National Research Center

What is College & Career Ready Math?

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ACTER Pre-Conference

NRC CTE
National Research
Center for Career and
Technical Education

Background to the Study

ACT (2006) in *Ready for college and ready for work: Same or different?* declared that whether students are planning to enter college or workforce training programs, they needed to be educated at a comparable level of readiness in math and reading.

HOT OFF THE PRESS!!!!

15 year olds in the US on the PISA:

- Performed below average in mathematics in 2012 and is ranked 26th among the 34 OECD countries

- Showed no significant change in this performance over time.

- Have particular ***weaknesses in performing mathematics*** tasks with higher cognitive demands, such as taking real-world situations, translating them into mathematical terms, and interpreting mathematical aspects in real-world problems

The Real Skills Gap
Business Roundtable Survey 2009

Gap Between Importance of Skill & Workers' Current Skill Level (As Perceived By Employers)

Value	Skill	Category
-29	Personal accountability for work	**Severe Deficit**
-28	Self-motivation	
-28	Strong work ethic	
-24	Punctuality/showing up to work on time	
-24	Time-management skills	
-23	Professionalism	
-20	Adaptability	
-17	Oral communication skills	**Moderate Deficit**
-17	Creative problem-solving	
-16	Teamwork	
-16	Critical thinking	
-15	Job-specific professional skills	
-12	Customer/client relationship management skills	
-11	Quantitative reasoning	
-9	Reading skills	**Small Deficit**
-8	English skills	
-7	Job-specific technical skills	
-4	Job-specific knowledge	
-4	Writing skills	
-3	Basic computer skills	
2	Specialized IT user skills	**No Deficit**
3	Management skills	
3	Administrative skills	
9	Mechanical/machine operating skills	

Q17: You are going to see a list of skills and attributes that employees could have. Please rank how important each skill or attribute is for your employees to have right now using a 7 point scale. **Q18:** Indicate the level of your current employees' skills overall, for each of the following skills, using a 7 point scale. (Showing difference between 6+7s)

12

STEMania – it's sweeping the nation!

Job openings for STEM positions take longer to fill than openings in other fields.

If STEM Jobs are so hard to fill:

Most with bachelor's degrees in science, technology and math don't get STEM jobs.

Amid a U.S. push to get more students interested in science, technology and math, often called STEM, the Census Bureau reported Thursday that 74% of those with a bachelor's degree in these subjects don't work in STEM jobs. (Census Report: July 14, 2014)

Engineering majors and majors in Computer, Math and Statistics	50%
Physical Science	26%
Psychology	10%
Social Science	7%

We've been here before… Remember Sputnik?

USA TODAY

A Challenge to Conventional Thinking

There isn't a problem with the capability of U.S. children. Even if there were a deficiency in math and science education, there are so many graduates today that there would be enough who are above average and fully qualified for ***the relatively small number of science and engineering jobs***. Science and engineering graduates just don't see enough opportunity in these professions to continue further study or to take employment.

http://www.businessweek.com/print/smallbiz/content/oct2007/sb20071025_827398.htm

Solution?

Since the mid-1980s we have:

Added the equivalent of *one full year* of core academics (math, science, language arts) to high school graduation requirements.

- (NAEP) *Reading scores have not improved or significantly declined**
- (NAEP) *Science scores have not improved or significantly declined**
- (NAEP) *math scores have remained relatively unchanged*

*Depends on the starting and ending timeframe

Meanwhile, Engagement Plummets

76%

61%

44%
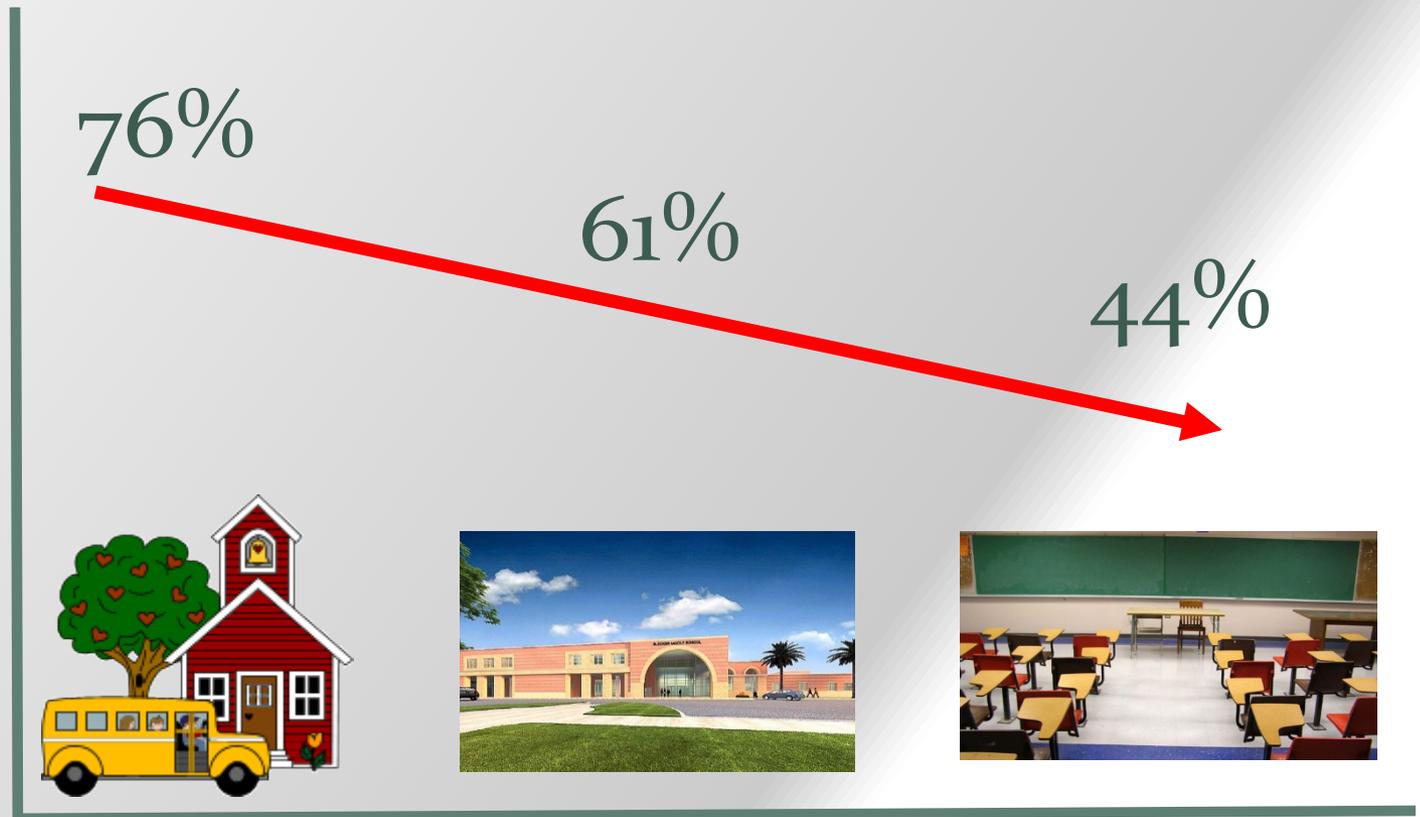
Brandon Busteed, Executive Director of Gallup Education
Presentation at the NASDCTEc October 21, 2014

Unintended Consequences:

More high school math, science linked to more dropouts

As math and science requirements for high school graduation have become more rigorous, dropout rates across the United States have risen, The tougher requirements appear to have had a major effect on high school graduation rates of Hispanic and African-American males.

Plunk AD, Tate WF, Bierut LJ, Grucza RA. Intended and unintended effects of state-mandated high school science and mathematics course graduation requirements on educational attainment. *Educational Researcher*, vol. 43(5), June/July 2014

Taking more math is no guarantee

- Only 26% of students who took Alg I, II & Geometry scored a 22 (ACT Benchmark) on the ACT exam scoring an average of 17.7[1]

- Adding Trig increases to the average score to 19.9[1]

- Not until calculus is added, does the average score exceed 22 – 5 years of high school math.

- 43% of ACT-tested Class of 2005[1] who earned A or B grades in Algebra II did not meet ACT College Readiness Benchmarks in math[2]

1. ACT, Inc (2004) *Crisis at the Core*

2. ACT, Inc. (2007) *Rigor at Risk*.

One solution?

Scale score		
161	Graduated from college	
148	Some education after high school	
138	Graduated from high school	
130	Did not finish high school	

0 ⟩ 100 110 120 130 140 150 160 170 ⟩ 300

Scale score
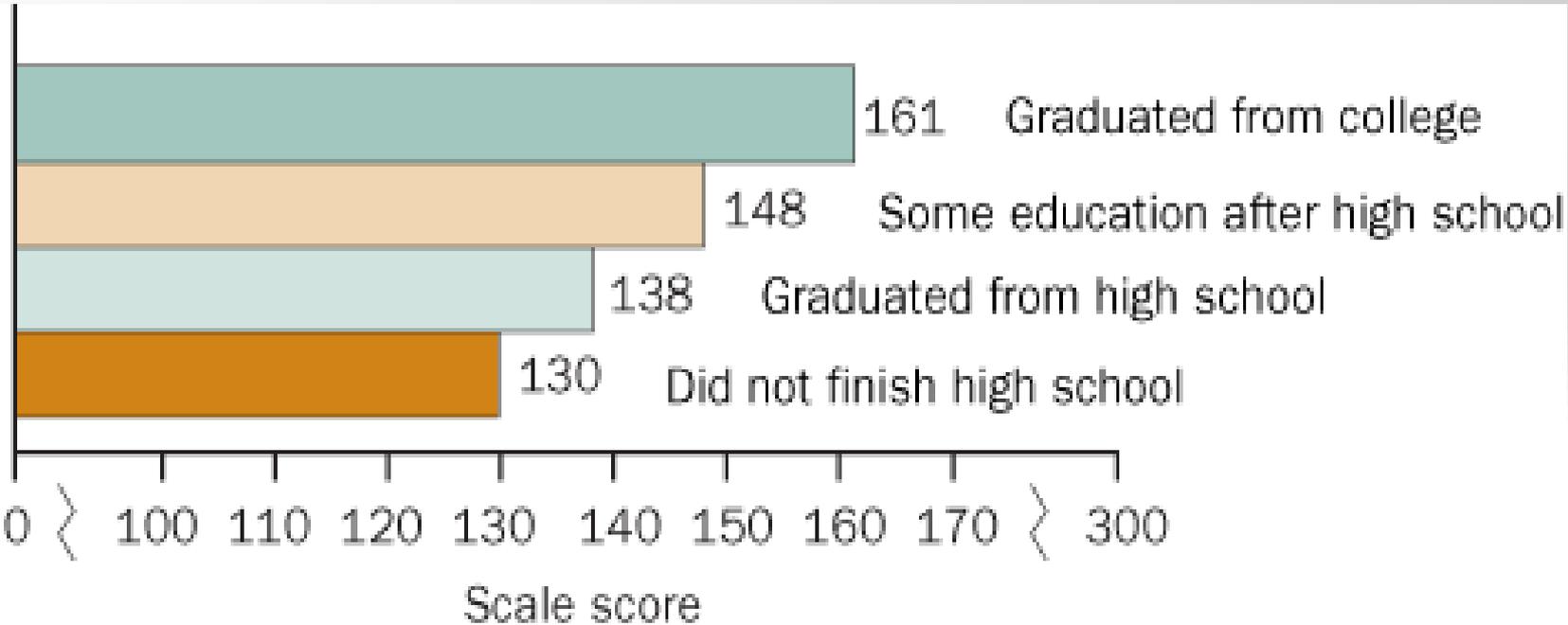
Be born to smarter parents!

Our Questions

- Where in a traditional sequence of math courses (middle school mathematics, Algebra I, Geometry, Algebra II) are these (college and career ready) skills and knowledge located?

- Are the math requirements and related math courses required for successful college entry the same as those required for successful career entry?

Middle Skill Jobs: Career Ready

47% of all new job openings
from 2010 to 2020 will fall into
the middle-skill range

Source: Harvard Business Review, 2012/12, *Who
Can Fix the "Middle Skills" Gap?*

Academic Skills Needed for College are the Same Needed for Careers . . . ?

Career Ready (the academic side)?

- ACT *Work Readiness Assessment* (based on O'Net data) measures:
  - Reading for information
  - Locating information
  - Applied math
- Zone 3 Jobs, Level 5 Math Skills

ACT determined that a score of 22 was necessary for both college readiness and (middle skill) career readiness.

Career Ready
Electronic Technician – Level 5*

Requirements

- Fundamental knowledge of PC and Server Operating Systems.
- Fundamental knowledge of networking principles.
- Strong electronics background
- Highly
- Strong
- Str
- Work
- Excellent troubleshooting
- Experience with IBM
- Experience with Lexmark printers
- Experience with Toledo and Hobart
- Experience with Nortel BCM and Toshiba Phone systems
- Experience with Fujitsu Self Checkout systems
- Experience with Cisco routers and HP network switches

Skills

- Tech Skills
- Tech Skills
- WBL
- Soft Skills
- Soft Skills
- Soft Skills
- Tech Skills
- Tech Skills
- WBL
- WBL
- WBL
- WBL
- WBL
- WBL

*Most ads call for 2-years of ed/training & experience

Is Algebra Necessary?

There are many defenses of algebra and the virtue of learning it. Most of them sound reasonable on first hearing; many of them I once accepted. But the more I examine them, *the clearer it seems that they are largely or wholly wrong — unsupported by research or evidence, or based on wishful logic*. (I'm not talking about quantitative skills, critical for informed citizenship and personal finance, but a very different ballgame.)

This debate matters. Making mathematics mandatory prevents us from discovering and developing young talent. *In the interest of maintaining rigor, we're actually depleting our pool of brainpower*. I say this as a writer and social scientist whose work relies heavily on the use of numbers.

Andrew Hacker, NYT July 29, 2012

Method

NRCCTE Researchers examined syllabi from California, Texas, Massachusetts (e.g., middle school, Algebra I, II, Geometry, Trigonometry) as well as the Common Core State Standards to map where students were exposed to the content that should have prepared them to achieve the ACT, College and Career Ready benchmark score of 22

State Sample
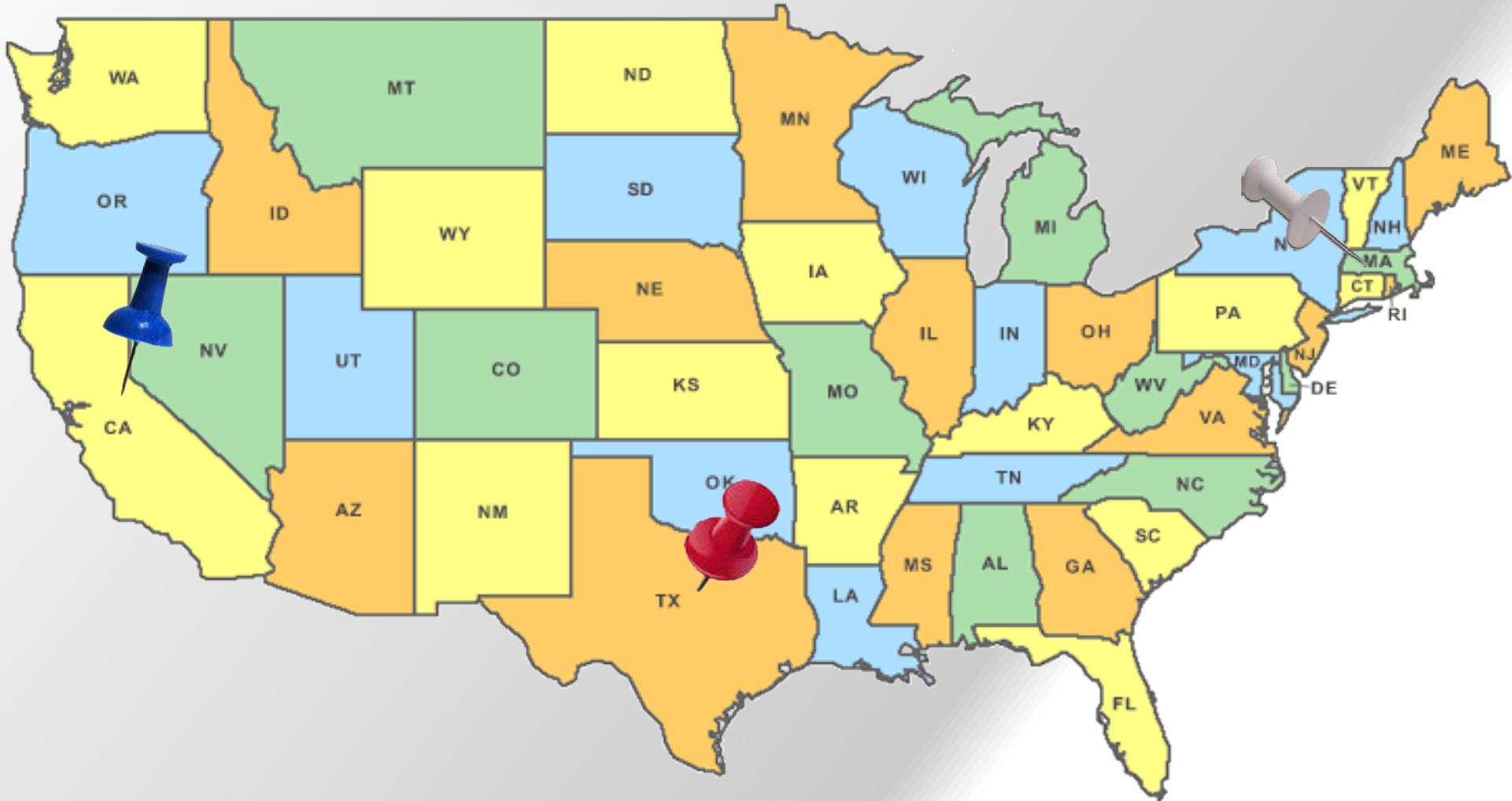
Findings

The following table summarizes more complex tables in the text. There was considerable similarity among the three states' syllabi.

College Ready (ACT) Math=22

ACT Score	Class	Common Core	ACT Topic/ Task
13-15	Alg. I	HS	Simplify ratios
16-19	Alg. I Alg. I	8th HS	**Add, subtract, multiply, and divide rational numbers** Use rational numbers to demonstrate knowledge of additive and multiplicative inverses

ACT Score	Class	Common Core	ACT Topic/ Task
20-23	Alg I	8th	Set up and solve problems following the correct order of operations with rational numbers
	Alg I	8th	Give the domain and range of relations and functions
	Alg I	8th	Evaluate functions at given values
	Alg I	HS	Apply algebraic properties to simplify algebraic expressions
	Alg I	HS	Translate real-world problems into expressions using variables to represent values
	Alg I	HS	Identify the effect on mean, median, mode, and range when a set of data is changed
	Alg I	8th	Find the probability of a simple event
	Geo	HS	Identify corresponding, same-side interior, same-side exterior, alternate interior, and alternate exterior angle pairs formed by a pair of parallel lines and a transversal and use these special angle pairs to solve problems (e.g., solve equations, use in proofs)
	Geo	HS	Use construction techniques, including straight edge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors

HVAC MATH Course/ Common Core	HVAC (Career Ready) MATHEMATICS ACT Topic	ACT Score
Alg I CC 8th	Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators	(16-19)
Alg I CC 8th HS	Use properties of exponents (including zero and negative exponents) to evaluate and simplify expressions	**(28-32)**
Alg I CC 8th	Find rational number square roots (without calculators) and approximate irrational square roots (with and without calculators)	**(24-27)**
Alg I CC 8th	Evaluate and simplify radical expressions	**(24-27)**
Alg I CC 8th	Use scientific notation when working with very large or very small quantities	**(24-27)**
Alg I CC 8th	Set up and solve problems following the correct order of operations (including proportions, percent, and absolute value) with rational numbers (integers, fractions, decimals)	(20-23)
Alg I CC 8th	Identify, formulate, and obtain solutions to problems involving direct and inverse variation	**(24-27)**
Alg I CC 8th	Recognize the concept of slope as a rate of change and determine the slope when given the equation of a line in standard form or slope-intercept form, the graph of a line, two points, or a verbal description	**(24-27)**
Alg I CC 8th	Translate between different representations of relations and functions: graphs, equations, sets of ordered pairs, verbal descriptions, and tables	**(24-27)**
Alg I CC 8th	Interpret data from line, bar, and circle graphs, histograms, scatterplots, box-and-whisker plots, stem-and-leaf plots, and frequency tables to draw inferences and make predictions	**(28-32)**
Alg I CC HS	Simplify ratios	(13-15)
Alg I CC HS	Solve formulas for a specified variable	**(24-27)**
Geo CC HS	Apply relationships between perimeters of similar figures, areas of similar figures, and volumes of similar figures, in terms of scale factor, to solve mathematical and real-world problems	**(28-32)**
Geo CC HS	Use cross sections of prisms, cylinders, pyramids, and cones to solve volume problems	**(28-32)**
Geo CC HS	Find the lateral area, surface area, and volume of prisms, cylinders, cones, and pyramids in mathematical and real-world settings	**(28-32)**
Geo CC HS	Find the surface area and volume of a sphere in mathematical and real-world settings	**(28-32)**

Career Ready Math Skills: Getting the job*

Algebra I	Telecommunication Junior Technician
	Nursing
	HVAC
	Survey Technician
	Plumbing
	Automobile Technician
Geometry	Survey Technician
	Plumbing
	Automobile Technician
	Nursing
	HVAC
Algebra II	Telecommunication Junior Technician

College & Career Ready Math
The Same?

ACT Scores	13-15	16-19	20-23	24-27	28-32	33-36
College Ready	1	2	9	NA	NA	NA
Career Ready	1	2	8	17	17	5

Math for Career Readiness: Another Perspective (NCEE, 2013)

- Math needed is mostly middle school
- Alg II is not a prerequisite for CC success or most careers
- College ***reading requires 11th/12th grade skills***
- Students enter CC weak in needed math and reading skills

College Ready Math
Liberal Arts Majors' Math Requirements

- Rutgers

- University of Minnesota

- UC-Berkeley

- One course in college-level mathematics.

- One course, (e.g., Mathematical Thinking)

- Test out (basic understanding and competency in math, statistics, or computer science) or 2-unit course.
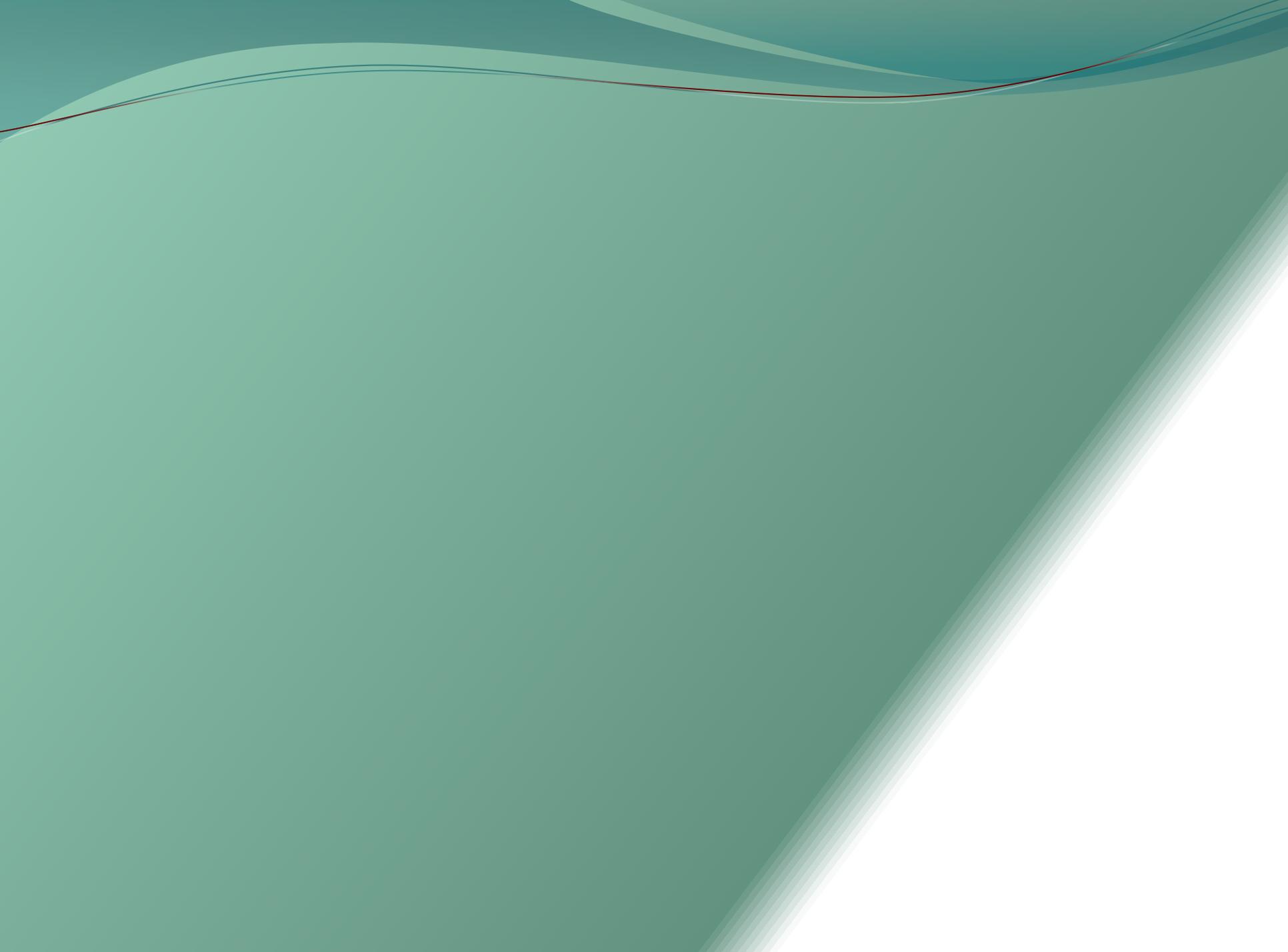
A Challenge to Math Assumptions: *Correlation and Causality*

There is no question that students who earn high school credits in trigonometry, pre-calculus, and calculus are more likely to obtain postsecondary degrees. To assume, however, that requiring more such courses will lead to more college graduates confuses cause and effect. It is not these courses, by themselves, that improve the likelihood of obtaining degrees. ***Students who succeed in advanced mathematics have a combination of skills, knowledge, and motivation that enables them to do well in school***. Simply requiring students to take more higher level courses will have little impact on the characteristics that produce this success. The more likely result of higher requirements is more dropouts (Stone & Lewis, 2012:22).

A Challenge to Math Assumptions: Fallacy of Composition (Cappelli, 2012)

The **fallacy of composition** arises when one implies that something is true of the *whole* from the fact that it is true of some *part* of the whole (or even of *every* [proper part](#)).

Or, **put another way**:
"I took lots of math, I am successful; Therefore everyone should take lots of math and they will be successful too."

COMMENTS, QUESTIONS...

Read the paper: http://bit.ly/1zO92yP

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www.nrccte.org