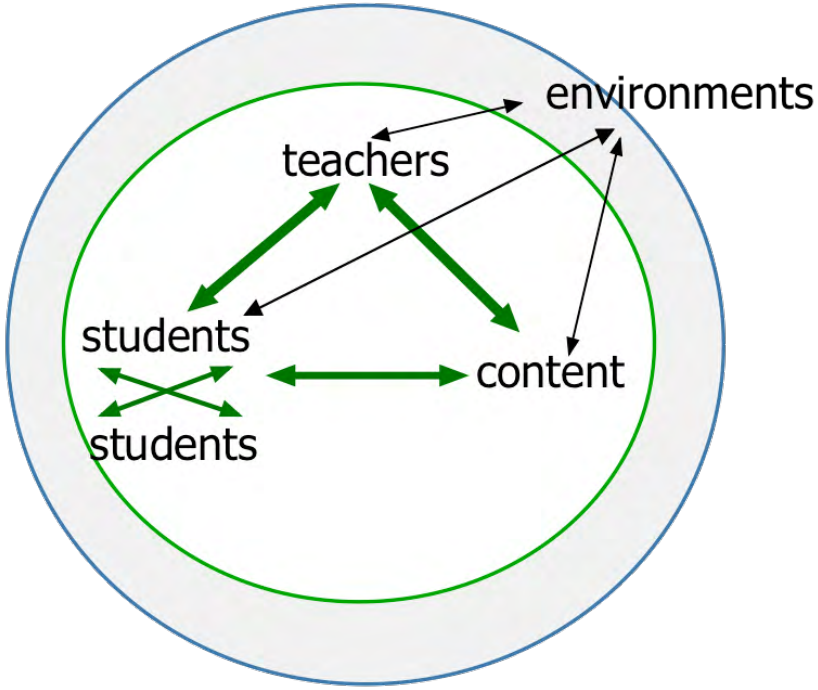
As the core home for specialized expertise in education in order to:

- Conduct work on educational problems, develop educational theory, using that expertise
- Train people with specialized expertise in education

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ASKING EDUCATIONAL QUESTIONS ABOUT EDUCATIONAL PROBLEMS



(Lampert, 2001)

- Studies that probe the *insides*
- The dynamic of "instruction," or policy implementation; "inside the black box"
- This is the part that is often invisible and overlooked
- Often more work is done on the corners and edges and contexts—research that **informs** education

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EXAMPLES OF CONTEMPORARY PROBLEMS IN EDUCATION

1. Persistent educational inequality: lack of adequate knowledge about instruction, interventions, policies
2. Weak mathematics and science education
3. The growing importance of access to higher education and the rising demand for quality and accountability (research, evaluation, and *teaching*)
4. Universities' need to engage in "outreach"
5. Weak effects of teacher education: what is our special role?

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WEAK MATHEMATICS AND SCIENCE EDUCATION

- Student achievement below the median of OECD countries, despite spending more than any other OECD country
- Underserving (or not serving) the majority of youth
- Lack of public literacy in mathematics and science

What is the history and what explains our nation's lack of progress?

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AGENDA FOR ACTION (NCTM, 1980)

RECOMMENDATIONS:

- Problem solving be the focus of school mathematics;
- Basic skills in mathematics be defined to encompass more than computational facility;
- Mathematics programs take full advantage of the power of calculators and computers at all grade levels;
- Stringent standards of both effectiveness and efficiency be applied to the teaching of mathematics;
- The success of mathematics programs and student learning be evaluated by a wider range of measures than conventional testing;
- More mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accommodate the diverse needs of the student population;
- Mathematics teachers demand of themselves and their colleagues a high level of professionalism;
- Public support for mathematics instruction be raised to a level commensurate with the importance of mathematical understanding to individuals and society.

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U.S. MATH REFORM, AGAIN AND AGAIN: A TIMELINE

- 1957: Sputnik launch, U.S. concern about math/science education
- 1960s: New Math era
- 1970s: Pendulum swings toward “basic skills”
- 1980: NCTM releases *An Agenda for Action*
- 1989: NCTM releases the *Curriculum and Evaluation Standards for School Mathematics*
- 2000: NCTM releases the *Principles and Standards for School Mathematics*
- 2006: NCTM releases *Curriculum Focal Points*
- 2008: National Mathematics Advisory Panel calls for a halt to all extreme positions
- 2010: NGA and CCSSO release the final Common Core State Standards

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PREDOMINANT APPROACHES TO "QUALITY TEACHING"

- Recruitment, raise selectivity
- Residency and induction programs
- Teacher evaluation (concerns for ineffective teaching)
- Small, local innovations

WHAT IS NOTABLY MISSING?

- A broad strategy for preparing responsible beginners

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ENTRY-LEVEL TEACHING AS A CRITICAL FOCUS

1. More U.S. schoolchildren have a teacher with fewer than six years of experience than a teacher with any other number of years of experience.
2. Most beginning teachers say they are underprepared for teaching, and on average they are less effective.
3. Distribution of beginning teaching is concentrated disproportionately in low-income and high-minority schools.

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WHAT ARE THE BARRIERS?

- A self-reinforcing skepticism that teaching can be taught.
- A view of skillful teaching as something remarkable, rather than the right of every child.
- The massive and unstable teacher workforce.
- Weak educational infrastructure (Cohen).

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② A LOOK AT BEGINNING TEACHING

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THE CONCEPT OF "AVERAGE"

- What is an "average" of a set of data?
- How would you explain the key idea to a group of 10-year-olds?

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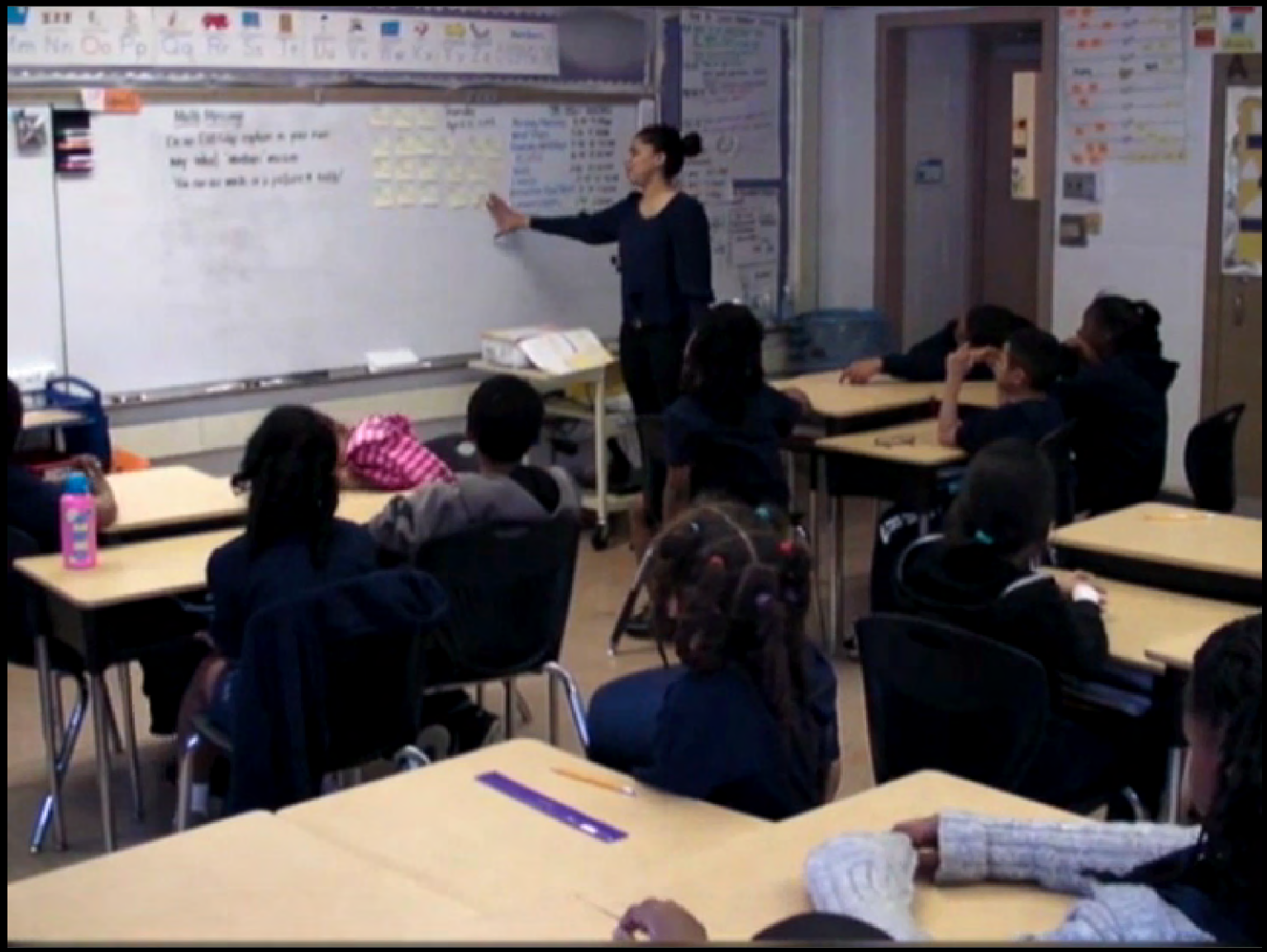
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A GLIMPSE OF BEGINNING TEACHING

1. What is skillful about this teaching? What is less so?
2. What does the video reveal about the challenges of beginning teaching, with respect to:
   - Knowing the content?
   - Knowing students?
   - Specific instructional capabilities?

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EXAMINING BEGINNING TEACHING

SKILLFUL

- Using an equitable problem context
- Engaging many learners
- Moving around classroom space
- Using strong voice and presence

LESS SKILLFUL

- Managing the mathematical-pedagogical issues with the context
- Focusing on the key mathematical point
- Eliciting student thinking
- Talking mathematics in teaching

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WHAT ABOUT TEACHING THIS LESSON COULD BE TAUGHT?

- To understand the core mathematical idea of "average" and what there is to understand
- To appraise the appropriateness of the context and to replace it with a better but mathematically similar one
- How to conduct a discussion about students' data and steer to the key mathematical point(s) (Sleep, 2010)
- Ways to engage all learners in the activity

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③ BUILDING A SYSTEM FOR SKILLFUL TEACHING AS AN ENTITLEMENT

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NO PROFESSIONAL SYSTEM FOR TEACHER PREPARATION OR CONTINUED DEVELOPMENT

- More than 3,000 independent providers of initial teacher training
- No common specific curriculum for preparation for initial teaching
- A reliance on conventional academic credentials as the standard content knowledge
- No common standard of performance for entry to independent practice with (on) young people

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NO EQUIVALENT IN TEACHING

- Objectives for coursework and for student teaching and other clinical experiences lack similarly precise professionally-determined and agreed-upon learning objectives
- Field experience often focused more on reflection than on development of actual skill and judgment
- Performance expectations for graduates of teacher education underspecified and weakly assessed

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MOVING FORWARD TO A PROFESSIONAL SYSTEM OF TEACHER PREPARATION

1. *Build on basic agreements about domains of teaching and evidence about content knowledge for teaching:* Identify **key practices of teaching** and **high-leverage content** essential for responsible beginning practice; key professional and ethical knowledge and orientation to role
2. *Build on commitment to clinical preparation:* Develop **specific approaches to training** beginners to carry out those practices, along a **continuum of contexts** for learning and practicing practice
3. *Build on commitment to performance assessment:* Develop **performance assessments of specific practices and content** and make them required for entry

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WHAT IS AN APPROPRIATE STANDARD FOR RESPONSIBLE ENTRY-LEVEL PRACTICE?

- Able to take independent responsibility for students' learning
- Able to appraise and work on one's practice, alone and with others, and to use resources for improvement

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EXAMPLES OF HIGH-LEVERAGE PRACTICES

- Explaining ideas or skills (including content, practices, and strategies) using modeling, representations, examples
- Leading a group discussion
- Eliciting and interpreting individual students' thinking
- Diagnosing particular common patterns of student thinking and development
- Establishing and maintaining a productive learning environment by implementing organizational routines and strategies and giving directions
- Learning about students' cultural, religious, family, intellectual, and personal experiences and resources
- Knowing and managing one's cultural and personal resources and practices with sensitivity to context
- Selecting and modifying tasks and texts for a specific learning goal
- Checking student understanding during lessons
- Providing oral and written feedback to students
- Communicating about a student with a parent or guardian

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CONTENT KNOWLEDGE **FOR TEACHING*

- Knowing the content that the students are supposed to learn
- Knowing ways to unpack, represent, and make that content learnable
- Knowing how students think about the specific content
- Knowing ways to teach the specific content

(Ball, Thames, and Phelps, 2008, *JTE*)

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ETHICAL PRACTICE AND THE COMMITMENT TO SOCIAL JUSTICE

- Inequity is reproduced inside of instructional practice.
- Teachers have leverage at strategic points in their work.
- This depends on joining concerns for social justice with the daily and minute-to-minute work of teaching.

(Ball, Shaughnessy, Mann, Farmer, 2014)

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CLINICAL TRAINING

- Deliberate guided learning from skilled teachers
- Study of videos and other primary records of practice
- Rehearsals
- Rubrics for providing detailed feedback
- Systematic clinical experience with supervision and feedback, staged across time

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TEACHER EDUCATION AT A (PUBLIC) RESEARCH UNIVERSITY

Our mission centers on two core commitments:

1. The study and improvement of education practice
2. The twin imperatives of diversity and equity

The education of teachers is one of the pressing problems of education practice. We do teacher education in order to develop, test, and study it, and to contribute to its study and improvement.

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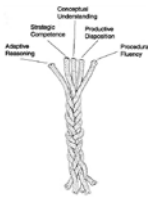


Image on slide 5:
Kilpatrick, J., J. Swafford, & B. Findell. (2001). *Adding it up: How children learn mathematics*. Washington, D.C.: National Academy Press.

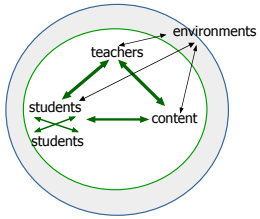


Image on slides 17 & 19:
Lampert, M. (2001). *Teaching problems and the problems of teaching*. New Haven, CT: Yale University Press.



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