

High School Mathematics in a Common Core Era

Revolution, Regression, or Life as Usual?

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Discussion:

What's working well (or
what have we improved)
in high school
mathematics today?

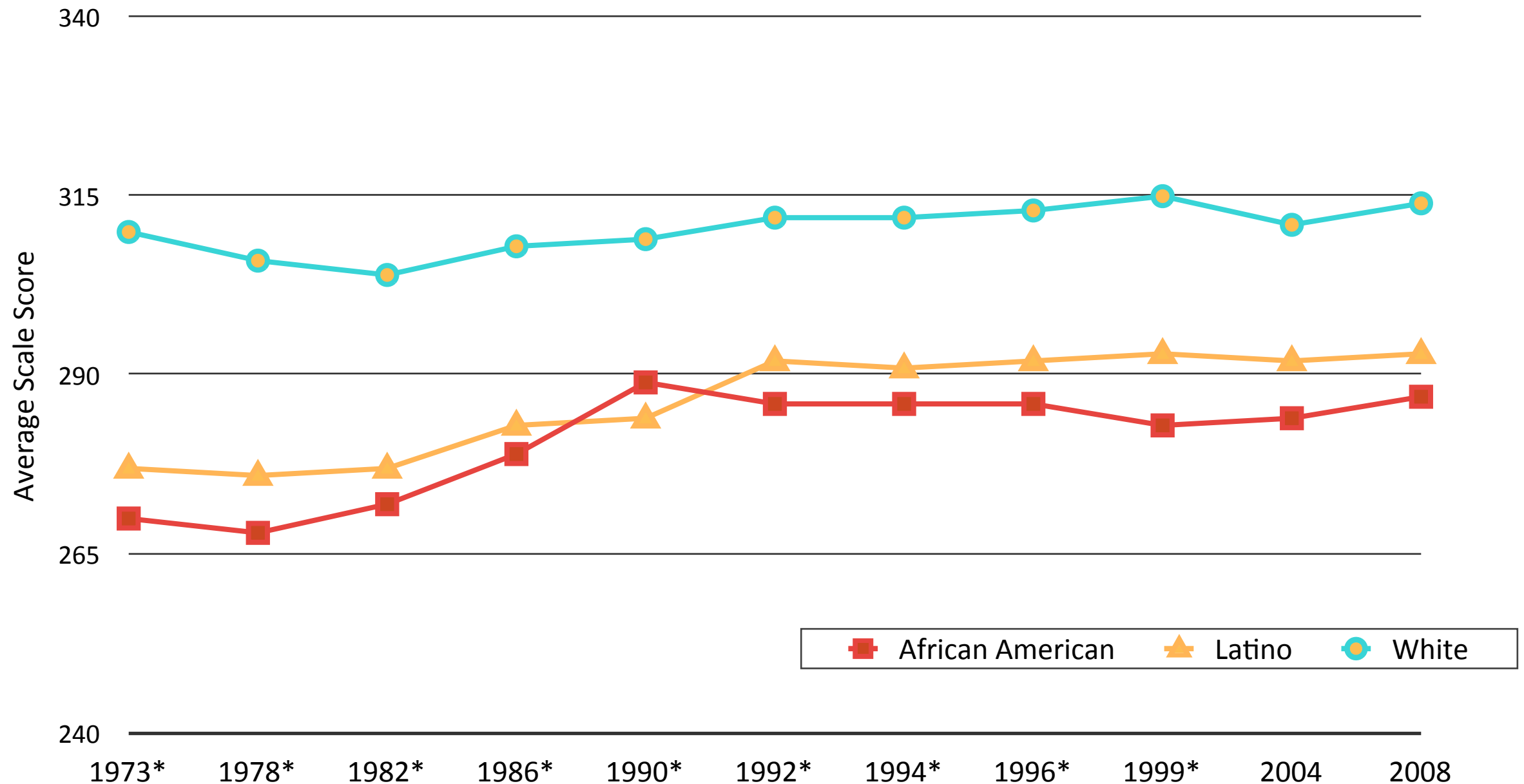
And some things aren't better

- Only two-thirds of kindergarten students graduate from high school in approximately 13-14 years.
- American students notoriously lack perseverance and complain if they see a problem they haven't been 'taught.'
- Many (most?) high schools offer the same math courses as they did at the end of World War II, when those courses were designed for a small portion of students.
- Only now we say these same courses are necessary for all students.

12th Grade Math: Results Mostly Flat

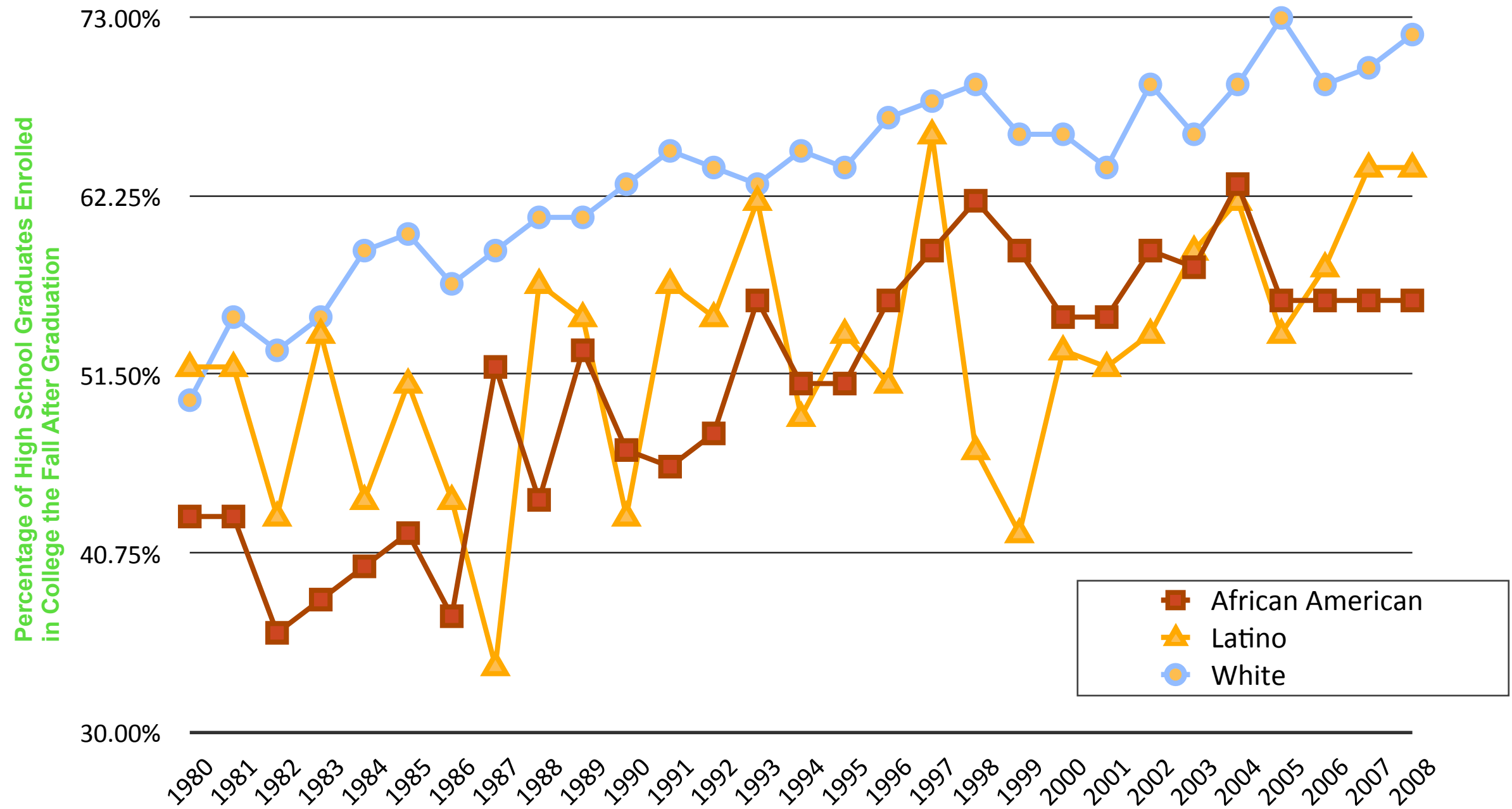
Gaps Same or Widening

17 Year Olds – NAEP Math



*Denotes previous assessment format

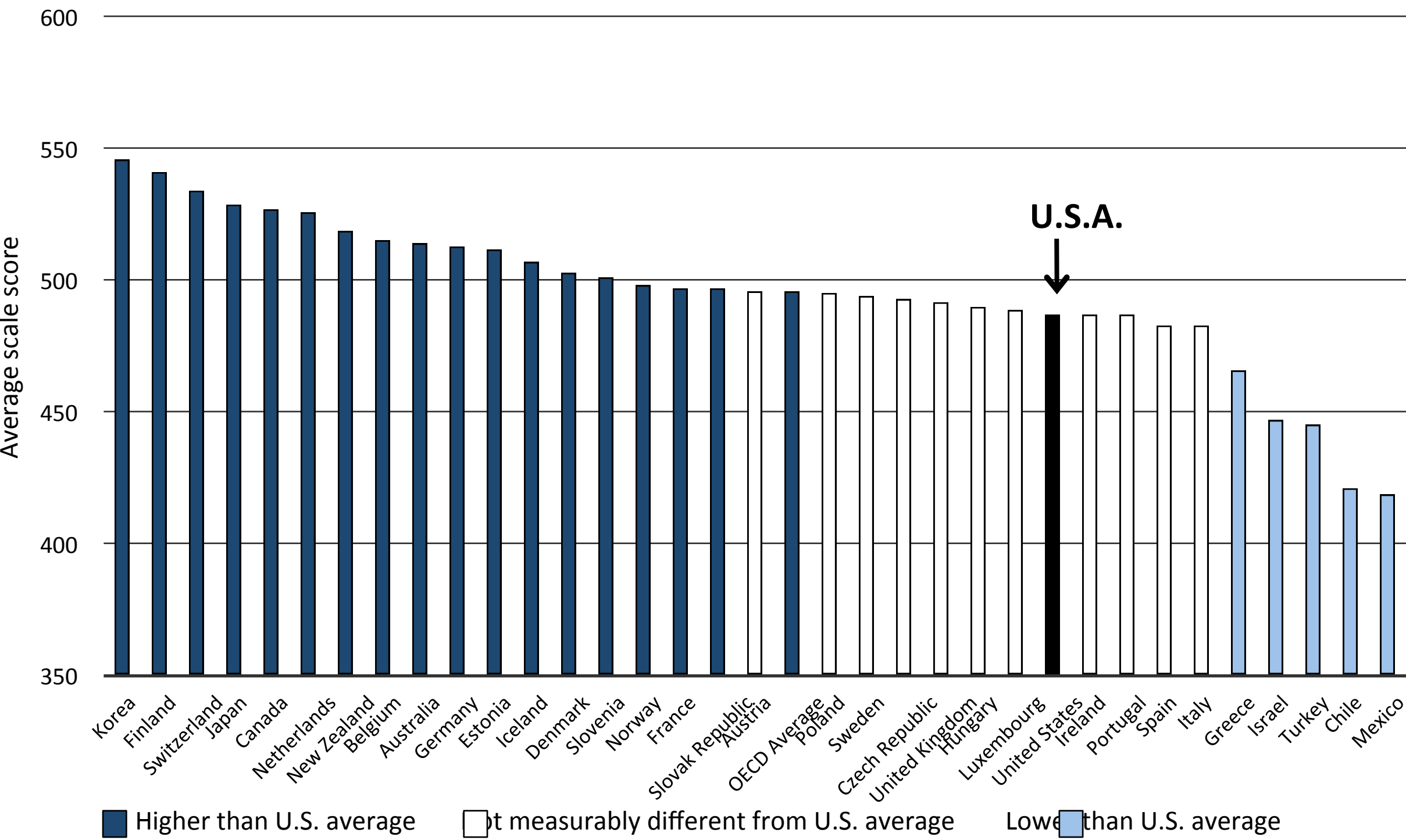
Immediate College-Going Increasing for All Racial/Ethnic Groups: 1980 to 2008



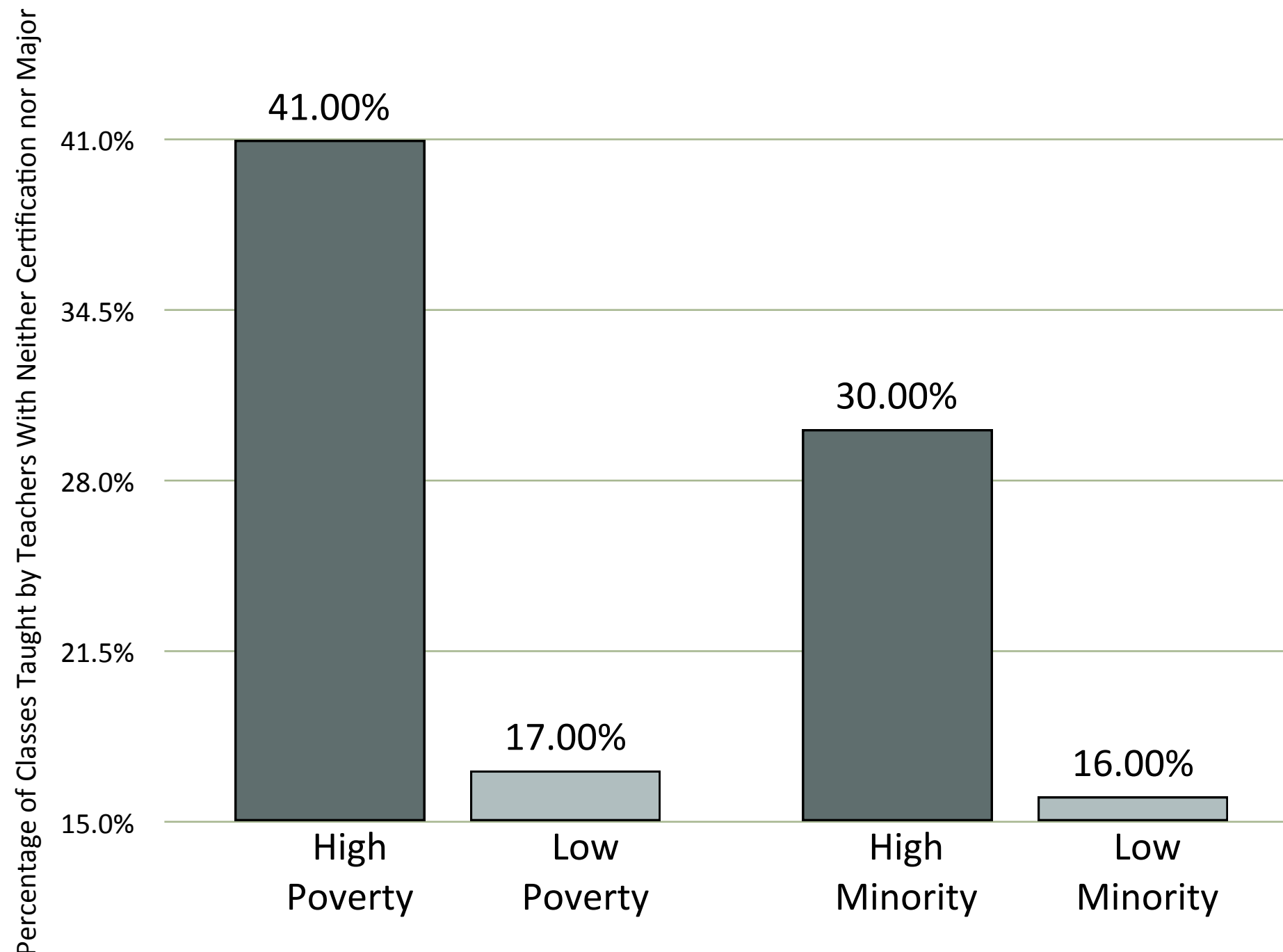
*Percent of high school completers who were enrolled in college the October after completing high school

U.S.A. Ranks 25th in Math of 34 OECD countries

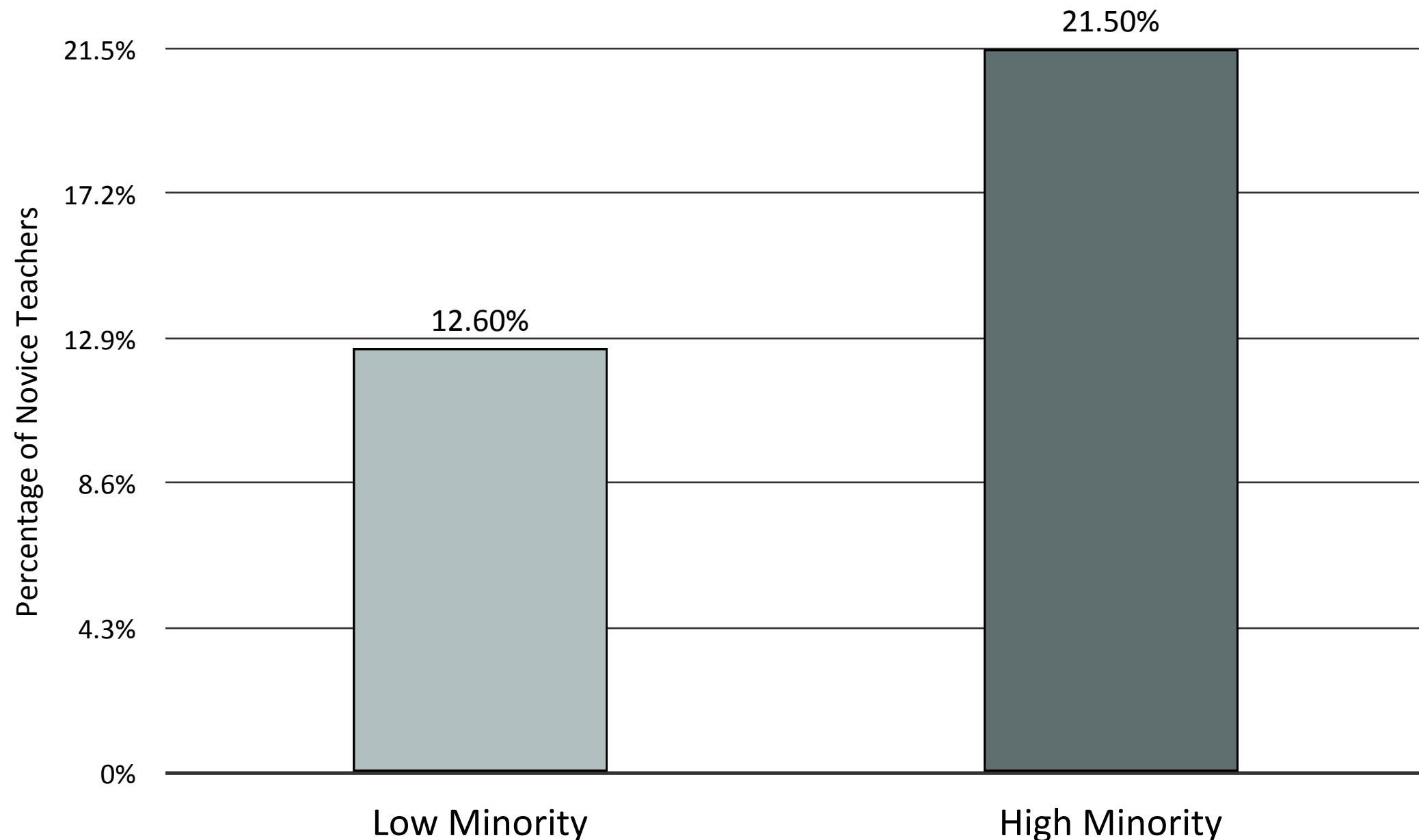
2009 PISA - Math



Core classes in high-poverty and high-minority secondary schools are more likely to be taught by out-of-field



Students at high-minority schools are more likely to be taught by novice teachers



The US has a Dropout Problem...

The Silent Epidemic,
Civic Enterprises, 2006

How we got to
where we are...

The 1940s and 1950s

Thousands of returning servicemen get educated and fuel huge economic growth

Transistor invented; 1st computer ENIAC (18,000 vacuum tubes)

Average salary \$2992; labor force male / female 5:2

Bread cost \$0.14; gas cost \$0.35 / gallon

Jackie Robinson 1st African-American in major league baseball

Radio prime information / entertainment media

US is greatest industrial nation—no other country even close

Sputnik...

Integrated circuit invented

H.S. Math in the 1940s and 1950s

- Math teaching based on college teaching pedagogy:
Textbook driven, lecture, homework
- Industrial Revolution education model (with agricultural overtones: calendar, courses, goals)
- Algebra I, Geometry, Algebra II, Solid geometry / trig
(Adkins & Weeks; Welchons & Krickengerger)
- Girls take home economics; boys take shop
- Lots of students not in school or in 'trade school'

The 1960s and 1970s

- Space research and engineering; Apollo program
- TI handheld calculator \$2500 in the 1960s
- Most products American made
- Computers in business: IBM, HP, Cray, Apple
- TV is main media for entertainment/news (3-5 channels)
- Intel's microprocessor
- Apollo18 and USSR's Soyuz 19 linked
- Entertainment-VCRs

H.S. Math in the 1960s and 1970s

- “New Math” introduced into schools via NSF
(focus on concepts, set theory, functions)
- In most schools, still Algebra I-Geometry-Algebra II
- Programmed instruction introduced
(computer-assisted instruction by the 1970s)
- Segregation still common; integration begins in schools
- Vocational programs thriving
- ~40% of students graduate from H.S.

The 1980s and 1990s

- Credit becomes the norm; inflation / interest double digits
- First Space Shuttle – Columbia
- Personal Computers become legitimate tools in business
- Imports gain market share in autos and electronics
- Internet opens up to public; grows to 100 million users
- Out-sourcing jobs; importing skills HB-1 visa program
- Cell phones become a “must”
- Medical technology racing and health care changing
- Reports from everyone about the importance of math and science and the need to overhaul schools

H. S. Math in the 1980s

- Back to the basics!
- Algebra I - Geometry - Algebra II for some students
- Analytic Geometry / Math Analysis / Trigonometry and Calculus for a few
- Lots of remedial and low-level courses
(general math, basic math, consumer math, fundamentals of math, introductory algebra, pre-algebra, etc.)

A Nation at Risk (1983)

- “If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war...We have even squandered the gains in student achievement made in the wake of the Sputnik challenge. Moreover, we have dismantled essential support systems which helped make those gains possible. We have, in effect, been committing an act of unthinking, unilateral educational disarmament.”

*Curriculum and Evaluation
Standards for School
Mathematics*

NCTM, 1989

H. S. Math in the 1990's

- NCTM's Decade of Implementation; Critical backlash
- Standards-based curriculum becoming the norm
- Development of 'Reform Curriculum'
(All high school NSF-funded programs were integrated;
other programs integrated content within course titles)
- Many schools offer Alg. I-Geometry-Alg. II-Precalculus
- (Graphing) calculators showing up more in high schools
- More reports

The 21st Century

- Integrated communications (cell phones, internet, digital TV)
- \$100 in 1940 is same as \$1322 today
- Average salary \$37,000 vs. \$2992 in 1940
- Labor force male: female 1:1 vs. 5:2 in 1940
- \$1.00 cost of loaf of bread vs. \$0.14 in 1940
- Computers...

H. S. Math in the 21st Century

- Many schools offer Alg. I-Geometry-Alg. II-Precalculus
- Some schools offer Integrated mathematics courses
- Some schools have great programs
- Some teachers are incredibly effective
- Teaching model is often based on teachers disseminating information

Principles and Standards for School Mathematics NCTM, 2000

Principles

- Equity
- Curriculum
- Teaching
- Learning
- Assessment
- Technology

Process Standards

- Problem Solving
- Reasoning
- Communication
- Connections
- Representation

Content Standards

- Number / Operations
- Algebra
- Geometry
- Measurement
- Data / Probability

Others...

- America Diploma Project, 2004
Achieve, Education Trust, Fordham Foundation
- College Board, 2008

Focus in High School Mathematics: Reasoning and Sense Making

- Addresses the nature of the mathematics and the factors that need to be considered if we focus on reasoning
- Advocates heterogeneous grouping



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The New Question

- *College and Career Readiness:*

Is every student graduating from high school ready for success in college or a well-paying career?

Discussion:

What is one way our high school mathematics program could change to help all students have what they need to succeed in college or a well paying career?

College and Career Ready

- What the recommendations say:
 - All students need challenging, academic high school courses (not remedial)
 - All students need Algebra II or equivalent
 - All students need research and communication skills
 - All students need independent learning skills and critical thinking skills

**Common Core State Standards Initiative:
Preparing America's Students for College & Career**

STANDARDS FOR MATHEMATICS

JUNE 2010

CCSS slides available at corestandards.org

Some issues related to CCSS...

- How far should the common high school math experience go?
- Is Algebra II the right course for all students? If not, what is?
- Where should statistics be in the high school program?
- How can we make sure all students, including those not well served by our schools, have access to high level mathematics without forcing everyone through the calculus path?
- How can we really make mathematics relevant for students?
- What has to happen to help high school teachers teach in ways that develop mathematical thinkers proficient in the standards for mathematical practice?

The questions not answered by CCSS...

- When should students start high school mathematics?
- How should we organize the first three years of high school?
- What are appropriate senior capstone courses?
- What should the role be of early college or dual-enrollment?
- How can we really make mathematics relevant for students?
- What has to happen to help high school teachers teach in ways that develop mathematical thinkers proficient in the standards for mathematical practice?

Starting high school mathematics early

- Make sure students have complete K-8 knowledge, skills, thinking, experiences.
- Make sure you have some place for them to go, and make sure they go there.
- Make sure the demographics of your *early algebra*, advanced courses, regular courses, and *special* classes look like the demographics of your whole student population. If not, the school system has a problem, not the students (although it can spread to them).
- Handout: “Pushing Algebra Down”

Organizing the first 3 years

- If we were starting from scratch today, would we organize it like it has been for over 50 years?
- This is our opportunity to think anew.
- Look at other countries (see the China *handout* posted)
- Determine how much of the program should be spent on algebra, geometry, statistics, discrete, etc.
- Regardless of how you organize, determine how to connect (algebra with geometry, statistics where it makes sense, finance, discrete,...)
- Georgia, Utah, at least one other state, and a growing number of schools are moving in the right direction.

Secondary Math Standards (China)

People's Republic of China, 2003 *Handout*

(5 Compulsory modules, 4 optional series, depending on interest)

1. Set, concept of function, basic elementary function I (exponential function, logarithmic function, power function).
2. Preliminary solid geometry, preliminary plane analytic geometry.
3. Preliminary algorithms, statistics, probability.
4. Basic elementary function II (trigonometric function), vectors on a plane, trigonometric identity transformation.
5. Solution of a triangle, sequence, inequality.

Senior courses

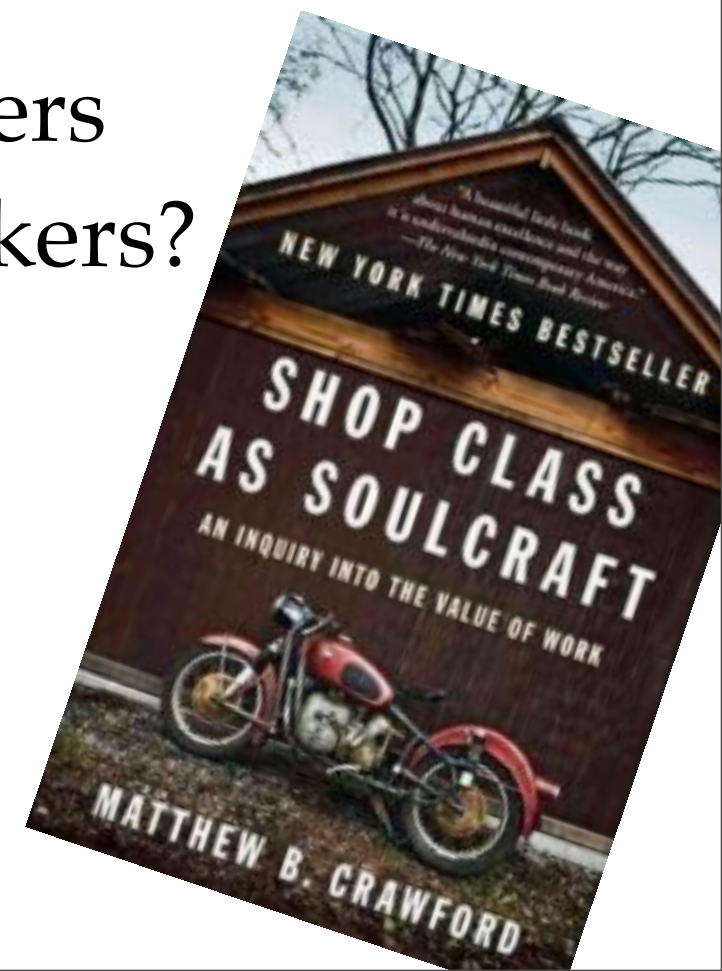
- Precalculus / AP Calculus
- AP Statistics
- Financial Literacy
- MINDSET (Operations Research)
- Quantitative Reasoning / Literacy
- Advanced Mathematical Decision Making
- Dual enrollment courses (college credit)
- Blended / custom courses...
- *2 Handouts...*

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Issues for the future...

- At what point should students branch / track?
- What should a high school education look like for a master furniture builder, plumber, welder, writer, artist, entrepreneur, business person?
- How can we really make mathematics relevant for students?
- What has to happen to help high school teachers teach in ways that develop mathematical thinkers?



Premise:

‘College and career readiness’ is as much about how students *think* as it is about what they *know*, and helping students succeed in college and careers is as much about *how* we teach as about *what* we teach.

College / Career Skills

- Intellectual curiosity
- Reasoning
- Problem solving
- Academic behaviors
- Work habits
- Academic integrity
- Reading / writing / research across the curriculum
- Use of data
- Technology

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments; critique others' reasoning.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and make use of regularity in reasoning.

Focus in High School Mathematics: Reasoning and Sense Making

- Addresses the nature of the mathematics and the factors that need to be considered if we focus on reasoning
- Advocates heterogeneous grouping



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Teach like their lives depend on it...

- Don't spoon feed them; give them an opportunity to wrestle with problems and figure things out (*Handout*)
- Ask more questions than you answer.
- Expect them to learn where to find information and how to back up their point of view with evidence.
- Give them opportunities to collaborate, as well as to work independently.
- Assign increasingly less structured and more complex tasks and projects throughout the year and across the grades, connected to real problems and other subjects.

Revolution, Regression, or Life as Usual?

Revolution?

- Consider a moderate revolution: planned, collaborative, inclusive, reasoned, visionary, practical, peaceful (?)
- Choose your skirmishes
- Be ready for resistance
- Persevere, regroup, and adjust
- This is the time.

Your leadership

Your leadership has
never been more
important, whatever
your role.

Leadership

- Communicating a Vision
- Using the Power of People
- Understanding the change process
- *and learning from geese...*

Handouts posted on NCSM blog

<http://grou.ps/mathedleaders>

1. “Pushing Algebra Down” (8th-grade algebra): NCTM President’s Message downloadable at nctm.org (also in *Faster Isn’t Smarter--Messages About Math, Teaching, and Learning in the 21st Century*)
2. “Constructive Struggling” (reprinted from *Faster Isn’t Smarter*)
3. Secondary Mathematics Curriculum Standards, People’s Republic of China, 2003, summarized from: www.apecknowledgebank.org
4. A sample of resources and options for alternative transition courses from high school to college/university, prepared by the MAA/NCTM Mutual Concerns Committee, January 2011
5. Advanced Mathematical Decision Making: Information available at utdanacenter.org/amdm; handout available as a pdf

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Their future is in our hands



...and ours is in theirs

