What is College & Career Ready Math?

James R. Stone III, SREB
Cara DiMattina, University of Louisville

Presented at the ACTE Vision 2014
ACTER Pre-Conference
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.
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)

The Real Skills Gap
Business Roundtable Survey 2009

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

- Personal accountability for work
- Self-motivation
- Strong work ethic
- Punctuality/showing up to work on time
- Time-management skills
- Professionalism
- Adaptability
- Oral communication skills
- Creative problem-solving
- Teamwork
- Critical thinking
- Job-specific professional skills
- Customer/Client relationship management skills
- Quantitative reasoning
- Reading skills
- English skills
- Job-specific technical skills
- Job-specific knowledge
- Writing skills
- Basic computer skills
- Specialized IT user skills
- Management skills
- Administrative skills
- Mechanical/machine operating skills

• Severe Deficit
• Moderate Deficit
• Small Deficit
• No Deficit
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)

<table>
<thead>
<tr>
<th>Engineering majors and majors in Computer, Math and Statistics</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>26%</td>
</tr>
<tr>
<td>Psychology</td>
<td>10%</td>
</tr>
<tr>
<td>Social Science</td>
<td>7%</td>
</tr>
</tbody>
</table>
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 Plummeted

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
One solution?

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?
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 and Mechanical background
- Highly motivated and energetic
- Strong communication skills and work ethic
- Strong organizational skills
- Working knowledge of Microsoft Office applications
- Excellent troubleshooting skills
- Experience with IBM POS equipment
- Experience with Lexmark printers
- Experience with Toledo and Hobart scale systems
- Experience with Nortel BCM and Toshiba CTX systems
- Experience with Fujitsu Self Checkout systems
- Experience with Cisco routers and HP network switches

Skills
- Tech Skills
- WBL
- Soft Skills
- Soft Skills
- Soft Skills
- Tech Skills
- Tech Skills
- 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.
<table>
<thead>
<tr>
<th>ACT Score</th>
<th>Class</th>
<th>Common Core</th>
<th>ACT Topic/ Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-15</td>
<td>Alg. I</td>
<td>HS</td>
<td>Simplify ratios</td>
</tr>
<tr>
<td>16-19</td>
<td>Alg. I</td>
<td>8th HS</td>
<td><strong>Add, subtract, multiply, and divide rational numbers</strong></td>
</tr>
<tr>
<td></td>
<td>Alg. I</td>
<td>HS</td>
<td>Use rational numbers to demonstrate knowledge of additive and multiplicative inverses</td>
</tr>
<tr>
<td>ACT Score</td>
<td>Class</td>
<td>Common Core</td>
<td>ACT Topic/ Task</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>20-23</td>
<td>Alg I</td>
<td>8th</td>
<td>Set up and solve problems following the correct order of operations with rational numbers</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>8th</td>
<td>Give the domain and range of relations and functions</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>8th</td>
<td>Evaluate functions at given values</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>HS</td>
<td>Apply algebraic properties to simplify algebraic expressions</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>HS</td>
<td>Translate real-world problems into expressions using variables to represent values</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>HS</td>
<td>Identify the effect on mean, median, mode, and range when a set of data is changed</td>
</tr>
<tr>
<td></td>
<td>Alg I</td>
<td>8th</td>
<td>Find the probability of a simple event</td>
</tr>
<tr>
<td></td>
<td>Geo</td>
<td>HS</td>
<td>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)</td>
</tr>
<tr>
<td></td>
<td>Geo</td>
<td>HS</td>
<td>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</td>
</tr>
<tr>
<td>HVAC MATH Course/ Common Core</td>
<td>HVAC (Career Ready) MATHEMATICS ACT Topic</td>
<td>ACT Score</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators</td>
<td>(16-19)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th HS</td>
<td>Use properties of exponents (including zero and negative exponents) to evaluate and simplify expressions</td>
<td>(28-32)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Find rational number square roots (without calculators) and approximate irrational square roots (with and without calculators)</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Evaluate and simplify radical expressions</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Use scientific notation when working with very large or very small quantities</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Set up and solve problems following the correct order of operations (including proportions, percent, and absolute value) with rational numbers (integers, fractions, decimals)</td>
<td>(20-23)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Identify, formulate, and obtain solutions to problems involving direct and inverse variation</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>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</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>Translate between different representations of relations and functions: graphs, equations, sets of ordered pairs, verbal descriptions, and tables</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC 8th</td>
<td>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</td>
<td>(28-32)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC HS</td>
<td>Simplify ratios</td>
<td>(13-15)</td>
<td></td>
</tr>
<tr>
<td>Alg I CC HS</td>
<td>Solve formulas for a specified variable</td>
<td>(24-27)</td>
<td></td>
</tr>
<tr>
<td>Geo CC HS</td>
<td>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</td>
<td>(28-32)</td>
<td></td>
</tr>
<tr>
<td>Geo CC HS</td>
<td>Use cross sections of prisms, cylinders, pyramids, and cones to solve volume problems</td>
<td>(28-32)</td>
<td></td>
</tr>
<tr>
<td>Geo CC HS</td>
<td>Find the lateral area, surface area, and volume of prisms, cylinders, cones, and pyramids in mathematical and real-world settings</td>
<td>(28-32)</td>
<td></td>
</tr>
<tr>
<td>Geo CC HS</td>
<td>Find the surface area and volume of a sphere in mathematical and real-world settings</td>
<td>(28-32)</td>
<td></td>
</tr>
</tbody>
</table>
## Career Ready Math Skills: Getting the job*

<table>
<thead>
<tr>
<th>Algebra I</th>
<th>Telecommunication Junior Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nursing</td>
</tr>
<tr>
<td></td>
<td>HVAC</td>
</tr>
<tr>
<td></td>
<td>Survey Technician</td>
</tr>
<tr>
<td></td>
<td>Plumbing</td>
</tr>
<tr>
<td></td>
<td>Automobile Technician</td>
</tr>
<tr>
<td>Geometry</td>
<td>Survey Technician</td>
</tr>
<tr>
<td></td>
<td>Plumbing</td>
</tr>
<tr>
<td></td>
<td>Automobile Technician</td>
</tr>
<tr>
<td></td>
<td>Nursing</td>
</tr>
<tr>
<td></td>
<td>HVAC</td>
</tr>
<tr>
<td>Algebra II</td>
<td>Telecommunication Junior Technician</td>
</tr>
</tbody>
</table>

*These skills are relevant to various career paths.
### College & Career Ready Math

**The Same?**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>College Ready</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Career Ready</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>17</td>
<td>17</td>
<td>5</td>
</tr>
</tbody>
</table>
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).
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

James.stone@nrccte.org

www.nrccte.org