TIMSS in Perspective

Lessons Learned from IEA's Four Decades of International Mathematics Assessment

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FIMS – The First International Mathematics Study

- Pioneering international assessment – IEA's first study
- Expanding education systems – need for effective measure of output in terms of student achievement
- Applying psychometric techniques
- The world as an educational laboratory

FIMS – The First International Mathematics Study (cont.)

FIMS conducted 1961-65 in 12 countries

- Two grades targeted (grade with most 13-year-olds; final grade for students studying advanced mathematics)
- Mathematics achievement in relation to school organization, mathematics curriculum and teaching, and student attitudes and backgrounds

Showed that international comparisons of student achievement were feasible, and could provide reliable data for policy makers

SIMS – The Second International Mathematics Study

- Major emphasis on curriculum and instruction
- SIMS mathematics curriculum model
  - Intended curriculum (curricular goals and intentions)
  - Implemented curriculum (what is taught in the classroom)
  - Achieved curriculum (what mathematics students have learned)

SIMS – The Second International Mathematics Study (cont.)

SIMS conducted 1980-82 in 20 countries

- Extensive curriculum analysis
  - Intended curriculum through expert reports
  - Implemented curriculum through "Opportunity to Learn" questionnaires
- Showed that improving mathematics education begins with the curriculum

TIMSS – Third International Mathematics and Science Study

- Conducted in 1994-95, first to include both mathematics and science
- Launch of TIMSS coincided with an upsurge of interest in international studies – almost 50 countries participated
- Ambitious scope
  - Wide-ranging assessment of student achievement
  - Comprehensive curriculum analysis
  - Video study of instructional practices

TIMSS – *Trends in* International Mathematics and Science Study

- TIMSS 1995 – 4th and 8th grades
  - also 3rd, 7th, and 12th
- TIMSS 1999 – 8th grade only
- TIMSS 2003 – 4th and 8th grades
- TIMSS 2007 – 4th and 8th grades

Planning TIMSS 2011 – 4th and 8th grades

TIMSS

Major methodological contributions

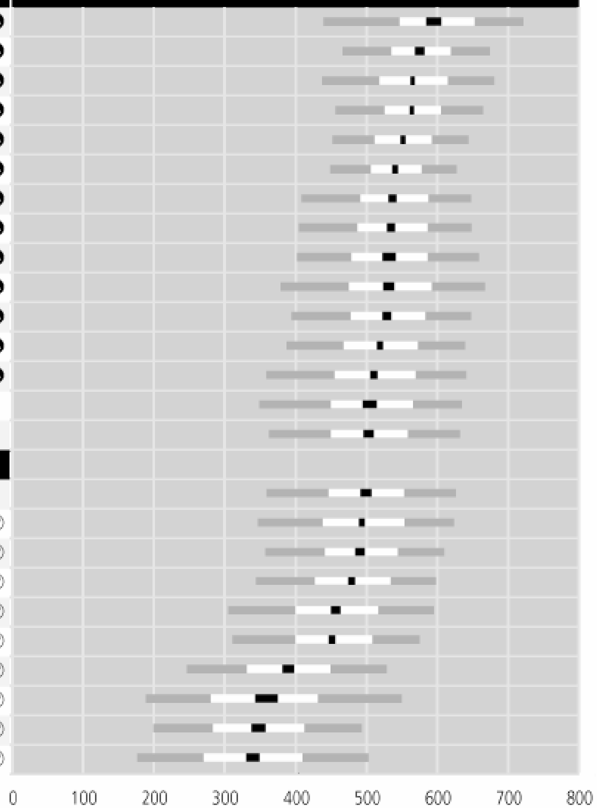
- Ambitious curriculum frameworks for mathematics and science
- Extensive pool of items
- Matrix-sampling design
- Advanced psychometric scaling for analysis and reporting of student achievement
- Systematic emphasis on data quality and data comparability

Exhibit 1: Distribution of Mathematics Achievement (2)

TIMSS2003 Mathematics Grade 4

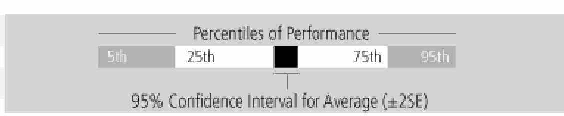
Countries	Average Scale Score	
Singapore	594 (5.6)	▲
† Hong Kong, SAR	575 (3.2)	▲
Japan	565 (1.6)	▲
Chinese Taipei	564 (1.8)	▲
Belgium (Flemish)	551 (1.8)	▲
† Netherlands	540 (2.1)	▲
Latvia	536 (2.8)	▲
[1] Lithuania	534 (2.8)	▲
Russian Federation	532 (4.7)	▲
† England	531 (3.7)	▲
Hungary	529 (3.1)	▲
† United States	518 (2.4)	▲
Cyprus	510 (2.4)	▲
Moldova, Rep. of	504 (4.9)	
Italy	503 (3.7)	
TIMSS Scale Avg.	**500**	
† Australia	499 (3.9)	
New Zealand	493 (2.2)	▼
† Scotland	490 (3.3)	▼
Slovenia	479 (2.6)	▼
Armenia	456 (3.5)	▼
Norway	451 (2.3)	▼
Iran, Islamic Rep. of	389 (4.2)	▼
Philippines	358 (7.9)	▼
Morocco	347 (5.1)	▼
Tunisia	339 (4.7)	▼

Mathematics Achievement Distribution



▲ Country average significantly higher than international average

▼ Country average significantly lower than international average



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

- 13 above average, U.S.

  3 about average

  9 below average

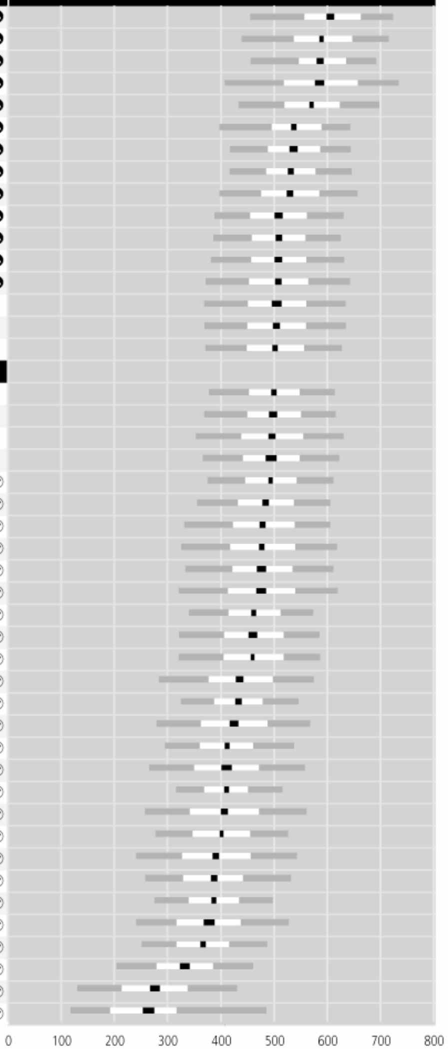
- Wide range of achievement – across and within countries

Exhibit 1: Distribution of Mathematics Achievement

TIMSS2003 Mathematics Grade 8

Countries	Average Scale Score	
Singapore	605 (3.6)	▲
†† Korea, Rep. of	589 (2.2)	▲
† Hong Kong, SAR	586 (3.3)	▲
Chinese Taipei	585 (4.6)	▲
Japan	570 (2.1)	▲
Belgium (Flemish)	537 (2.8)	▲
† Netherlands	536 (3.8)	▲
Estonia	531 (3.0)	▲
Hungary	529 (3.2)	▲
Malaysia	508 (4.1)	▲
Latvia	508 (3.2)	▲
Russian Federation	508 (3.7)	▲
Slovak Republic	508 (3.3)	▲
Australia	505 (4.6)	
‡ United States	504 (3.3)	
1 Lithuania	502 (2.5)	
TIMSS Scale Avg.	500	
Sweden	499 (2.6)	
† Scotland	498 (3.7)	
2 Israel	496 (3.4)	
New Zealand	494 (5.3)	
Slovenia	493 (2.2)	▼
Italy	484 (3.2)	▼
Armenia	478 (3.0)	▼
1 Serbia	477 (2.6)	▼
Bulgaria	476 (4.3)	▼
Romania	475 (4.8)	▼
Norway	461 (2.5)	▼
Moldova, Rep. of	460 (4.0)	▼
Cyprus	459 (1.7)	▼
2 Macedonia, Rep. of	435 (3.5)	▼
Lebanon	433 (3.1)	▼
Jordan	424 (4.1)	▼
Iran, Islamic Rep. of	411 (2.4)	▼
1 Indonesia	411 (4.8)	▼
Tunisia	410 (2.2)	▼
Egypt	406 (3.5)	▼
Bahrain	401 (1.7)	▼
Palestinian Nat'l Auth.	390 (3.1)	▼
Chile	387 (3.3)	▼
1 ‡ Morocco	387 (2.5)	▼
Philippines	378 (5.2)	▼
Botswana	366 (2.6)	▼
Saudi Arabia	332 (4.6)	▼
Ghana	276 (4.7)	▼
South Africa	264 (5.5)	▼

Mathematics Achievement Distribution



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

- 13 above average

  7 about average, U.S.

  25 below average
- Wide range of achievement – across and within countries
- Range between 5th and 95th percentiles approximately 270-300
- Average in Singapore same as 95th percentile in lowest countries

The TIMSS Advanced International Benchmark (625)

Percentage of eighth-grade students reaching the advanced benchmark in 2003

Singapore	44%
Chinese Taipei	38%
Korea, Rep. of	35%
Hong Kong SAR	35%
Japan	24%
United States	7%

Exhibit 3: Trends in Average Mathematics Achievement (2)

TIMSS2003
MATHEMATICS Grade 4

Countries	2003 Average Scale Score	1995 to 2003 Difference	
Australia	499 (3.9)	4 (5.2)	
Cyprus	510 (2.4)	35 (4.0)	▲
England	531 (3.7)	47 (5.0)	▲
Hong Kong, SAR	575 (3.2)	18 (5.1)	▲
Hungary	529 (3.1)	7 (4.8)	
Iran, Islamic Rep. of	389 (4.2)	2 (6.5)	
Japan	565 (1.6)	-3 (2.4)	
Latvia (LSS)	533 (3.1)	34 (5.5)	▲
Netherlands	540 (2.1)	-9 (3.6)	▼
New Zealand	496 (2.1)	26 (4.9)	▲
Norway	451 (2.3)	-25 (3.8)	▼
Scotland	490 (3.3)	-3 (5.3)	
Singapore	594 (5.6)	4 (7.2)	
Slovenia	479 (2.6)	17 (4.1)	▲
United States	518 (2.4)	0 (3.8)	
TIMSS Scale Avg.	500		

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

2003 Country average significantly higher ▲

2003 Country average significantly lower ▼

- 6 countries improved from 1995 to 2003
- 7 stayed the same, including U.S.
- 2 countries declined

TIMSS2003 Mathematics Grade 8

Exhibit 3: Trends in Average Mathematics Achievement

Countries	2003 Average Scale Score	1999 to 2003 Difference	1995 to 2003 Difference
Australia	505 (4.6)	- -	-4 (6.0)
Belgium (Flemish)	537 (2.8)	-21 (4.3) ▼	-13 (6.5) ▼
Bulgaria	476 (4.3)	-34 (7.3) ▼	-51 (7.2) ▼
Chile	387 (3.3)	-6 (5.5)	✧ ✧
Chinese Taipei	585 (4.6)	0 (6.1)	✧ ✧
Cyprus	459 (1.7)	-17 (2.4) ▼	-8 (2.8) ▼
Hong Kong, SAR	586 (3.3)	4 (5.4)	17 (7.0) ▲
Hungary	529 (3.2)	-2 (4.9)	3 (4.5)
Indonesia	411 (4.8)	8 (6.9)	✧ ✧
Iran, Islamic Rep. of	411 (2.4)	-11 (4.1) ▼	-7 (4.5)
Israel	496 (3.4)	29 (5.2) ▲	- -
Italy	484 (3.2)	4 (5.0)	- -
Japan	570 (2.1)	-9 (2.7) ▼	-11 (2.6) ▼
Jordan	424 (4.1)	-3 (5.4)	✧ ✧
Korea, Rep. of	589 (2.2)	2 (2.9)	8 (2.9) ▲
Latvia (LSS)	505 (3.8)	0 (5.1)	17 (5.2) ▲
Lithuania	502 (2.5)	20 (4.9) ▲	30 (4.8) ▲
Macedonia, Rep. of	435 (3.5)	-12 (5.5) ▼	✧ ✧
Malaysia	508 (4.1)	-11 (6.0)	✧ ✧
Moldova, Rep. of	460 (4.0)	-9 (5.6)	✧ ✧
Netherlands	536 (3.8)	-4 (8.1)	7 (7.2)
New Zealand	494 (5.3)	3 (7.4)	-7 (7.1)
Norway	461 (2.5)	✧ ✧	-37 (3.3) ▼
Philippines	378 (5.2)	33 (7.9) ▲	✧ ✧
Romania	475 (4.8)	3 (7.5)	2 (6.6)
Russian Federation	508 (3.7)	-18 (7.0) ▼	-16 (6.5) ▼
Scotland	498 (3.7)	✧ ✧	4 (6.8)
Singapore	605 (3.6)	1 (7.2)	-3 (5.4)
Slovak Republic	508 (3.3)	-26 (5.2) ▼	-26 (4.5) ▼
Slovenia	493 (2.2)	- -	-2 (3.7)
South Africa	264 (5.5)	-11 (8.8)	- -
Sweden	499 (2.6)	✧ ✧	-41 (5.0) ▼
Tunisia	410 (2.2)	-38 (3.3) ▼	✧ ✧
United States	504 (3.3)	3 (5.2)	12 (5.8) ▲
TIMSS Scale Avg.	500		

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

- 17 three-cycle trends

  34 two-cycle trends

- 5 had improvement 1995-2003, U.S.

  Hong Kong SAR and Korea

  Latvia and Lithuania

Summary

- Many lessons learned since the pioneering days
- Different countries use different approaches but an effective educational system always requires enormous effort
  - High percentages of students in school through secondary school, and taking advanced courses
  - A rigorous and progressive curriculum
  - Well-prepared teachers
  - Economic resources, facilities, and materials
  - Students ready to learn and encouraged by society

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January 23, 2008

Lack of Focus in the Mathematics Curriculum: A Symptom or a Cause

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January 23, 2008

Instructional Content Constructs

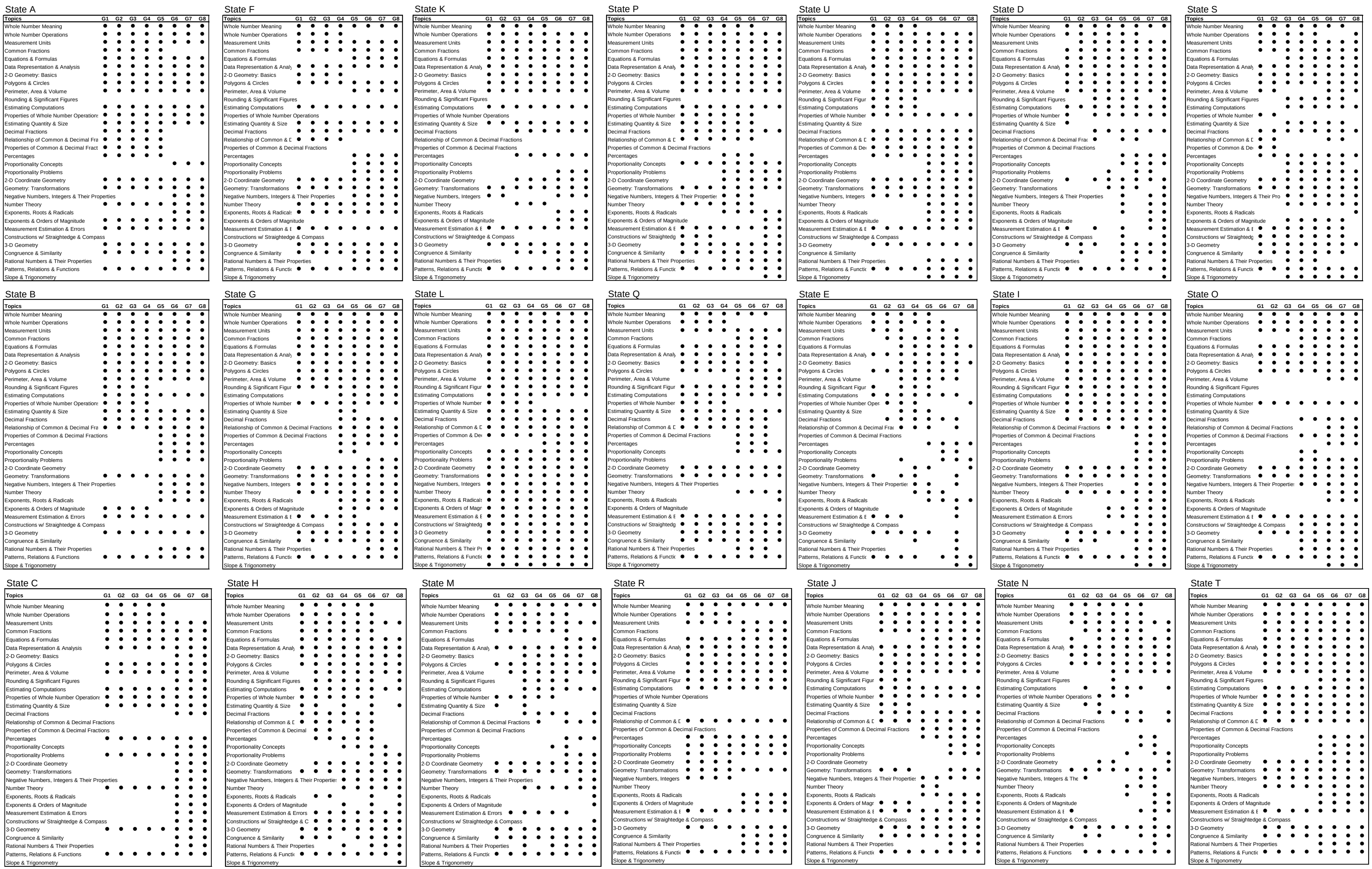
- **Curricular Coherence**
  - **Curricular Structure**
- **Curricular Focus**
  - **Exposure Time (OTL)**
- **Curricular Rigor**
  - **Level of Cognitive Complexity**

High Achieving Countries' Mathematics Standards

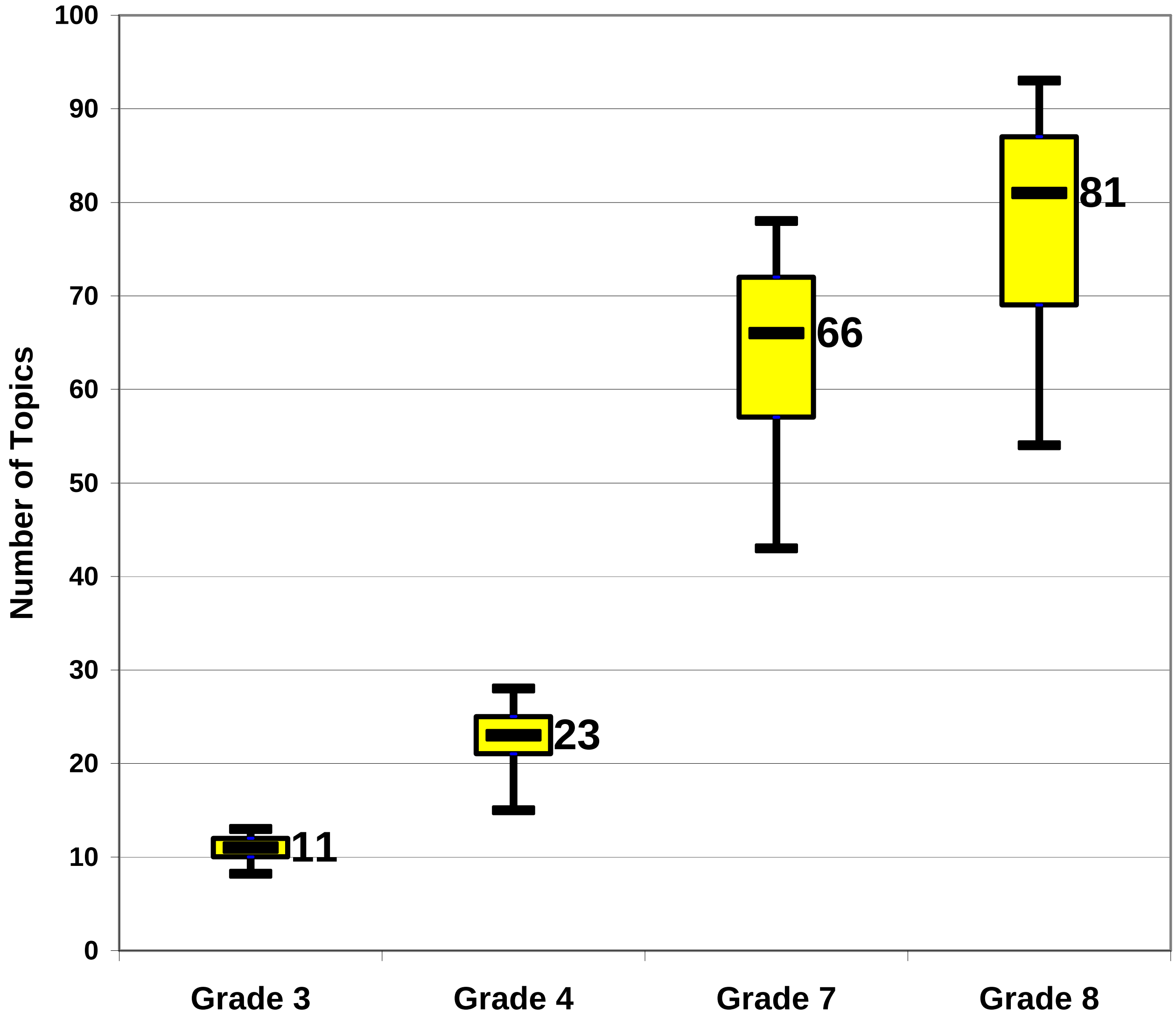
Mathematics Topics

Topic	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Whole Number Meaning	●	●	●	●	●			
Whole Number Operations	●	●	●	●	●			
Measurement Units	●	●	●	●	●	●	●	
Common Fractions			●	●	●	●		
Equations & Formulas			●	●	●	●	●	●
Data Representation & Analysis			●	●	●	●		●
2-D Geometry: Basics			●	●	●	●	●	●
Polygons & Circles				●	●	●	●	●
Perimeter, Area & Volume				●	●	●	●	●
Rounding & Significant Figures				●	●			
Estimating Computations				●	●	●		
Properties of Whole Number Operations				●	●			
Estimating Quantity & Size				●	●			
Decimal Fractions				●	●	●		
Relationship of Common & Decimal Fractions				●	●	●		
Properties of Common & Decimal Fractions					●	●		
Percentages					●	●		
Proportionality Concepts					●	●	●	●
Proportionality Problems					●	●	●	●
2-D Coordinate Geometry					●	●	●	●
Geometry: Transformations						●	●	●
Negative Numbers, Integers & Their Properties						●	●	
Number Theory							●	●
Exponents, Roots & Radicals							●	●
Exponents & Orders of Magnitude							●	●
Measurement Estimation & Errors							●	
Constructions w/ Straightedge & Compass							●	●
3-D Geometry							●	●
Congruence & Similarity								●
Rational Numbers & Their Properties								●
Patterns, Relations & Functions								●
Slope & Trigonometry								●

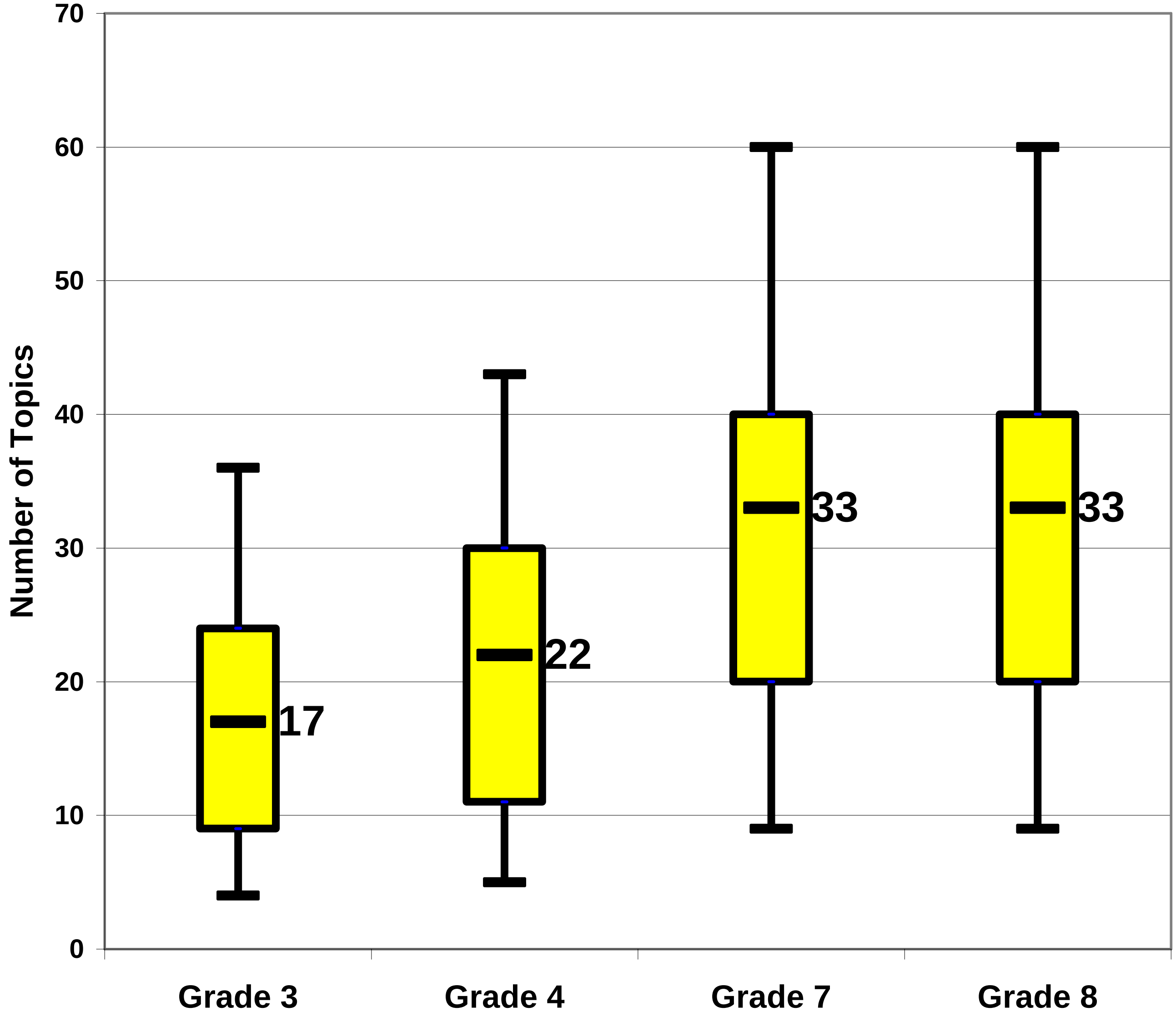
21 States' Mathematics Standards



Number of Topics Aligned with Ideal Scenario



Number of Topics Not Aligned (Introduced Prior to Ideal Scenario)



Alignment with Ideal Scenario

Country	*Total Number of Topics in Curriculum*	*Number of Topics Not Aligned (Introduced Prior to Ideal Scenario)*	*Number of Topics Aligned with Ideal Scenario*	*Number of Topics Not Aligned (Introduced Following the Ideal Scenario)*
Argentina	81	3	54	24
Australia	136	32	75	29
Belgium (Fl)	155	37	87	31
Canada	181	58	92	31
Cyprus	162	49	87	26
Czech Republic	119	32	83	4
France	156	40	85	31
Germany	117	33	74	10
Hong Kong	79	9	62	8
Hungary	158	49	93	16
Iceland	137	32	81	24
Japan	128	39	86	3
Korea	125	27	90	8
Netherlands	97	14	54	29
Norway	159	33	96	30
Portugal	144	48	84	12
Singapore	115	11	84	21
Spain	109	23	69	17
USA	186	63	98	25

8th Grade Math Scaled Score vs. Ratio of No. of Aligned topics to the Total No. of Topics in Curriculum

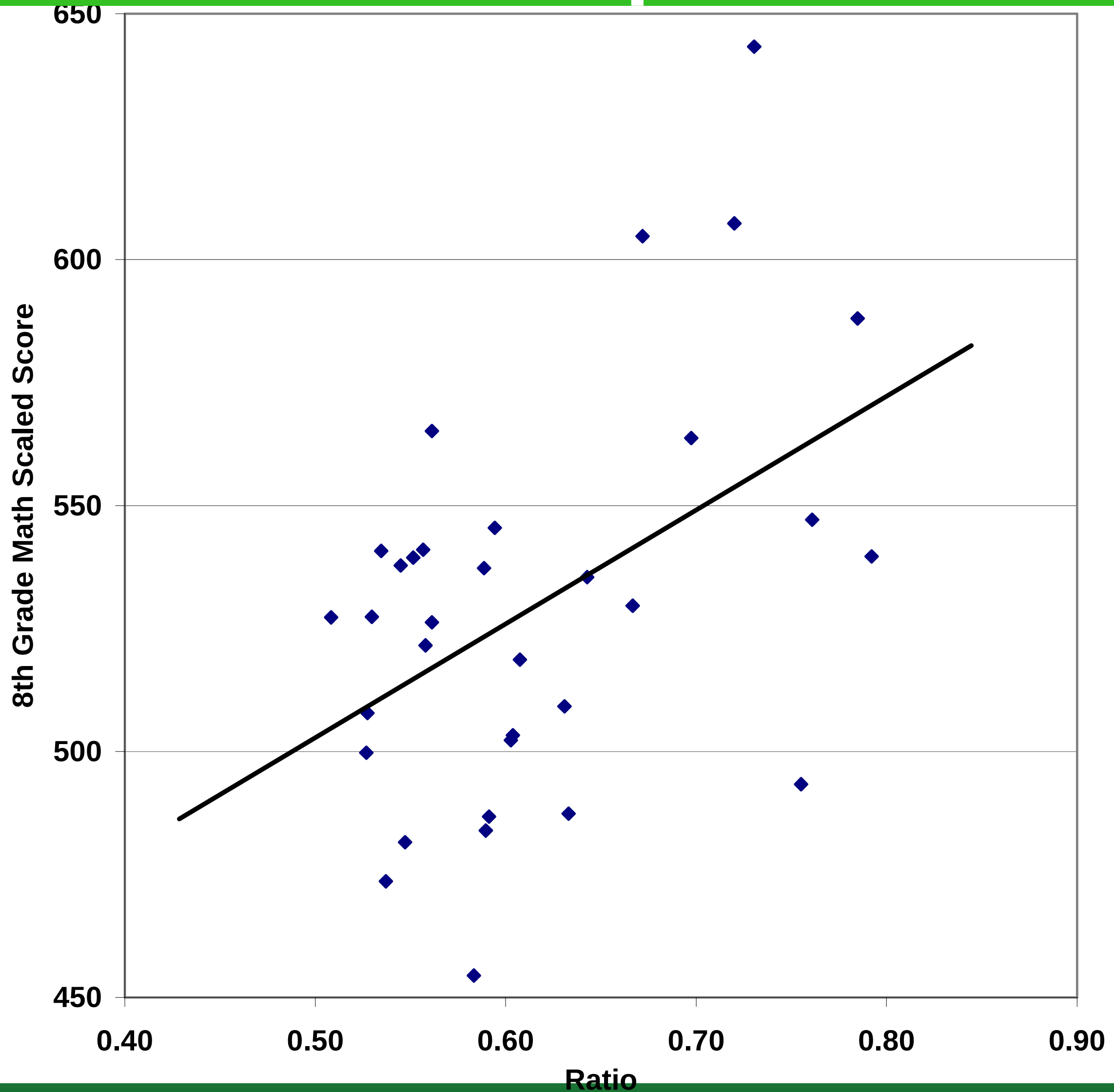


Table 1: Regression Analyses relating Achievement to Coherence and Focus Measure

Model	*Grade 3*	*Grade 4*	*Grade 7*	*Grade 8*
Predictor	**Estimate (StdError, p)**	**Estimate (StdError, p)**	**Estimate (StdError, p)**	**Estimate (StdError, p)**
Number of Topics Aligned with Ideal Scenario	**9.94** (7.38 , *0.196*)	**7.48** (4.04 , *0.081*)	**3.57** (1.48 , *0.023*)	**2.83** (1.12 , *0.017*)
Total Number of Topics in Curriculum	**-2.42** (1.13 , *0.047*)	**-2.58** (1.05 , *0.025*)	**-1.64** (0.57 , *0.008*)	**-1.39** (0.45 , *0.004*)
Model Fit				
R-Square	**0.2191**	**0.2574**	**0.2205**	**0.2490**
Residual Mean Sq.	**1652.9**	**1489.0**	**1476.0**	**1331.4**
p<	*0.1222*	*0.0687*	*0.0270*	*0.0136*
No. of Countries	20	21	32	33
Standardized Coefficient				
Number of Topics Aligned with Ideal Scenario	**0.4374**	**0.7331**	**0.8481**	**0.8240**
Total Number of Topics in Curriculum	**-0.6969**	**-0.9703**	**-1.0044**	**-1.0204**

Table 2: Regression Analyses relating Achievement to Coherence and Specific Focus Measure

Model	*Grade 3*	*Grade 4*	*Grade 7*	*Grade 8*
Predictor	**Estimate (StdError, p)**	**Estimate (StdError, p)**	**Estimate (StdError, p)**	**Estimate (StdError, p)**
Number of Topics Aligned with Ideal Scenario	**7.52** (6.57 , *0.268*)	**4.91** (3.19 , *0.141*)	**1.84** (1.06 , *0.094*)	**1.66** (0.87 , *0.068*)
Number of Topics Not Aligned (Introduced Prior to Ideal Scenario)	**-2.42** (1.13 , *0.047*)	**-2.58** (1.05 , *0.025*)	**-1.79** (0.71 , *0.017*)	**-1.97** (0.70 , *0.009*)
Model Fit				
R-Square	**0.2191**	**0.2574**	**0.1826**	**0.2122**
Residual Mean Sq.	**1652.9**	**1489.0**	**1547.9**	**1396.6**
p<	*0.1222*	*0.0687*	*0.0538*	*0.0279*
No. of Countries	20	21	32	33
Standardized Coefficient				
Number of Topics Aligned with Ideal Scenario	**0.3309**	**0.4807**	**0.4382**	**0.4825**
Number of Topics Not Aligned (Introduced Prior to Ideal Scenario)	**-0.6209**	**-0.7646**	**-0.6405**	**-0.7151**

U.S. Algebra Performance in an International Context

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Coauthors:

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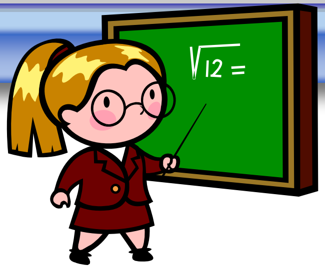
U.S. school algebra



- Separate high school courses
- Designed for the college bound
- Arose from college entrance requirements as algebra moved from the college to the high school
- Beginning algebra moving to Grade 8 and earlier
- Began as generalized arithmetic; has kept much of that character
- Slowly becoming more practical and functions based

Performance in TIMSS 2003

- U.S. 4th graders’ performance in algebra, measured by score points, was somewhat better than it was on all mathematics items taken together and better than the average for 4th graders in other countries
- U.S. 8th graders’ performance in algebra was above its average on all items and above that of 8th graders in other countries

TIMSS 2003: Performance of U.S. fourth graders

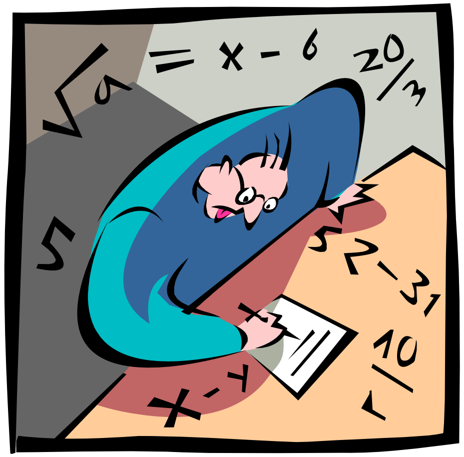
	Number of items	U.S. average scaled score	26-country average scaled score
Number	63	516	495
Patterns, equations, & relationships	22	524	495
Measurement	33	500	495
Geometry	24	518	495
Data	17	549	495
Total	**161**	**518**	**495**

TIMSS 2003: Performance of U.S. eighth graders

	Number of items	U.S. average scaled score	26-country average scaled score
Number	57	508	466
Algebra	47	510	466
Measurement	31	495	466
Geometry	31	472	466
Data	28	527	466
Total	**194**	**504**	**466**

Item characteristics

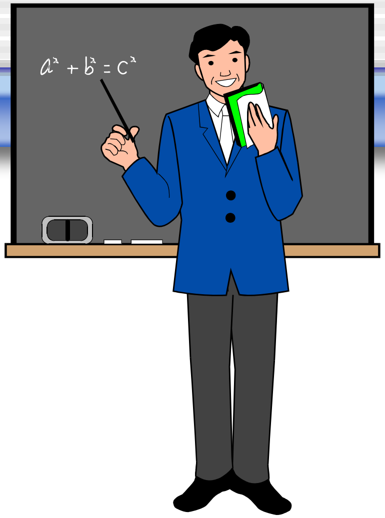
- *Content*
- *Representation*
- *Cognitive demand*



Content

- Patterns
- Informal algebra
- Equations
- Inequalities
- Functions
- Algebraic reasoning
- Algebraic manipulation

Representation



- Numerical
- Verbal
- Graphical
- Symbolic
- Pictorial

- N → V
- V → G
- S → N
- P → P
- etc.

Cognitive demand

Content dimension

Rich

Quadrant II: Tasks tend to measure specific content in particular settings

Quadrant I: Tasks tend to be complex, open-ended, and require extensive mobilization of information

Process dimension

Constrained

Open

Quadrant III: Tasks tend to assess factual knowledge

Quadrant IV: Tasks tend to be lean in content and assess creativity

Lean

Seven systems

- Members of the Organisation for Economic Cooperation and Development (OECD)
- Participated in TIMSS 1995, 1999, 2003
- 1995 & 1999: Australia, Canada, Czech Republic, Hungary, the Netherlands, New Zealand, the United States
- 2003: Australia, Ontario, Quebec, Hungary, the Netherlands, New Zealand, the United States
- All but the U.S. and New Zealand were "A" countries in TIMSS 1995 (Valverde & Schmidt, 2000)

Relative high performance

1999 Item P09 (Grade 8)

Algebraic manipulation, $S \rightarrow S$, Quadrant III

Which of these expressions is equivalent to $n \times n \times n$ for all values of n?

A. $\frac{n}{3}$

B. $n + 3$

C. $3n$

D. n^3

U.S. percent correct:	85%
Next highest percent correct (Czech Republic):	81%

Relative high performance items

- 3 in 1995, 1 in 1999, 7 in 2003
- 6 at Grade 4, 5 at Grade 8
- Tend to involve transition from arithmetic thinking to algebraic thinking
  - Algebraic manipulation
  - Patterns
  - Informal algebra
- Do not involve pictorial or graphical representation
- Most located in Quadrant III (content lean and process constrained)

Relative low performance

1999 Item V04a (Grade 8)

Patterns, $P \rightarrow N$, Quadrant III

The figures show four sets consisting of circles.

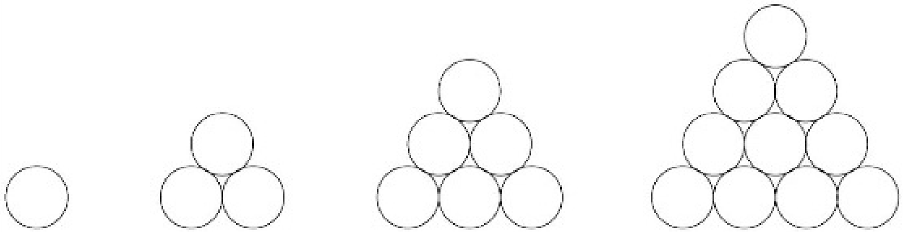


Figure 1 Figure 2 Figure 3 Figure 4

a) Complete the table below. First, fill in how many circles make up Figure 4. Then, find the number of circles that would be needed for the 5th figure if the sequence of figures is extended.

Figure	**Number of circles**
1	1
2	3
3	6
4	
5	

U.S. percent correct (lowest): 73%

Hungary percent correct (2nd lowest): 77%

Relative low performance items

- 8 in 1995, 5 in 1999, 4 in 2003
- All at eighth grade
- Most involve pattern generalization
- Most involve numerical or pictorial representations (no graphical)
- Most are in either Quadrant II (rich content, process constrained) or III (lean content, process constrained)
- Items are generally difficult for students in all selected countries

Observations about U.S. performance

- Fourth graders do relatively well in interpreting a rule, engaging in transitive reasoning, translating from words to symbols, and extending numerical patterns
- Twelfth graders can interpret a function graph, but their performance otherwise is relatively weak
- Eighth graders can understand exponential notation, interpret simple algebraic expressions, reason about sequences, and solve an equation for one variable in terms of another
- Their performance is relatively weak, however, in interpreting symbols in an equation, completing tables, finding sums of series, manipulating expressions, generalizing patterns, and solving word problems

Final observations

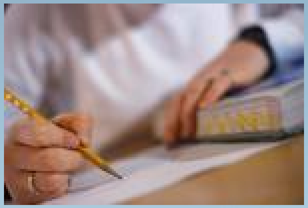
- AIR study (Alan Ginsburg et al., 2005):
  - U.S. performance below the average for 12 countries at high and low levels of rigor for TIMSS items and at high and low levels of difficulty for TIMSS and PISA items
  - Countries: Australia, Belgium, Hong Kong, Hungary, Italy, Japan, Latvia, Netherlands, New Zealand, Norway, the Russian Federation, and the United States
- Our results indicate, however, that although U.S. students' performance may be low in general, it is not uniformly low
- The most and greatest differences in algebra performance between the U.S. and other TIMSS countries are at eighth grade
- U.S. eighth graders do better in algebra than might be expected given their limited exposure to it

Final observations

- AIR study also found that U.S. eighth-grade teachers far more likely (66% to 36% for other 11 countries) to say they relate mathematics to students' daily lives in most lessons
- TIMSS video studies show that U.S. eighth-grade teachers use few high complexity problems and spend 30% of lessons on review
- Algebra is of limited use if it is understood as generalized arithmetic only
- If students are to use algebra, they need to be proficient in functional thinking

Lessons Learned

A Response



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TIMSS in Perspective: Lessons Learned from IEA's Four Decades of International Mathematics Assessments

Ina V. S. Mullis & Michael O. Martin

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Teacher Experience & Preparation

- ...little evidence of a direct relationship between teacher training and student achievement.
- Requirements for being certified to teach mathematics:

Requirements	**47 countries, 8th grade only**
Degree	**33**
Practicum	**33**
Exam	**28**
Probationary Period	**23**
Induction	**11**

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Instruction

- The three predominant activities at both 4th and 8th grade (accounting for 60% of class time) were teacher lecture, teacher-guided student practice, and students working on problems on their own.

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Home Support for Learning

- TIMSS 2003 data make it clear that higher levels of parents' education are associated with higher 8th grade student achievement in mathematics in almost all countries.

p. 33

Attitudes and Values

- At both grades (TIMSS 2003) students had higher mathematics achievement, on average, if they were more self-confident in learning mathematics and placed higher value on the subject.
- Nevertheless…some research has indicated that the students following a demanding curriculum may have higher achievement, but little enthusiasm for the subject matter.

The Happiness Factor!!

p.34

Lack of Focus in the Mathematics Curriculum: Symptom or Cause?

William H. Schmidt & Richard T. Houang

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A Mile Wide and an Inch Deep

- 1997
  - U.S. curriculum typically covered more topics at each grade level than did any other country participating in TIMSS
  - True of state standards, textbooks, and the NCTM Standards
  - Little focus, resulting in a surface or skim level of coverage

p.65

Coherence

- Coherence – articulated over time as a sequence of topics and expectations which deepen and **reach closure**.
- Lack of focus (larger number of topics) is the symptom, lack of coherence is the problem.

p. 65-66

Focus

- A decrease of fifty in the number of intended topic and grade combinations would predict an increase in achievement of almost three-fourths of a standard deviation. This is especially relevant to the U.S., …a decrease of fifty combinations would bring it more into line with Japan and Korea.

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Focus

Country	Topics	Before Ideal	Aligned with	After Ideal
U.S.	**186**	**63**	**98**	**25**
CFP	**111**	**34**	**72**	**5**

Focus & Coherence

- For a country to have a high mean level of performance, it must have a high degree of focus as well as coherence.

- The amount of “clutter” created by covering too many topics too early or before their time from a mathematical point of view must be kept small.

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And now…

- The results of these analyses do not bode well for the United States. They predict poor levels of performance, especially in the middle grades. In fact, poor performance in the middle grades has been seen repeatedly, as recently as 2003.

Gr. 6-8	Before Ideal	After Ideal
NCTM Standards	10	30
CFPs	5	4

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U.S. Algebra Performance in an International Context

Jeremy Kilpatrick, Vilma Mesa, & Finbarr Sloane

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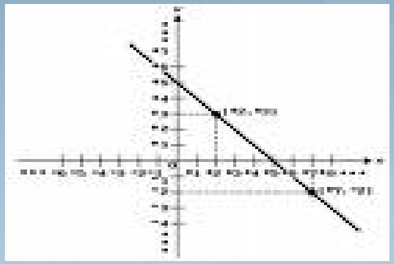
History of U.S. Algebra Courses

- Not until after the Civil War, however, was geometry required for entrance. The order in which these mathematical subjects…continues to shape, the college preparatory courses offered in secondary school, …



- In 2000, 26% of 8th graders reported taking algebra – **this has grown to ~40%, with ~5% of 7th graders taking algebra.**

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Findings

- U.S. students do not do well on items that involve the extension of a pattern if the item requires that they explicitly produce, describe, or represent a relationship rather than simply find the next few terms in a sequence.
- U.S. students do relatively poorly in setting up an equation to model a real situation.
- U.S. 8th grade teachers spend considerable time reviewing topics already taught; almost 30% of their lessons are devoted entirely to review.

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Thoughts

- U.S. students appear to need many more opportunities to engage in functional thinking with complex problems, and in particular, in functional thinking as it related to realistic situations.

- Algebra is of limited use if it is understood as generalized arithmetic only.

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Hmm…

- The U.S. is not the only country in which 8th grade teachers could be giving greater attention to functions, but it is one in which too many people have assumed for too long that most students cannot learn, use, or value algebra.
- Implications – math panel charge; NAEP and Algebra

p.123

What can TIMSS Surveys Tell Us about Mathematics Reforms in the United States during the 1990s?

Laura S. Hamilton & Jose Felipe Martinez

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Is it "approaches" or mathematics?

- There are signs of a partial cease fire…
- …growing acceptance of more traditional approaches on the part of NCTM.
- NMP…includes individuals who have been associated with both sides of the debate. Early indications…greater degree of consensus than has been obtained in the past.

p. 128, 129

Now what?

- Overall, the evidence of changes in U.S. teachers' use of reform practices is very limited and can only be interpreted as suggestive, among other reasons because of the limited number of practices compared.

- Limitations in survey use and analysis

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Examining Educational Technology and Achievement through Latent Variable Modeling

Elena C. Papanastasiou & Efi Paparistodemou

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Calculator Use & Mathematics

- The advent of calculator technology has influenced the teaching of mathematics…

- The graphic calculator's value lies in its intrinsic use of variables in its operations and in its multiline display that allows the user to see, reflect upon, and react with several sequential inputs or outputs.

p. 207

Results

- Children from stronger educational backgrounds are advantaged in school while children from less educated backgrounds are disadvantaged.

- To be effective, educational technology has to be used appropriately.

- The inverse relationship between technology use and student achievement found in this study is in contrast to other studies that tend to praise the use of technology and showcase its positive results.

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- Activities associated with lower levels of achievement in mathematics:
  - Use of the internet
  - Use of software or online games
  - Using the computer to write reports
  - Using the computer to analyze data
  - Using the computer as a resource

Literacy use not helpful to learning mathematics

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p. 222

Technology Use & Achievement

- “There is plenty of evidence to indicate a positive relationship between technology and student achievement.” p. 208

- Where is it? Particularly related to use of the graphic calculator?

Threads

1. Need for focus and coherence – **across** <u>and</u> **within** (e.g algebra)
2. Lack of penetration of reform
3. Need for research

Thank you!

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