

 THE **Blueprint**

 for EDUCATIONAL CHANGE™

**Research-Based Practices
For Mathematics**


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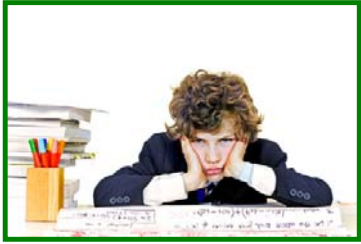
Agenda


- Why do we need Math?
- What can research tell us?
- Reports
 - The “Consumer Report” on Math Programs
 - Math Instructional Practices Matrix
 - Practices Worthy of Attention (PWOA) Study
- What can we bring back to our colleagues?





Why do we need math?





Comparing U.S. to Other Nations

- International comparisons often “apples to oranges” but alarming nonetheless...
- **7%** of U.S. fourth-graders scored at the advanced level in TIMSS, *compared to 38%* of fourth-graders in Singapore, a world leader in mathematics achievement ¹
- On the 2007 Programme for International Student Assessment (PISA), U.S. 15-year-olds *ranked 25th among 30* developed nations in math literacy and problem solving ¹
- In China, **42%** of college undergraduates earn science or engineering degrees compared to only **5%** of U.S. undergraduates ²



1: Foundations for Success: The Final Report of the National Mathematics Advisory Panel, 2008
2: The Academy of Medicine, Engineering, and Science of Texas (TAMEST), The Next Frontier, 2009



The Need for Student Success in K-12 Math

- A foundation in high school math through Algebra II is strongly correlated to¹:
 - Entering college
 - Graduation from college
 - Earning in the top quartile of income from employment
- Growth in *mathematics-intensive science and engineering jobs* is outpacing overall job growth by **3:1**²
- **15 out of the 20** fastest growing occupations in U.S. require significant science or mathematics preparation³



1: National Mathematics Advisory Panel. The final report of the National Mathematics Advisory Panel. U.S. Department of Education, Washington, D.C., 2008. Retrieved from: <http://www.ed.gov/about/foia/commission/mathpanel/report-final-report.pdf>
2: The Final Report of the National Mathematics Advisory Panel, 2008
3: U.S. Department of Labor Statistics



Mathematics Education in the U.S. Today

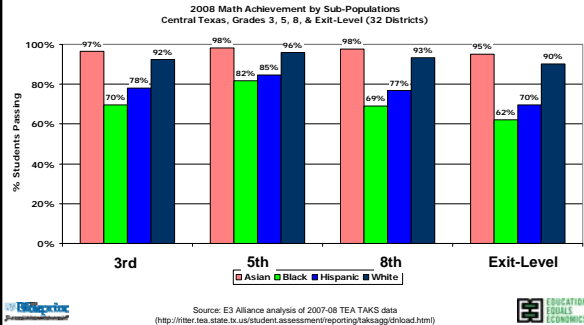
- In grades 4 and 8, the average mathematics scale scores on NAEP were higher in 2007 than in all previous assessment years.¹
- U.S. students tend to do well in mathematics until late elementary school.²
- But U.S. mathematics achievement falls off around late middle school when many students begin Algebra I.³



1: The Nations Report Card, 2007. Retrieved from: http://nationsreportcard.gov/math_2007/m0002.asp
2: The Final Report of the National Mathematics Advisory Panel, 2008
3: The Final Report of the National Mathematics Advisory Panel, 2008



Central Texas TAKS Results: Can we close the gaps? Why do they exist?



Cost of Remediation in U.S.

- **22%** of U.S. 1st year college students *require* remedial courses in math (2 & 4 yr colleges)¹
- **63%** of U.S. students who take remedial courses in math *fail to earn* an associate's or a bachelor's degree²
- It costs **\$1.4 billion** per year for remedial education college coursework in math and reading *for recent high school graduates*³

1: National Center for Education Statistics, *Remedial Education at Degree-Granting Postsecondary Institutions in Fall 2000, 2003* as cited in Achieve.org Case for Action Presentation <http://www.achieve.org/case-action>
 2: National Center for Education Statistics, *The Condition of Education, 2004* as cited in Achieve.org Case for Action Presentation <http://www.achieve.org/case-action>
 3: Alliance for Excellent Education, *Paying Double: Inadequate High Schools and Community College Remediation*, Issue Brief, 2008 as cited in Achieve.org Case for Action Presentation <http://www.achieve.org/case-action>

Remediation

- Only **41%** of Texas high school graduates are ready for college-level algebra¹
- **~40%** students at Texas 2-year colleges and **~25%** students at Texas 4-year colleges *took at least 1 remedial course (in reading or math)*²
- About half of the remedial courses are math, about a fourth are in reading and the other fourth are in writing

1: The Academy of Medicine, Engineering, and Science of Texas, *The Next Frontier*, 2009
 2: Texas Public Policy Foundation, *The Cost of Remedial Education*, September 2007, retrieved from: <http://www.texaspolicy.com/pdf/2007-09-PP25-remediation-b1.pdf>

What about Our Teachers?

- Texas teachers paid only **85¢** on each \$1 paid to the average American teacher (as of 2005-2006)¹
- In 2007, **~4,000** Texas math and science teachers *left the classroom*, costing the state **~\$27M** to replace them ¹
- Implementation of the state 4x4 requirement will require **114 additional math teachers** in Central Texas alone ²

1: The Academy of Medicine, Engineering, and Science of Texas, The Next Frontier, 2009
2: Fuller, E.J. (2009b). Analysis of the Impact of the 4x4 Course Requirement in Central Texas Public High Schools. E3 Alliance: Austin, TX.



Mathematics Education Research Yesterday, Today and Tomorrow?



Adding It Up, 2001

Mathematics Learning Study Committee

Jeremy Kilpatrick, Jane Swafford, and Bradford Findell, editors

Their Call was:

- To synthesize the rich and diverse research on pre-kindergarten through eighth-grade mathematics learning.
- To provide research-based recommendations for teaching, teacher education, and curriculum for improving student learning and to identify areas where research is needed.
- To give advice and guidance to educators, researchers, publishers, policy makers, and parents.

Center for Education: Division of Behavioral and Social Sciences and Education
National Research Council (NRC)
National Academy Press
Washington, DC



Math Panel Report, 2008

- On March 13, 2008, the National Mathematics Advisory Panel presented Foundations for Success: The Final Report of the National Mathematics Advisory Panel.
- Panel's call was to compile sufficient scientific research evidence for best programs and practices in mathematics.

Mathematics Education Research

- Definitions:
 - Review of Research-Meta Analysis
 - RA: Randomized Assignment
 - CS: Comparison Studies
 - QED: Quasi-Experimental Design
 - RCT: Randomized Controlled Trial
 - Qualitative vs Quantitative Design

Problems and Positives

- *Children are not washing machines nor are they afflicted with an illness...*
- *Quantitative Studies with enough power to make generalizations are expensive, and difficult to do in school settings.*
- *Quantitative studies do little to explain why a program works.*

Problems and Positives

- Positive changes in Instruction **should** lead to positive changes in student learning, understanding and performance.
- The push toward quantitative studies may encourage the research community to address problems of scale.

Reviews Using RA & CS Studies

- Gold standard in education research?
 - Not many RA & CS studies
 - In RA & CS, conditions not entirely “natural”
- What do RA & CS studies tell us?
 - Research findings about *effects*, e.g.,
 - Effects on “student achievement”
 - Effects on “student learning”
 - Description of effects use *specific language*
 - “Positive”, “Mixed”, “Indiscernible”

Difficulties in Bridging Research to Practice

- Individual studies of programs, professional development or student cognition are not sufficient.
- Adoption of a particular practice or program needs to have a solid theory of learning and teaching behind it, and more than one or two studies of any design need to provide a similar result.
- No one study, or group of studies addresses a problem perfectly.

Difficulties in Bridging Research to Practice

- Time from development to research to results to consumable products/services/programs is long!
- The “quick fix” mentality--
- Research results introduce new approaches that are difficult to implement
- Positive research findings are difficult to translate into affordable, scalable activity.

How can research be better? What counts as “better”?

New Standard recommended to NSF:

scientifically established as effective:

- *Collection* of scientifically valid evaluation studies
- Establish that an implemented curricular *program* produces *valid improvements* in learning for students
- Convincingly demonstrate that these improvements *are due to* the curricular *intervention*
- Use a *combination* of methodologies (content analyses, comparative studies, case studies)



Reports on Curriculum



Consumer Report on Mathematics Programs

- E3 Alliance combined 4 sources
 - Best Evidence Encyclopedia (<http://www.bestevidence.org>)
 - Institute of Education Sciences (<http://ies.ed.gov/pubsearch/pubsinfo.asp?pubid=NCEE20094052>)
 - Urban Institute (<http://www.urban.org/publications/411149.html>)
 - What Works Clearinghouse (<http://ies.ed.gov/ncee/wwc/>)
- Review of 363 studies (including duplicated sources)
- But only **59** programs out of **242** had research conducted scientifically, that is:
 - With a rigorous research design (RA or CS)
 - Reported effect on student achievement
 - Had high quality & valid data



Key for Symposium Reports

Math Programs & Evidence of Effects on Student Learning:



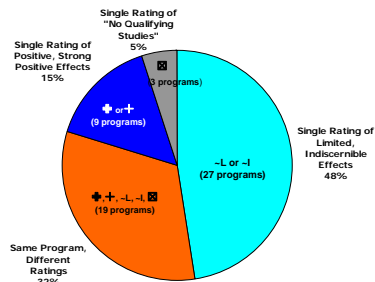
- +** Strong evidence of positive effects
- +** Moderate evidence of positive effects or Potentially positive effects
- ~L Limited evidence of effectiveness
- ~M Evidence of mixed effects
- ~I Insufficient evidence or no discernable effect



- Moderate evidence of negative effects or Potentially negative effects
- Strong evidence of negative effects
- No qualifying studies or No studies meeting eligibility requirements
- Program not reviewed



Summary of Consumer Report Rating For Math Programs



Mathematics Instructional Practices Matrix

- Also known as the “Sherbet Chart”
- Sources:
 - National Math Panel
 - Institute of Education Sciences (IES) Practice Guide
- Together, yielded **11** different instructional strategies
- Each strategy reported with the level of *effects* on *student achievement*



Practices Worthy of Attention Study

- **Local Innovations in Strengthening Secondary Mathematics**
- 2 cross-case analyses; 22 practice profiles
- *Descriptive, thematic*, about *structures and strategies*
- PWOA addresses challenges not typical in random assignment and comparison studies
 - At-risk populations / wider range of student need
 - Changes that succeed in years, not months

<http://www.utdanacenter.org/pwoa/>



Paek, Pamela. *Practices Worthy of Attention*. Charles A Dana Center and Achieve, Inc. 2008



Success to Serving All Students

- Intensification: extra instructional time, student motivation, social supports, academic habits, summer bridge programs
- Higher expectations and rigorous coursework: backward mapped curriculum + vertical articulation
- Embedded student supports: small schools, culture, better tutorials & advising
- 22 highlighted **local** practices yield hope!



What will you bring back to your colleagues?

- What does the research on effective mathematics programs *mean* for you and your job responsibilities?
- *What if* a research review reports that your favorite strategy has “limited effects” on student achievement?
- What will you *tell others* about what you have learned this morning? What actions might you take?

**Thank you and
enjoy lunch!**

**See you back here
at 12:15 pm!**