

Becoming a Nation of Mathematically Literate People: What Will it Take?

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What's the problem?

- http://www.nsf.gov/news/special_reports/math/classroom.jsp

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A short pre-test

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Which are myths? Which are true?

Mark M (myth) or T (true).

a. The U.S. mathematics education system used to work better than it does now.

b. The number of mathematics courses that a teacher has taken is a good predictor of how effective he or she will be.

c. Most high-performing countries use math specialist teachers in the upper primary grades.

d. Societal problems —– e.g., inequality, poverty, the declining family —– are so overwhelming that schools cannot do their job.

e. The U.S. math curriculum is similar to the one taught 50 years ago.

f. Alternative routes into teaching prepare teachers better than college and university programs.

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The urgency

1. Enormous gaps in learning opportunities and disparities in achievement (within U.S. and in international comparisons)
2. Rapidly changing school population
3. Higher, more complex academic goals
4. High expectations for <u>all</u> students



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What do we mean by "mathematically literate"?

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What is the chance of rain?

Weather forecast:

Saturday: 50% chance of rain

Sunday: 50% chance of rain



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What is the chance of rain on the weekend?



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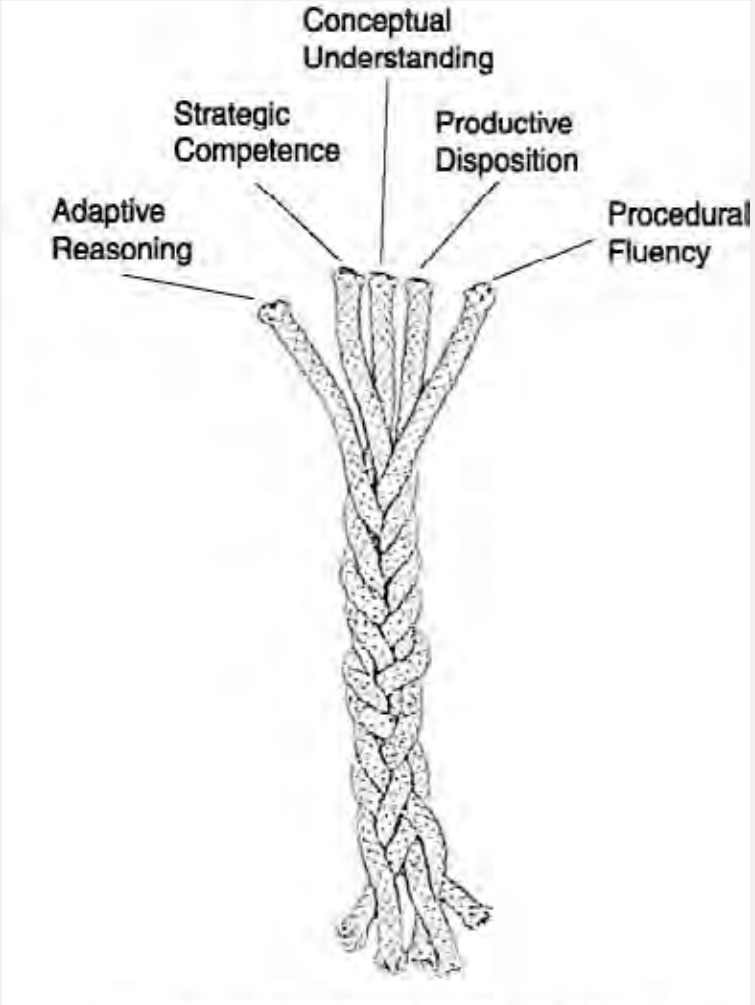
Being mathematically literate involves being able to . . .

- Deploy mathematical skill and understanding
- Frame and solve problems involving quantity, space, and probability
- Interpret and reason about quantitative, probabilistic, and spatial information and situations
- Use mathematical language, symbols, and representations to communicate about mathematical ideas
- Think with and use data

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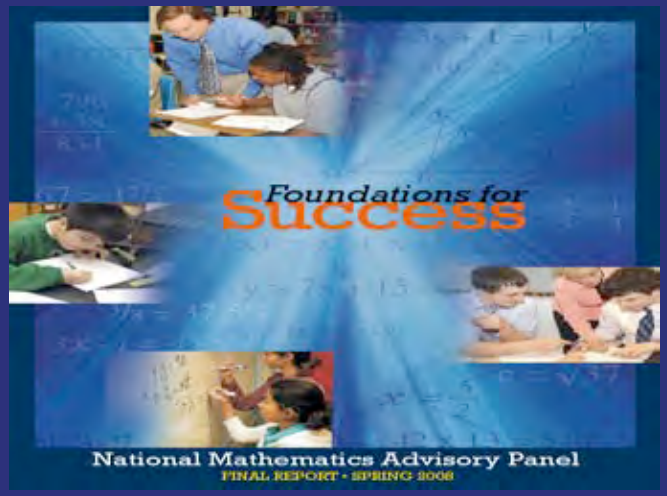
Mathematical proficiency

- Procedural fluency
- Conceptual understanding
- Adaptive reasoning
- Strategic competence
- Productive disposition



Kilpatrick, Swafford, & Findell, (2001). *Adding It Up*, National Research Council.

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What can we "harvest" from the National Mathematics Advisory Panel report?

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Presidential Executive Order April 2006

- The Panel will advise the President and the Secretary of Education on the best use of scientifically based research to advance the teaching and learning of mathematics, with a specific focus on preparation for and success in algebra.

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Elements of the report

1. Conceptual knowledge and skills
2. Learning processes
3. Instructional practices
4. Teachers and teacher education
5. Assessment
6. Standards of evidence
7. Survey of algebra teachers
8. Instructional materials

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Headlines

1. Substantial agreement about what students should learn to be successful in algebra (algebra as gate)—foundations, benchmarks, critical topics. Neither inclusive nor comprehensive.
2. Conceptual understanding, procedural skill, reasoning, use of language and representations are intertwined in mathematical competence.
3. Early opportunities to learn mathematics can capitalize on and extend young learners' resources; this is a particularly important intervention to narrow opportunity gaps.
4. Automaticity and fluency are important, to free attention; achieving this takes practice.
5. Instruction cannot be reduced to oversimplified dichotomies (e.g., teacher-directed versus student-centered).
6. Teachers' mathematical knowledge matters; strongest signal with content measured close to its use in practice.
7. Lack of evidence to identify effective teacher education at any stage of teacher development.
8. U.S. textbooks tend to be long and cluttered.

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So what can we do?

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We want a lot of our schools

- Reduce disparities in opportunities and achievement
- Aim for higher and more complex outcomes for more students than ever before

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- We've been here many times before (e.g., the "new math," back to basics, A Nation at Risk, the Glenn Commission report, *A Gathering Storm*).
- We keep gravitating to the same strategies.
- Have we learned anything that can help change the pattern? Can we avoid assembling the same NMP report 10 years from now?

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What are some of the most widely-touted strategies for educational improvement?

1. Teacher-proof instruction.
2. Install a more challenging curriculum.
3. Increase accountability.
4. Reorganize schools.
5. Pay teachers more.
6. Recruit teachers: lower the barriers for entry to teaching.

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What persistently impedes progress?

1. Persisting with extinct arguments about skills versus conceptual understanding (Adding it Up [2001]; National Math Panel Report [2008])
2. Lack of a central or common mathematics curriculum
3. Persisting with outdated and refuted ideas about "teacher quality," especially with respect to content knowledge (National Math Panel Report [2008])
4. Persisting with pendulum shifts from teacher-proofing to teachers, but rarely focusing on teachING
5. Persisting with approaches to teacher education that emphasize things other than practice (e.g., reflection, beliefs, propositional knowledge, experience) (Hiebert & Stigler, 2007)

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What are the most promising areas to target, and why?

1. Teachers with the knowledge and skills to do the work
   - High-leverage initial training, certified by performance
   - Continued professional education to develop to higher levels of skilled performance
   - ◆Evidence that teachers leave teaching because they cannot be effective (Ingersoll studies)
   - ◆Evidence that current teacher training (in higher education or in alternative routes) has weak impact on teacher performance (e.g., Mathematica study, 2009)

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What are the most promising areas to target, and why?

2. Focus teacher education on a common K-12 mathematics curriculum
   - A national or state common curriculum
   - Use of common curriculum material in TE
   - ◆Evidence that teachers' learning is enhanced when grounded in the pupils' curriculum (Cohen & Hill, 2001; Japanese lesson study)

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What are the most promising areas to target, and why?

3. Focus mathematics teacher education on practice
   - Mathematical knowledge for teaching (Ball, Hill, & Bass, 2005)
   - Decomposition and close modeling, training, and coaching on highest leverage practices (Ball, Sleep, Boerst, & Bass, 2009; Grossman & McDonald, 2008; Grossman, Compton, Igra, Ronfeldt, & Shahan, 2009; Lampert & Graziani, 2009)
   - ◆ Evidence that there is professional knowledge of content and that it can be taught (Hill & Ball, 2004); teaching practice can be taught and scaffolded; addresses the unpredictability of learning from experience and the scale problem

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What are the most promising areas to target, and why?

4. Build common assessment systems to support and evaluate teachers' learning and performance of mathematics teaching that produces student learning
   - Build assessments that are keyed to gains for students
   - Develop ways to appraise whether teachers can do the work rather than the pathway through which they come

◆Evidence that assessments can be built that are linked to student achievement gains (Hill, Rowan, and Ball, 2005; Rockoff, Jacob, Kane, Staiger, 2008)

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What are the most promising areas to target, and why?

5. Support early years of teaching (years 0 -5)
   - Mentoring programs
   - Differentiated staffing for beginning teachers, more collective responsibility (like nursing)
   - Continued installments of more advanced practice

◆ Early career support is assumed in other occupations and professions (hairdressing, retail sales, service, architecture, nursing, medicine, social work)

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The post-test
Checking your answers

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c. Most high-performing countries use math specialist teachers in the upper primary grades.

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Which are myths? Which are true?

M The U.S. mathematics education system used to work better than it does now.

M The number of mathematics courses that a teacher has taken is a good predictor of how effective he or she will be.

T Interventions that focus on instruction are more likely to impact student learning than ones that focus on school organization or context.

M Most high-performing countries use math specialist teachers in the upper primary grades.

T The U.S. math curriculum is similar to the one taught 50 years ago.

M Alternative routes into teaching prepare teachers better than college and university programs.

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