

Massachusetts' Efforts to Develop a World Class Math Education System

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Overview

1. Education Reform in Massachusetts.
2. Mathematical Preparation of Elementary Teachers.
3. Exemplary Curriculum – Singapore Math

Education Reform - 1993

Before

Two requirements for a high school degree.

- One year of American history.
- Four years of gym.

Spending disparities - \$3000 to \$10000 per student

“Grand Bargain”

- Massive infusion of state dollars.
- Standards and accountability.

Politics

- Support was bipartisan. Republican governors and Democratic legislatures.
- Massachusetts has a history of local control of schools.
- There still is strong opposition to testing (but not to the funding.)

What's Missing?

- Frameworks need to be more focused.
- Testing lacks any emphasis on basic computation, so teachers do not spend enough time on it.

Where Are We Now?

- Standards and accountability have produced nation-leading NAEP results.
- BUT math proficiency still lags high-performing countries and is especially disappointing in low-income and minority schools.
- This deficit **begins in elementary school** and grows annually because math is "ruthlessly cumulative."

The Problem

Most elementary school teachers are weak in mathematics. They lack a deep understanding of the math they teach.

- If our third grade teachers read at the sixth grade level, there would be cries for action.
- However, many elementary teachers can't "do" sixth grade math.

How do you teach a mathematical subject when you aren't proficient in it?

You focus on rules, procedures and memorization; or on manipulatives, games and activities that you can't readily connect to concepts.

The habit of memorizing rules and algorithms without understanding is counterproductive. Its negative effects become particularly apparent as students move into middle school.

Teachers who don't understand math well can't teach for understanding.

Why Has This Happened?

Few teachers were asked to learn much math in their preparation programs.

Compare this to the number of courses they take that emphasize reading and writing.

Often the math courses they take are not relevant to the task of teaching elementary school mathematics.

Massachusetts

Old Regulation:

“Math appropriate to an elementary teacher.”

New Regulation– April, 2007

- a. Basic principles and concepts important for teaching elementary school mathematics in the following areas.
 - i. Number and operations (the foundation of areas ii-iv)
 - ii. Functions and algebra
 - iii. Geometry and measurement
 - iv. Statistics and probability
- b. Candidates ... must demonstrate not only that they know *how to do elementary mathematics, but that they understand and can explain to students, in multiple ways, why it makes sense.*
- c.

New Requirements

“...the Massachusetts Tests for Educator Licensure (MTEL) “General Curriculum Test” will include a **separately scored section of 40 questions on the mathematics** specified in the new regulation.”

Commissioner’s Guidelines document articulates “...the scope and depth of mathematics knowledge—*both skills and understanding—that are expected of elementary teachers and that will be assessed on the test.* “

New Requirements

“...three to four college-level, subject-matter courses, i.e., 9–12 semester-hours, taught by mathematics faculty, ... These should be taken after any necessary remedial courses and either integrated with or taken prior to math methods courses.”

Issues

- Spread the word to higher education.
- Develop courses if needed.
- Gain and maintain support from various stakeholders.

First Test Administration

- March, 2009
- Pass rate – 27%
- Proposal before Board to give conditional pass given to an additional 15% with requirement of successful retest within 5 years

What about textbooks? Why are people interested in Singapore Math?

a. TIMSS Studies

a. National Math Panel Report

What's different about Singapore Math?

What are its key characteristics?

- **Depth emphasized over breadth:**
More time is spent on each topic.
Fewer topics are covered in a year.
Greater focus on mastery.

Depth versus Breadth

	Grade 1	Grade 3	Grade 6			
Textbook	Number of Lessons	Avg. pages/lesson	Number of Lessons	Avg. pages/lesson	Number of Lessons	Avg. pages/lesson
Singapore	34	15	42	12	24	17
Scott-Foresman	157	4	164	4	158	5
Everyday Math	110	2	120	2	113	4

(Source: American Institute for Research – “What the United States Can Learn From Singapore’s World-Class Mathematics System”)

Key Characteristics

- **Concrete-Pictorial-Abstract Approach:** Abstraction gives math its power. But abstraction must be grounded in understanding.
- **Problem Solving Emphasis:** Model drawing diagrams are used to promote understanding of word problems and provide a bridge to algebraic thinking.
- **More Multi-Step Problems:** Problems often require the use of several concepts.

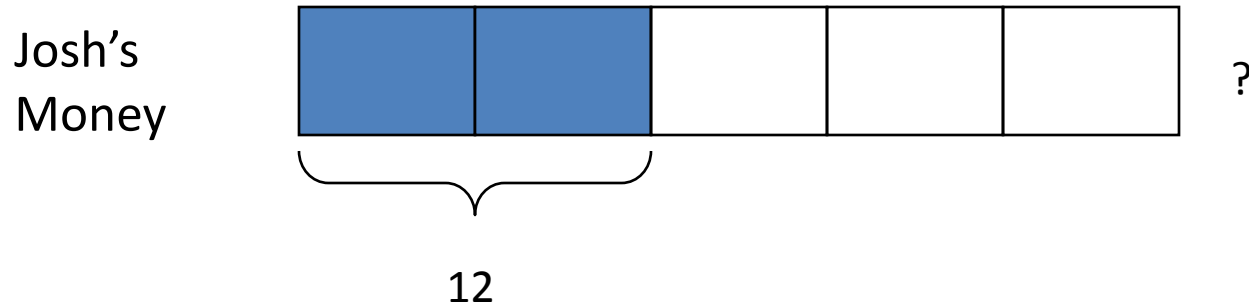
- **Absence of Clutter and Distraction:** Presentation is clean and clear and uses simple, concise explanations that do not require extensive language skills.
- **Coherent Development:** Topics are introduced with simple examples and then incrementally developed until more difficult problems are addressed.
- **Mental Math:** Techniques encourage understanding of mathematical properties and promote numerical fluency.

- **Teacher and Parent Friendly:** Since mathematical content is clear, it is often easier for teachers to plan lessons. Parents can read the books and help children.
- **Review of concepts is not explicitly incorporated** into the curriculum. Students are expected to have mastered a concept once it has been taught.
- **A high level of expectation** is implicit in the curriculum.

Stress on Developing Conceptual Understanding: Students and teachers learn to focus on “why” not just “how.”

The curriculum teaches for mastery through understanding and practice.

Example (grade 4): Josh spent $\frac{2}{5}$ of his money on a CD. The CD cost \$12. How much money did he have at first?

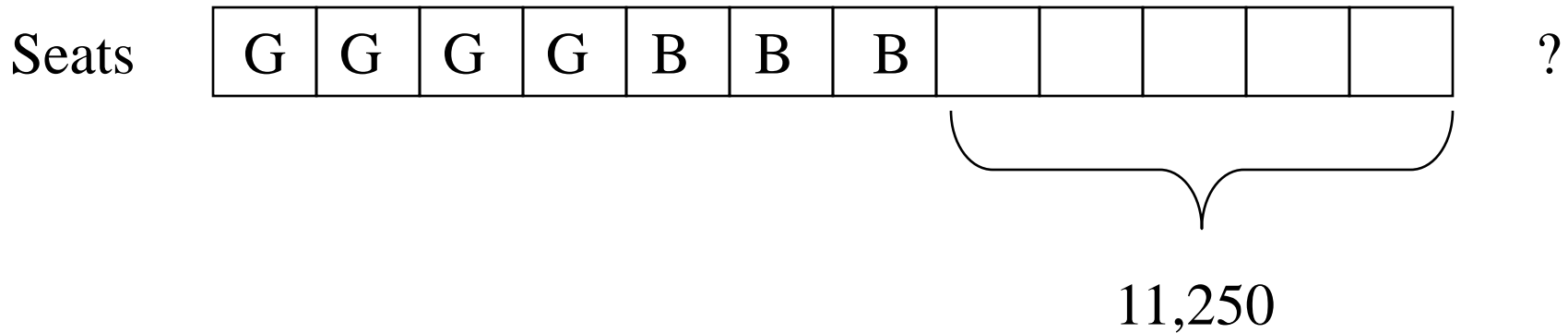


$$2 \text{ units} = 12$$

$$1 \text{ unit} = 6$$

$$5 \text{ units} = 30 \quad \text{Josh started with } \$30.$$

"Of the people in attendance at a recent baseball game, one-third had grandstand tickets, one-fourth had bleacher tickets, and the remaining 11,250 people in attendance had other tickets. What was the total number of people in attendance at the game?"



$$5 \text{ units} = 11,250$$

$$1 \text{ unit} = 2,250$$

$$12 \text{ units} = 27,000$$

The total attendance was 27,000.

Number of Classrooms

Year

2000-01

6

2001-02

19

2002-03

55

2003-04

79

2004-05

106

2005-06

130

05-06 Implementation level:

100% grades 1-6

75% grades 7-8

Grade 10
Percentages of Students at Each Performance Level
Comparison of and State Results (1998-2005)

	Advanced		Proficient		Needs Improvement		Failing	
	NMRSD	State	NMRSD	State	NMRSD	State	NMRSD	State
Math 2005	57%	35%	30%	27%	11%	24%	2%	14%
2004	40	29	34	28	22	28	4	15
2003	24	24	33	27	31	28	12	20
2002	26	20	31	24	27	31	16	25
2001	27	18	32	27	29	30	13	25
2000	13	15	21	18	29	22	37	45
1999	7	9	19	15	29	23	46	53
1998	9	7	18	17	34	24	39	52