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The National Math Panel Report: Foundations for Success

Learning More Than Just Fractions!

AIMS Conference
Baltimore, MD
November 3, 2008

Francis (Skip) Fennell
Professor of Education
McDaniel College
Westminster, MD
&
Past President
National Council of Teachers of Mathematics

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The Competitiveness Thing

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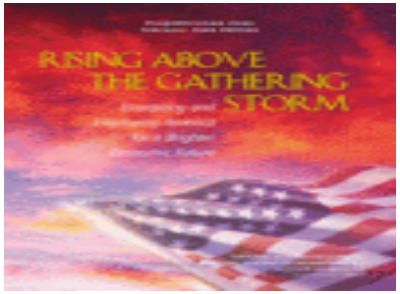
- The need to increase the number of workers with a background in science and mathematics;
- Necessity to compete in the global economy.



- The Tom Friedman – effect!
- Competitiveness – an advantage for new ideas

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Need for…

- Math and science intending majors
- Math majors
- “Hard” science majors
- Engineers
- Mathematics Teachers
  - Where did the need for 70,000 teachers come from anyway?

BILL & MELINDA GATES foundation

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And from the Secretary…

- "We must encourage students to take more advanced math and science classes. Employers today need workers with '***pocket protector***' skills – creative problem solvers with strong math and science backgrounds."

Margaret Spellings, June 21, 2007

Nerds Rock!!

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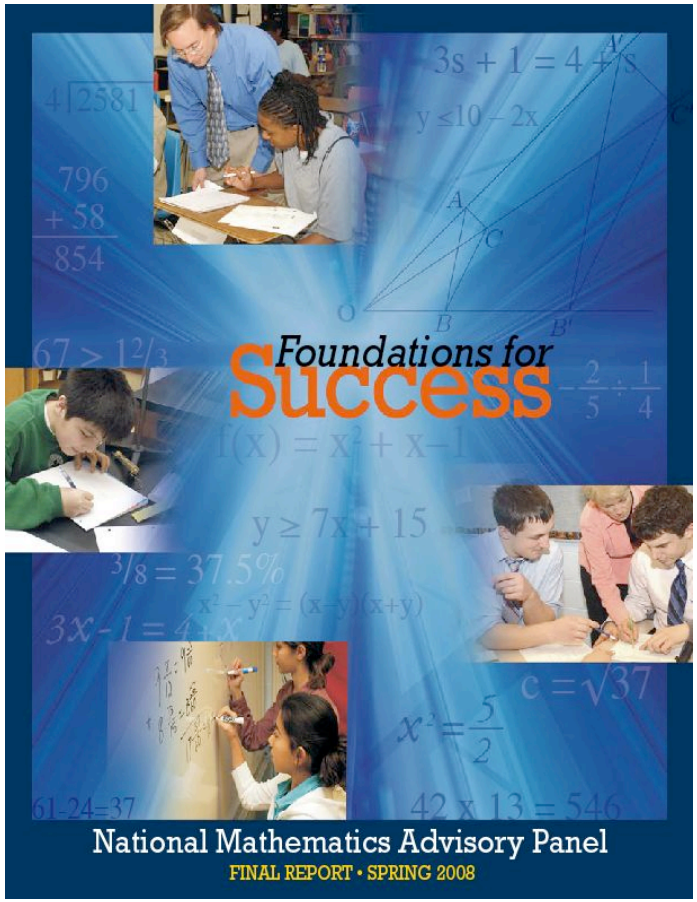
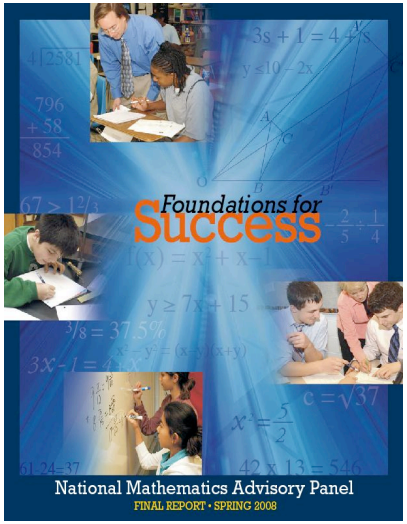


What do we do with this??

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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Concern: Math Proficiency of U.S. Students

- International comparisons
- Low level of proficiency particularly with fractions (decimals, %, ratio, leading to proportion):
  - on NAEP
  - on state assessments
  - pretty much anywhere
- Falling proficiency at higher grades
- Heavy remedial demand upon entry into college
- Achievement and opportunity gap

Algebra as a gateway

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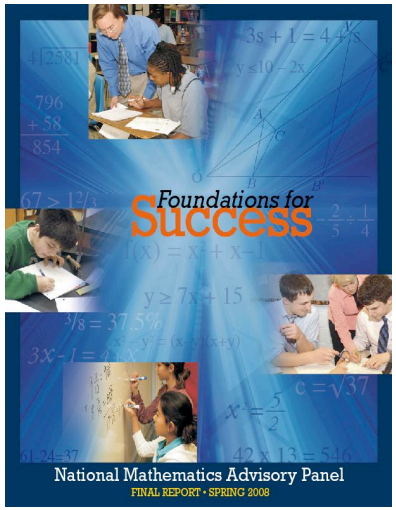
The Story

- Is not about:
  - the ‘math wars’
  - reform vs traditional mathematics
  - or how hard mathematics is.



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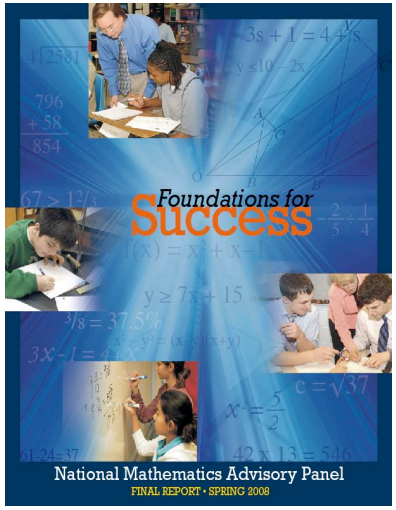
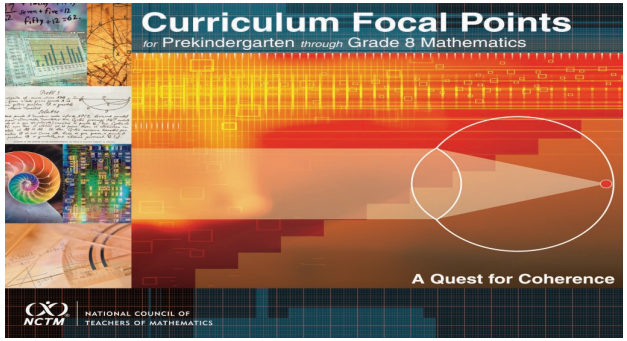
The story is about…

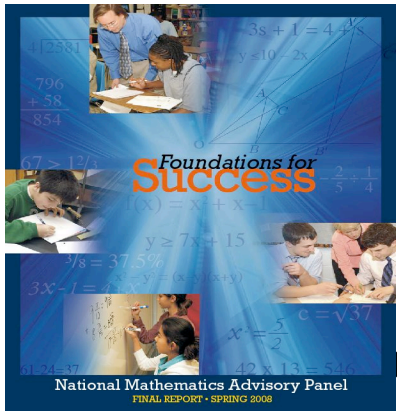


Focus and Coherence of Curricular Content

Grades PreK-8:

- **Focus on the Critical Foundations for Algebra**
  - Proficiency with Whole Numbers
  - Proficiency with Fractions (fractions, decimals, percent)
  - Particular Aspects of Geometry and Measurement
- Revise the curriculum to avoid approaches that continually revisits topics without closure





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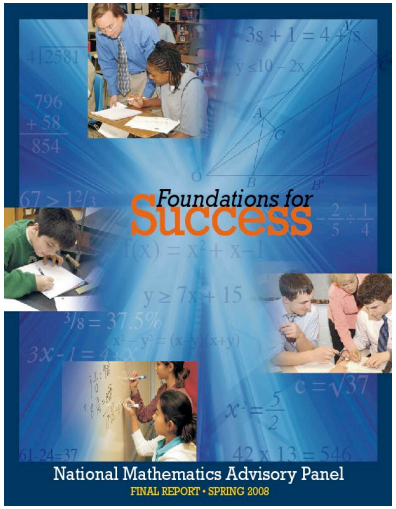
Curricular Content

Benchmarks Should Guide:

- Classroom Curricula
- Mathematics Instruction
- Textbook Development
- State Assessment



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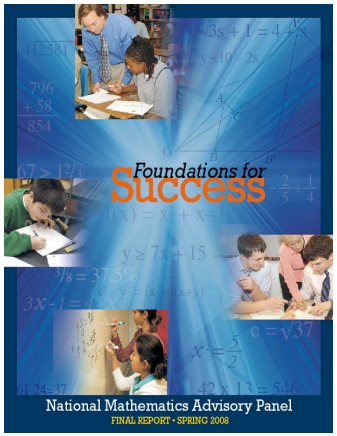
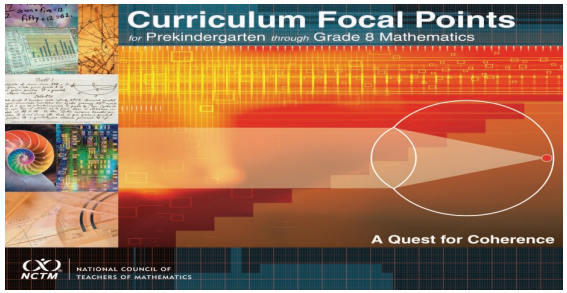
Why Focus and Coherence?

- Long lists of state learning expectations
- "Mile wide, inch deep" math curriculum
- Identify the mathematics that should be the focus of instruction and student learning, preK-8
- Mobility
- **International Comparisons**
- **National Curriculum Clamoring**
- **National Math Advisory Panel Recommendation**





Curriculum Focal Points and Connections for Grade 4

The set of three curriculum focal points and related connections for mathematics in grade 4 follow. These topics are the recommended content emphases for this grade level. It is essential that these focal points be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations.

Grade 4 Curriculum Focal Points

***Number and Operations* and *Algebra:* Developing quick recall of multiplication facts and related division facts and fluency with whole number multiplication**

Students use understandings of multiplication to develop quick recall of the basic multiplication facts and related division facts. They apply their understanding of models for multiplication (i.e., equal-sized groups, arrays, area models, equal intervals on the number line), place value, and properties of operations (in particular, the distributive property) as they develop, discuss, and use efficient, accurate, and generalizable methods to multiply multidigit whole numbers. They select appropriate methods and apply them accurately to estimate products or calculate them mentally, depending on the context and numbers involved. They develop fluency with efficient procedures, including the standard algorithm, for multiplying whole numbers, understand why the procedures work (on the basis of place value and properties of operations), and use them to solve problems.

***Number and Operations:* Developing an understanding of decimals, including the connections between fractions and decimals**

Students understand decimal notation as an extension of the base-ten system of writing whole numbers that is useful for representing more numbers, including numbers between 0 and 1, between 1 and 2, and so on. Students relate their understanding of fractions to reading and writing decimals that are greater than or less than 1, identifying equivalent decimals, comparing and ordering decimals, and estimating decimal or fractional amounts in problem solving. They connect equivalent fractions and decimals by comparing models to symbols and locating equivalent symbols on the number line.

***Measurement:* Developing an understanding of area and determining the areas of two-dimensional shapes**

Students recognize area as an attribute of two-dimensional regions. They learn that they can quantify area by finding the total number of same-sized units of area that cover the shape without gaps or overlaps. They understand that a square that is 1 unit on a side is the standard unit for measuring area. They select appropriate units, strategies (e.g., decomposing shapes), and tools for solving problems that involve estimating or measuring area. Students connect area measure to the area model that they have used to represent multiplication, and they use this connection to justify the formula for the area of a rectangle.

Connections to the Focal Points

Algebra: Students continue identifying, describing, and extending numeric patterns involving all operations and nonnumeric growing or repeating patterns. Through these experiences, they develop an understanding of the use of a rule to describe a sequence of numbers or objects.

Geometry: Students extend their understanding of properties of two-dimensional shapes as they find the areas of polygons. They build on their earlier work with symmetry and congruence in grade 3 to encompass transformations, including those that produce line and rotational symmetry. By using transformations to design and analyze simple tilings and tessellations, students deepen their understanding of two-dimensional space.

Measurement: As part of understanding two-dimensional shapes, students measure and classify angles.

Data Analysis: Students continue to use tools from grade 3, solving problems by making frequency tables, bar graphs, picture graphs, and line plots. They apply their understanding of place value to develop and use stem-and-leaf plots.

Number and Operations: Building on their work in grade 3, students extend their understanding of place value and ways of representing numbers to 100,000 in various contexts. They use estimation in determining the relative sizes of amounts or distances. Students develop understandings of strategies for multidigit division by using models that represent division as the inverse of multiplication, as partitioning, or as successive subtraction. By working with decimals, students extend their ability to recognize equivalent fractions. Students' earlier work in grade 3 with models of fractions and multiplication and division facts supports their understanding of techniques for generating equivalent fractions and simplifying fractions.

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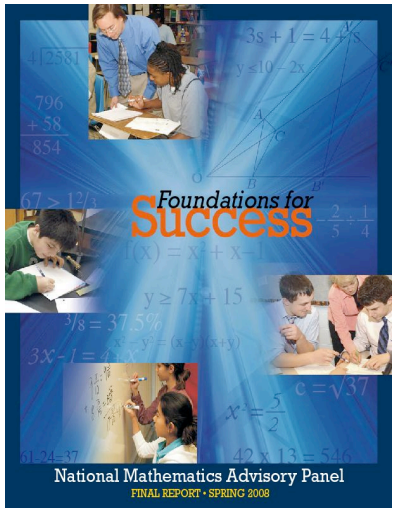
Curricular Content

The Major Topics of School Algebra

Covering all of school algebra traditionally extending over two courses, Algebra I and Algebra II or within Integrated Curricula:

- Symbols and Expressions
- Linear Equations
- Quadratic Equations
- Functions
- Algebra of Polynomials
- Combinatorics and Finite Probability



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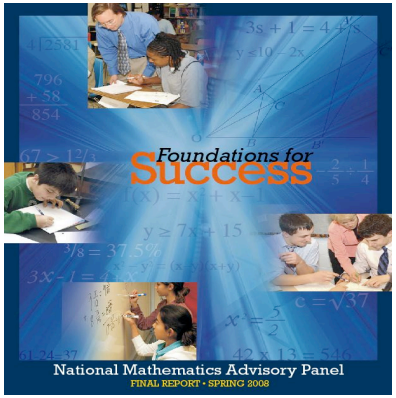
Curricular Content

Access to algebra

All school districts:



- Should ensure that all prepared students have access to an authentic algebra course, and
- Should prepare more students than at present to enroll in such a course by Grade 8.

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Learning Processes

Scientific Knowledge on Learning and Cognition Needs to be Applied to the Classroom to Improve Student Achievement:

- Most children develop considerable knowledge of mathematics before they begin kindergarten.
- Children from families with low incomes, low levels of parental education, and single parents often have less mathematical knowledge when they begin school than do children from more advantaged backgrounds. This tends to hinder their learning for years to come.
- There are promising interventions to improve the mathematical knowledge of these young children before they enter kindergarten.

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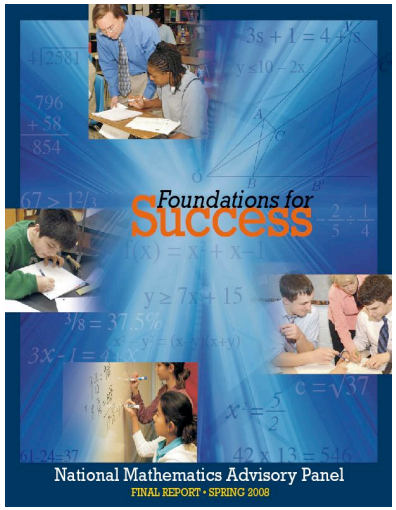
Learning Processes

- To prepare students for Algebra, the curriculum must simultaneously develop conceptual understanding, computational fluency, factual knowledge and problem solving skills.

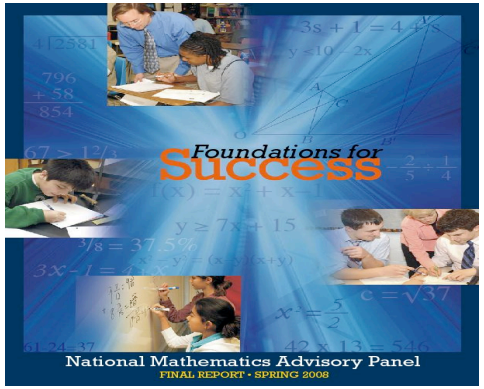


Learning Processes

Children's goals and beliefs about learning are related to their mathematics performance.

- Children's beliefs about the relative importance of effort and ability can be changed.

- Effort matters!
- Anecdotal comment – forget the math gene stuff!



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Teachers & Teacher Education

Mathematically Knowledgeable Classroom Teachers Have a Central Role in Mathematics Education.

- Evidence shows that a substantial part of the variability in student achievement gains is due to the teacher.
- Less clear from the evidence is exactly what it is about particular teachers—what they know and do–that makes them more effective.
- The mathematics preparation of elementary and middle school teachers must be strengthened as one means for improving teacher effectiveness in the classroom

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Teachers & Teacher Education

- **Currently there are multiple pathways into teaching.**
  - Research indicates that differences in teachers' knowledge and effectiveness between these pathways are small or non-significant compared to very large differences among the performance of teachers within each pathway.

- **The Panel recommends that research be conducted on the use of full-time mathematics teachers in elementary schools, often called elementary math specialist teachers.**

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Instructional Practices

Instructional practice should be informed by high quality research, when available, and by the best professional judgment and experience of accomplished classroom teachers.

- All-encompassing recommendations that instruction should be student-centered or teacher-directed are not supported by research.

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Instructional Practices

Use of technology shows promise when:

- Computer-assisted instruction supports drill and practice
- Well designed tutorials are delivered through computer-assisted instruction
- Learning is supported by the careful, targeted application of computer programming

More research is needed

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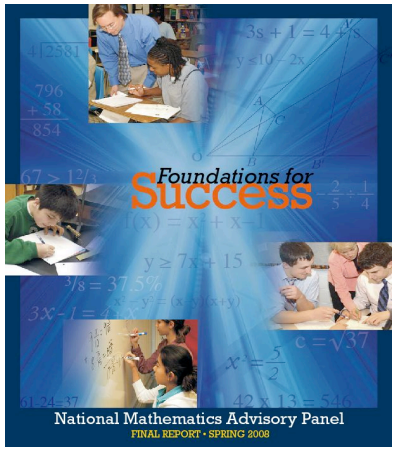
Instructional Materials

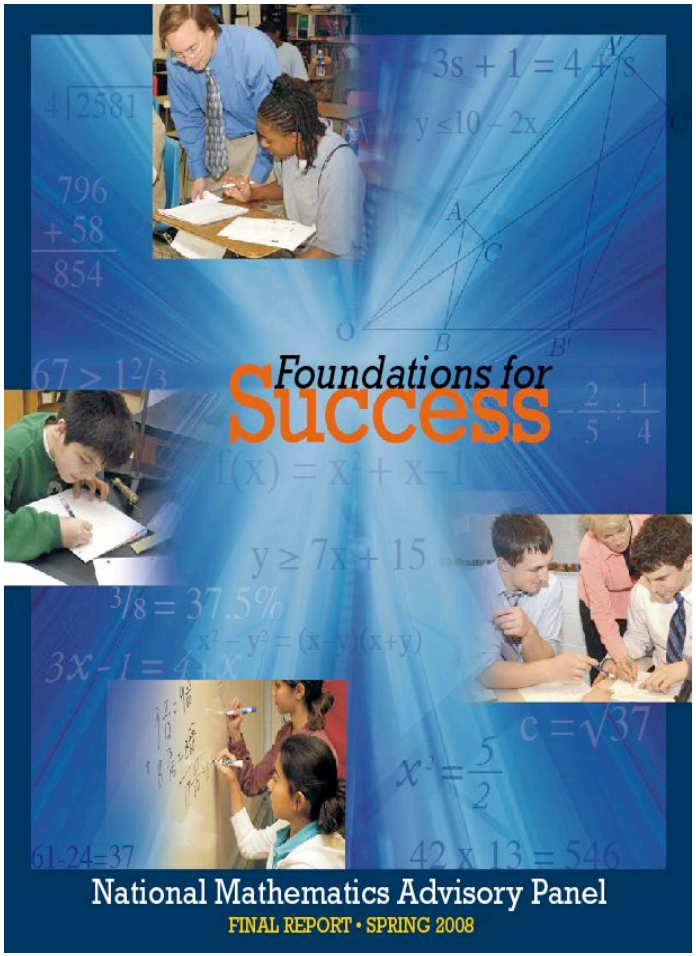
- U. S. mathematics textbooks are far too long -- often 700-1000 pages. Mathematics textbooks are much smaller in many nations with higher mathematics achievement than the U.S. Excessive length makes our books unnecessarily expensive and tends to undermine coherence and focus.

- Publishers must ensure the mathematical accuracy of their materials.



Next Steps

- Release of the Final Report—March 13, 2008
- Publication of Final Report
- Publication of Task Group and Subcommittee Reports
- Expiration of the National Mathematics Advisory Panel—April 18, 2008
- National Forums – October 5-6, 2008, March, 2009



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OK, but what about…

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Opportunities

- **Right now:**
  - National Mathematics Advisory Panel Report - Forums
  - America Competes and Math Now – where is this going?
- **The Immediate Horizon**
  - Election
  - Education Debate

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Communication

Three Views!

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WSJ.com THE WALL STREET JOURNAL. ONLINE

September 12, 2006

Arithmetic Problem

New Report Urges Return to Basics in Teaching Math

By JOHN HECHINGER

Critics of ‘Fuzzy’ Methods Cheer Educators’ Findings; Drills Without Calculators

The nation’s math teachers, on the front lines of a 17-year Curriculum war, are getting some new marching orders: Make sure students learn the basics.

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THE WALL STREET JOURNAL. ONLINE

Education Panel Lays Out Truce In Math Wars

Effort to Fix 'Broken' System Sets Targets for Each Grade, Avoids Taking Sides on Method

By JOHN HECHINGER

March 5, 2008; Page D1

A presidential panel, warning that a "broken" system of mathematics education threatens U.S. pre-eminence, says it has found the fix: A laserlike focus on the essentials.

The National Mathematics Advisory Panel, appointed by President Bush in 2006, is expected to urge the nation's teachers to promote "quick and effortless" recall of arithmetic facts in early grades, mastery of fractions in middle school, and rigorous algebra courses in high school or even earlier. Targeting such key elements of math would mark a sharp departure from the diverse priorities that now govern teaching of the subject in U.S. public schools.

"Without substantial and sustained changes to the educational system, the United States will relinquish its leadership in the twenty-first century," reads a draft of the final report, due to be released next week by the Department of Education

These benchmarks mirror closely a September 2006 report by the National Council of Teachers of Mathematics, which many viewed as a turning point in the math wars because it recognized the importance of teaching the basics after the group for years had placed more emphasis on conceptual understanding. Francis Fennell, president of the math teachers group and a panel member, said the group's specific recommendations could help parents determine whether their kids are on the right track.

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The Tonight Show with Jay Leno
Friday, March 14, 2008

Opening Monologue: 9:46-10:11
Jay Leno: “And a blue ribbon panel of educators put together by President Bush. President Bush put these guys together. He’s determined that other countries’ kids are better at math because we try to teach our kids too much. Huh. That’s the problem. We’re teaching them too much. Teach them less and they’ll learn more. In fact don’t teach them at all, they could grow up to be President of the United States. “

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It's not about basics

What are the critical foundations ALL students need?

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- Fractions are a major area of study in upper elementary school mathematics. It is time to shift the emphasis and redefine the goal of fraction instruction from learning computation rules to developing fraction operation sense (Huinker, 2002).

- Do we do this?

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Plastics…

A major goal for K-8 mathematics should be proficiency with fractions…

NMAP, 2008

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NMAP - Student Preparation

- The first question concerned the adequacy of student preparation coming into the Algebra I classes. The topics that were rated as especially problematic were:
  - Rational numbers;
  - Solving word problems, and;
  - Basic study skills.

Final Report on the National Survey of Algebra Teachers for the National Math Panel, NORC, September, 2007

Fraction Sorting

- Sort the fractions below as near: 0, ½, or 1

4/7	1/7	8/9	3/5
2/3	1/10	4/8	6/11
4/5	2/12	9/12	5/12
1/8	3/8	4/9	7/14

- What's alike about all fractions near 1? Near 0?

Partitioning

- How can we share **eleven** hoagies (aka subs) among four people?

- How can we share **eleven** hoagies (aka subs) among five people?

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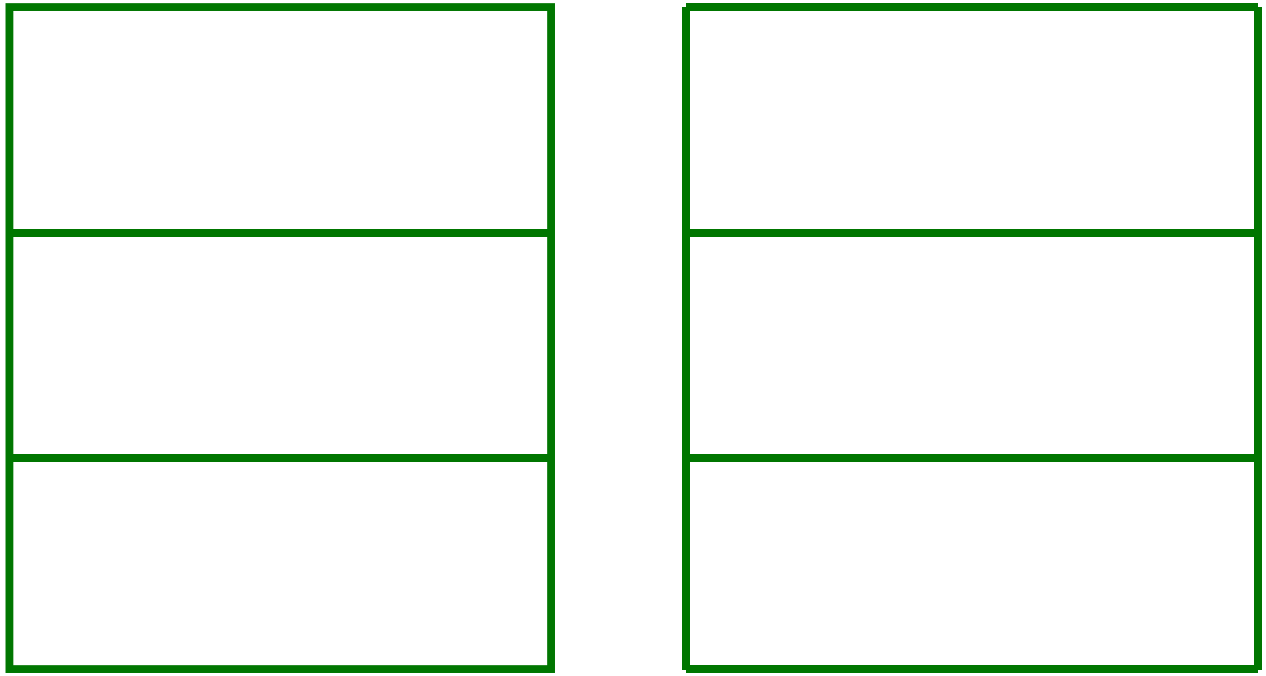

Could the drawing above be shaded to show 5/3? 5/6? Why is this a concern?

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Now what?

- There are 25 students in our class. Each student will get ¼ of a pizza. Your job is to find out how many pizzas we should order. Be sure to show your work.

- How many pizzas should we order?

Fractions!

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$\frac{3}{4}$

- What happens to the value of the fraction if the numerator is increased by 1?
- What happens to the value of the fraction if the denominator is decreased by 1?
- What happens to the value of the fraction if the denominator is increased?

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Ordering Fractions

Write these fractions in order from least to greatest. Tell how you decided.

- 5/3 5/6 5/5 5/4 5/8
- 7/8 2/8 10/8 3/8 1/8

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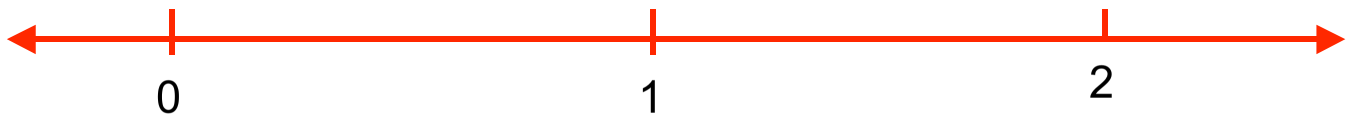
- Tell me about where 2/3 + 1/6 would be on this number line (Cramer, Henry, 2002).



Sense Making:

“2/3 is almost 1, 1/6 is a bit more, but the sum is < 1”

Decimals - What Happens?

Number	x 0.05	x 0.48	x 0.9
100			
60			
24			
?			

- In general, what happens when you multiply a whole number by: 0.05; 0.48; 0.9?
- Begin thinking of 0.05 as 5% or nickel:dollar, etc.

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What Happens Here?

- 1/2 x 3/4 **<** or **>** 3/4
- 3/4 x 1/2 **<** or **>** 1/2

- 1/2 ÷ 3/4 **<** or **>** 1/2
- 3/4 ÷ 1/2 **<** or **>** 3/4

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Use Percent – Don't Wait!

- Put 2/3; 0.5 and 3/4 in order from smallest to largest.
- It's easy, 0.5 is 50% and 2/3 is 66%, and so it goes first 0.5, then 2/3 and then ¾ because that's 75%.*

*response by Andy in New Approaches to Teaching the Rational Number System by Joan Moss in How Students Learn: Mathematics in the Classroom, NRC, 2005.

Percent Benchmarks

	0%	
100%	50%	< 10%
~25%	~75%	~90%
> 50%		< 50%

- Lefthanders in the room or class
- Once lived in **New Jersey**
- Been involved in education > 10 years
- People who were born in **Maryland**

Missing Numbers

- What's my number?
- $2x + 7 = y$
- Rule: Double the number and add 7. What's the number if x =

10

100

0.1

0.01

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Where's the decimal point go?

- 8.432 x 5.75 = 48484
- 3.044 x 16.5 = 50226
- 3.326 x 0.32 x 31.5 = 3352608
- 306.15 ÷ 75.4 = 40603448

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Teacher's Role in Discourse

- Posing questions and tasks that elicit, engage, and challenge each student's thinking.
- Listening carefully to students' ideas.
- Asking students to clarify and justify their ideas orally and in writing.
- Deciding what to pursue in depth from among the ideas that students bring up during a discussion.
- Deciding when and how to attach mathematical notation and language to students' ideas.
- Deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty.
- Monitoring students' participation in discussions and deciding when and how to encourage each student to participate.

NCTM, 1991

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Communication with parents and others…

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More and better mathematics for all students

This is an imperative for America's competitiveness.

Do the kids care that Singapore is #1?

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And yet…

Ewing Marion KAUFFMAN Foundation

- ***Important, but NOT for me***
  - Parents are aware of the importance of math, but remain complacent
  - Students pay lip service to the importance of higher level math…

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A recurring nightmare

- “Ya, know, I was never good in math either.”

- What you might like to say?
  - Can ya read the newspaper?
  - Do you think parents from Singapore say that?
  - Wouldn’t you want something better for YOUR child?

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"The Happiness Factor"

A good thing!

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- Effort makes a difference! NMAP
- Support is necessary – and shows promise in varied settings. NMP
- **If our students enjoy the subject and approach it with curiosity and confidence as well as the perseverance that embraces struggle within mathematics learning—what then? Well, just maybe our students will be more competitive and as they continue to mature value the importance of mathematics learning.**

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Choices

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What Algebra? When?

- Grade level?
- Background?
- Who's teaching?
- The Misplaced Math Student – Lost in 8th Grade Algebra…

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If we don't step up to the challenge of finding and supporting the best teachers we'll undermine everything else we are trying to do to improve our schools.

Louis Gerstner, former Chair, IBM

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Reflecting on your career…

Why did you decide to teach?

- Love of the subject
- “I knew I could get a job”
- Change the world syndrome
- Parental influence – “we, in my family, are all teachers.”

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Immersion Issues

- Mentors – why?
- Things nobody told me about:
  - The principal
  - The secretary
  - The custodian
- The faculty lounge

- AYP and NCLB and other accountability issues

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But, what about…

- Supervision issues!
- Getting along with others
- Finding stuff – copy machine wars!
  - Locating a printer
  - Cartridges!
- Day-to-day victories and losses

SCHOOL CULTURE ISSUES

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Do you remember?

- When I got everything done, I just sat down in the middle of my room and cried.

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"I didn't call myself anything. I was more than a teacher. And less. In the high school classroom you are a drill sergeant, a rabbi, a shoulder to cry on, a disciplinarian, a singer, a scholar, a clerk, a referee, a clown, a counselor, a dress-code enforcer, a conductor, an apologist, a philosopher, a collaborator, a tap dancer, a politician, a therapist, a fool, a traffic cop, a priest, a mother-father-sister-brother-aunt-uncle, a bookkeeper, a critic, a psychologist, the last straw."

This is a memory test!!!

"Teacher Man" Frank McCourt (p.19, 2005)

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Why do they leave?

- Too little planning time,
- Too much paperwork
- Unreliable assistance
- **A general lack of support, including limited pay!**
- **We must sustain and support teachers!**

We share a responsibility

- This must be a concerted team effort, it's about every child every day.
- Mathematics is the gateway to good jobs!

But it's more than Algebra II