College & Career Ready Mathematics

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Abstract

Education reform policy discussions are increasingly dominated by two themes: college and career readiness and the common core standards. The Common Core Standards were designed to address the level of abilities students should reach prior to receiving their high school diploma in order to be college and career ready (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Forty-five states and three territories have adopted these standards into their curriculum. The focus of this paper is to determine the mathematics knowledge and skills students need to be college and more importantly, career ready.

Introduction

College and career readiness has replaced the concept of "college for all" as the focus of high school education reform efforts (Stone & Lewis, 2012; U.S. Department of Education, 2010). Among policymakers, educators, and the employer community, there is broad agreement that the nation needs to improve how it prepares all youth to continue their formal learning beyond high school and successfully compete in a continually evolving global economy (e.g., Brynjolfsson & McAfee, 2011; Carnevale, Smith, & Strohl, 2010; Spence & Hlatshwayo, 2011; U.S. Department of Education, 2010). As part of this effort most states and U.S. territories have adopted the Common Core State Standards (CCSS), a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO), as the best way to prepare both "career ready" and "college ready" graduates. CCSS has sought to establish the level of abilities students should reach prior to receiving their high school diploma (NGA CEBP & CCSSO, 2010). At this stage of the development of the CCSS, standards have been identified and the grade level location of each concept associated with those standards has been identified, but assessments and benchmark scores related to the standards and concepts associated with them have not, although efforts are underway.

However, the discussions that have been influencing education systems to update their approaches have emphasized preparing students to be college ready, with limited attention paid to career readiness; many have tacitly assumed the two standards to be the same (for a discussion, see Association for Career and Technical Education [ACTE], 2010; Stone & Lewis, 2012). As a result, new efforts have begun to establish a definition of career readiness. The general consensus defines career ready as meeting core academic, employability, and technical skills (ACTE, 2012; Career Readiness Partner Council, 2012; Stone & Lewis, 2012). However, the process for narrowing this definition and measuring it has been approached in various ways. Each of the states has taken some step to begin the process of measuring what it means to be career ready. The Kentucky Department of Education defines career ready students as those that pass one of their four career readiness measures, an industry certificate, the Kentucky Occupational Skills Standards Assessment, WorkKeys, or the Armed Services Vocational Aptitude Battery. Arkansas offers a career ready certificate to those who pass a test derived from ACT's WorkKeys. Florida's career preparatory program requires students take three courses in a single career and technical education program (Student Support Services Project, 2011).

What is College and Career Ready Math?

One of the areas that have received the least attention based on career ready standards but has been effected most is core academics, especially mathematics. In many cases, the increased rhetoric that has occurred has led states to operationalize college and career readiness by simply increasing graduation requirements. Assumptions about what is necessary to ensure students are college and career ready has influenced an increase in math requirements for high school graduation in 37 states and the District of Columbia between 2000 and 2008 and twenty states require at least Algebra II to graduate (Achieve, 2007, 2011; Raphael, Sage & Ishimaru, 2012; Stillman and Blank, 2009).

Academic and other skills required for career success are a function of the career path that students choose to take and the development of industries. For example, the National Center on Education and Economy (2013) reported on the mathematics required for first year occupational programs in community colleges. Contrary to much of the established literature, the study reported that for the programs studied, middle school level mathematics was sufficient. The report further argued that the higher levels of math often required for program entry were a function of the community college mathematics department to ensure individuals could pass the gateway course to college algebra and ultimately calculus. For many if not most middle school occupations, such mathematics is not necessary.

None-the-less, discussions driving the benchmark for career-ready math are generally stressed in regards to STEM (science, technology, engineering and mathematics) occupations (e.g., Atkinson & Mayo, 2010; Kuenzi, Matthews & Mangan, 2006; Thomasian, 2011) often explicitly or implicitly assuming all STEM oriented students must take a sequence to prepare them for calculus. However, this discussion should be broadened as it becomes clear that a large proportion of employers are unable to find qualified applicants (Manpower Group, 2012; National Association of Manufacturers, 2005; U.S. Bureau of Labor Statistics, 2012). The Manpower Group’s (2012) most recent annual survey found that 49% of U.S. employers were not able to find qualified employees for job openings, especially among those in the skilled trades. It is not clear how the sample for this survey was derived or how methodologically rigorous it was. However, it is supported by other research, including the National Association of Manufacturers (2005), which found that 80% of U.S. employers experienced difficulties hiring qualified workers, citing such deficiencies as poor math, reading, and writing abilities and a lack of soft skills, including timeliness, general work ethic, communication skills, and attitude. ACT (2011a) reported that a large portion of employees currently in high-level and mid-level positions in the fields of manufacturing, construction, healthcare, and energy were reported as not meeting minimum math benchmarks required for their jobs. ACT data (2011d) also showed that less than half of high school students who had taken the ACT exam met the minimum math benchmark needed for their chosen career paths.

Some sources have stated that math achievement can predict postsecondary (Achieve, Inc., 2008; Lee, 2012; Rose & Betts, 2001) and workforce (Achieve, Inc., 2008; Rose & Betts, 2001) success. It should be stated that postsecondary institutions are generally reluctant to reject students based on a student’s math score on the SAT or ACT, instead they prefer to look at the students score holistically and only 1 in four institutions have defined a cutoff threshold (Briggs, 2009). Yet, four out of every 10 students entering college and half of students entering two-year colleges need some form of academic remediation (U.S. Department of Education, 2010), with the largest percentages needing remediation in math (Bettinger & Long, 2005; Merisotis & Phipps, 2000; U.S. Department of Education, 1997; U.S. Department of Education, 2008). Remedial needs can reduce the likelihood of persistence through postsecondary education and increase the length of time a student needs to achieve a postsecondary credential (Bettinger & Long, 2005). In addition, students who indicated they were interested in pursuing a math-type major were more likely to graduate on time, while students who were interested in pursuing a careers that focused on their verbal or writing abilities were less likely to persist if a remedial math course was required (Bettinger & Long, 2005). Martorell & McFarlin (2007) found that remedial coursework did little to improve a Texas student's opportunities in the labor market or academically. Given that poor math skills negatively impact students' ability to make a successful transition to college and the labor market, how do we ensure that students take the right math courses—and do well enough in them to prosper after high school?

Purpose of Study

ACT (2006) 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. ACT stated in this report that the college readiness benchmark for mathematics was a score of 22. Using ACT's list of math skills associated with a score of 22 (ACT, 2006) we asked two questions:

1. Where in a traditional sequence of math courses are these skills and knowledge located?
2. Are the math requirements and related math courses required for successful college entry the same as those required for successful career entry?

We first sought to identify what specific math skills or knowledge are necessary to be college ready according to ACT. We then mapped the mathematics knowledge needed to become college and career ready against traditional mathematics courses (e.g., Algebra I, Geometry) and the common core state standards. In this process, we also sought to determine if college readiness is the same or different than career readiness.

For this study, we define college and career ready as students with academic knowledge and employability and technical skills necessary to enter a career pathway of choice (Stone & Lewis, 2012). Thus the college ready student is academically prepared to enter postsecondary education without a need for remediation. Career ready students are also prepared to enter postsecondary education or training (e.g. certificate or industry credential program, associate's degree or other college credential required for career entry) without the need for remediation and prepared to work in a career pathway, entry-level position. This paper adds to our understanding of college and career readiness by (a) providing a deeper understanding of the type of math needed to meet a college ready benchmark in mathematics established by ACT and (b) identifying the specific math knowledge needed in the workplace.

Defining College Ready Math

There is general agreement that students not needing remediation upon entering postsecondary education is the minimum level of math ability required to be considered college ready (e.g., Allen & Sconing, 2005; National Center on Education and the Economy, 2007). Two approaches have been generally taken to identify whether students meet this minimum standard of preparation: (1) achieving benchmark scores on standardized college admission examinations (e.g., ACT, SAT), or (2) successfully completing specific course sequences in math (ACT, 2006; Adelman, 1999; Lee, 2012; Young & Fisler, 2000).

For example, ACT (ACT, 2011b, 2011c), one of the nation's largest developers of college entrance exams, states that a score of 22 on the mathematics portion of the ACT exam indicates that a transitioning student has a 50% chance of achieving a grade of B or higher or a 75% chance of achieving a C or higher in their postsecondary math coursework (see also Allen & Sconing, 2005). For this study, we used ACT's benchmark of 22 as our benchmark for college readiness in math. While the most common math curriculum used in American high schools consists of two algebra courses and a geometry course (CCSS, 2011), increasingly states are moving Algebra to middle school to make space for more advanced courses in high school including courses in advanced Algebra, Geometry, trigonometry, calculus or courses in probability and statistics (Achieve, Inc., 2012; CCSS, 2011).

The driving assumption behind most policy debates regarding math course requirements is that students who complete advanced math courses like Calculus or Trigonometry have a better foundation for future workforce success and postsecondary achievement (Achieve, Inc., 2008; Rose & Betts, 2001). As a result of this assumption, many states have increased math requirements for graduation (Clune & White, 1992; Council of Chief State School Officers, 2004), but to what end? Stone and Lewis (2012) have noted that the average high school graduate today is exposed to a full year more of academics—defined as math, science, social studies, and language arts—than high school students in the 1980s. They also pointed out that the average high school graduate completes more than three years of high school math. Yet data from the National Assessment of Educational Progress (U.S. Department of Education, 2009) reveal that students' math scores have not changed over the last 30 years, despite the fact that math graduation requirements have more than doubled. This suggests that adding more math courses to the high school curriculum does not improve students' preparedness for college.

Adding more math to the high school curriculum has in turn put pressure on middle schools to teach Algebra I in eighth grade. Some have argued that taking Algebra I too early may be harmful to students that struggle with math, lowering their math GPAs by about 7% and generating no impact on eighth-grade state math tests; residual, negative effects may persist for even the students more comfortable with the subject (Clotfelter, Ladd, & Vigdor, 2012; Sparks, 2012). Research has shown that students who have a higher math self-efficacy are more likely to take more advanced courses, in which they are more likely to perform better due to their confidence in performing math-related tasks (Stone & Lewis, 2012). It appears there are no benefits to students taking advanced math courses, if they are not already proficient in Algebra I.

Assuming the ACT benchmark signifies a student is college ready in math, we then asked which math courses deliver the content associated with these skills. We began by analyzing ACT's descriptions of the math concepts associated with the benchmark score of 22. According to ACT (2011c), the tasks shown in Table 1 illustrate the skills needed to score between a 20 and a 23 on the test. This range encompasses the recommended minimum score of 22 as the threshold for college readiness (ACT, 2011c) Table 1 does not include the 19 standards listed needed to achieve lower-ranging scores (i.e., ACT scores of 16-19, 13-15, or 1-12) that define basic math operations and numeracy.

Table 1
ACT College Readiness Standards for Mathematics: Requirements to Score 20-23

Areas of Skill or Knowledge	Standards
Basic operations & applications	Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average
Probability, statistics, & data analysis	Calculate the missing data value, given the average and all data values but one
	Translate from one representation of data to another (e.g., a bar graph to a circle graph)
	Determine the probability of a simple event
	Exhibit knowledge of simple counting techniques
Numbers: Concepts & properties	Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor
Expressions, equations & inequalities	Substitute whole numbers for unknown quantities to evaluate expressions
	Solve one-step equations having integer or decimal answers
	Combine like terms (e.g., 2x + 5x)
	Evaluate algebraic expressions by substituting integers for unknown quantities
	Add and subtract simple algebraic expressions
	Solve routine first-degree equations
	Perform straightforward word-to-symbol translations
	Multiply two binomials
Graphical representations	Locate points on the number line and in the first quadrant
	Locate points in the coordinate plane
	Comprehend the concept of length on the number line
	Exhibit knowledge of slope
Properties of plane figures	Exhibit some knowledge of the angles associated with parallel lines
	Find the measure of an angle using properties of parallel lines

	Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°)
Measurement	Compute the perimeter of polygons when all side lengths are given
	Compute the area of rectangles when whole number dimensions are given
	Compute the area and perimeter of triangles and rectangles in simple problems
	Use geometric formulas when all necessary information is given
Functions	Evaluate quadratic functions, expressed in function notation, at integer values

Source: ACT, 2011c.

We then sought to determine which math courses contain the knowledge and skills outlined in Table 1. To do this, we turned to ACT's own research. ACT has produced several studies over the past decade that have sought to determine which math course-taking patterns predict success. In a recent publication, the ACT reported that 46% of ACT test takers met the mathematics benchmark (ACT, 2012). In a seemingly contradictory finding they found that only 26% of students who took the recommended mathematics core (Algebra I, Geometry, Algebra II) scored at least a 22 on the ACT math test, the average score was 17.7 (ACT, 2011e). Adding a course in trigonometry or other advanced math course, increased the average score to 19.9 still below their established benchmark. To meet the ACT benchmark of 22 required students to take the equivalent of five years of high school math (Algebra I, Algebra II, Geometry, Trigonometry, another advanced math course or Calculus).

Understanding Career-Ready Math

The previous discussion of college-ready math purposefully did not distinguish between college-ready and career-ready math—that is, the math skills most people need to be successful in the workplace.

ACT (2006) argued that the academic skills required for college success are the same as those needed to enter the workforce, basing this conclusion on their analysis of the reading and math skills needed for sub-baccalaureate jobs that also pay a family-supporting wage and offer career advancement. ACT's analyses used data from the U.S. Department of Labor's Occupational Information Network (O*NET) database. ACT focused on O*NET's Zone 3 jobs, which met their wage and advancement criteria; these jobs are often described as middle-skill occupations. Middle-skill occupations are those requiring less than a baccalaureate degree but more than high school (e.g., electricians, registered nurses, plumbers). ACT (2006) determined that in order to be considered adequately prepared for Zone 3 jobs, students need to achieve a Level 5 in the math portion of the WorkKeys, an ACT assessment measuring occupational skills. A Level 5 WorkKeys score is comparable to a score of 22 on the ACT college preparedness assessment (ACT, 2006; WorkKeys, 2012).

A survey conducted at Northeastern University and reported by Cavanagh (2007) found that 94% of jobs require only basic math skills, with only 22% requiring the routine use of advanced math. This may be changing: According to Carnevale et al.'s (2010) labor market projections, most workers will need some form of postsecondary credentials in order to earn a family-sustaining wage, suggesting there is an increased need for advanced skills in the workplace, including mathematics.

Method

As ACT's data suggest, on average students need to take five years of high school math to ensure they can achieve the benchmark score of 22. Is that much math coursework and the curriculum space it consumes actually necessary to provide students what they need to be college ready? Or, is there a subset of math skills that all students should master to ensure college and presumably career readiness? So rather than focus on the number of years of math required, our analysis focuses on first identifying these necessary math skills that will aid in achieving college and career readiness. Mapping the math skills associated with a 22 against traditional math course curricula (e.g., Algebra I, Geometry) will illustrate where in the math curriculum students are exposed to the college readiness math skills.

To address the first question of the study and locate the math needed to achieve the benchmark score we used concept mapping, linking a specific math task or skill to a specific math course or grade level. Mathematics curriculum standards were then collected from three states—Massachusetts (Massachusetts Department of Elementary and Secondary Education), California (California Department of Education), and Texas (Texas Board of Education) —in order to determine at which course level the concept was expected to be taught. These states were chosen because of their reputation for offering high-quality math curricula and influence on national education standards. These and subsequent analyses were conducted by two math experts from the University of Louisville's Center for Research in Mathematics and Science Teacher Development.

To determine the math necessary for career readiness, we focused on identifying *occupational math*. In this, we sought to replicate the study conducted by ACT (2006) that compared O*Net Zone 3 occupational skill requirements to math scores on ACT's WorkKeys assessment. As noted, ACT (2006; WorkKeys, 2012) declared a math score of 22 on the WorkKeys test (an indicator of career readiness) as comparable to a math score of 22 on the regular ACT test (an indicator of college readiness). We did this in order to determine if college and career readiness are indeed comparable. We also accepted ACT's (2006) logic for defining workforce readiness and focused on middle-skill occupations. Middle-skill occupations are likely to offer a family-supporting wage and have opportunity for personal advancement (U.S. Department of Labor, 2004). Rather than replicate ACT's general approach that relies on O*Net data that assesses the skills of incumbent workers, we chose to focus on the math knowledge and skills required for entry into specific O*Net Zone 3 occupations. In this case, middle-skill occupations we selected as the focus and selected from O*Net's Zone 3. In selecting occupations, we prioritized those occupations identified by O*NET as having a positive outlook for growth over the next decade. We then gathered available training manuals, tests, and workbooks for these occupations so that we could compare them with ACT's math standards and math content standards identified by the state. We were able to obtain testing materials for entry into the following careers: telecommunication junior technician; nursing; heating, ventilation, and air conditioner (HVAC) worker; survey technician; plumbing; automobile technician; RESNET (residential energy services network) field inspector; and electrical apprentice. Readers should note that this limited set of occupations is not necessarily representative of all middle-skill occupations; nor were we able to acquire the full range of training manuals, tests, and workbooks associated with these occupations. Our ability to acquire real employment tests was limited, as many organizations and unions consider them proprietary and are reluctant to make them public.

We should note that the complete methodology for the 2006 ACT study was never published, and although we sought to obtain it from the author, we were unable to do so. As a result, we used the framework outlined in the ACT brief about the study (2006) to guide our study.

Our concept map of generated a table spanning 142 rows and 7 columns.[1] One sample row of which is presented in Table 2, includes the ACT standards to math course standards from three states, ACT standards to CCSS math standards, and ACT standards to occupational tests.

Table 2

Sample Analysis

Course/ Common Core	**ACT Standard**	**WorkKeys Equivalent**	**O*NET Occupation**	**CA**	**MA**	**TX**
Alg I / CC 8th	Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators (16-19)	Find the best deal using one- and two- step calculations and then comparing results. Divide negative numbers.	Telecommunication Junior Technician, Nursing, HVAC, Survey Technician, Plumbing, Automobile Technician, RESNET Field Inspector, Electrical Apprentice	Addressed in 7th grade curriculum: Apply and extend previous understandings of operations with fractions to add, subtract, multiply and divide rational numbers	Addressed in 7th grade curriculum: Apply and extend previous understandings of operations with fractions to add, subtract, multiply and divide rational numbers	Addressed in 7th grade curriculum: Apply and extend previous understandings of operations to solve problems using addition, subtraction, multiplication, and division of rational numbers

Results

We first sought to explore where in the curriculum the math needed to be college and career ready is taught. To determine college readiness, we identified which math concepts need to be mastered in order to acquire an ACT math score of 22, and where these concepts are located in the curriculum, as recommended by the CCSS. The results are shown in Table 3. The first column shows the Standard-Associated Tasks that students must master, the second shows the associated ACT score. We assume a linear relationship, that is, one must master the tasks associated with lower ACT scores in order to be able to master the tasks associated with higher scores. We then align this by ACT score groupings and math courses (e.g., Algebra I or

[1] The full table is available upon request from the authors.

Geometry). We identified 10 standards associated with Algebra I and two standards associated with Geometry that were linked to an ACT math score of 22. Our data suggest that the math needed to score a 22 on the ACT exam is currently identified with or recommended for being taught in middle school and high school Algebra I. One Geometry requirement is recommended to be taught in middle school, the other in high school.

Table 3 *Mathematics Skills Needed to Score a 22 on the ACT*

ACT Standard-Associated Task	ACT Score	Course / Common Core
Simplify ratios	13-15	Alg I / CC HS
Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators	16-19	Alg I / CC 8th
Use rational numbers to demonstrate knowledge of additive and multiplicative inverses		Alg I / CC HS
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
Give the domain and range of relations and functions		Alg I / CC 8th
Evaluate functions at given values		Alg I / CC 8th
Apply algebraic properties (e.g., commutative, associative, distributive, identity, inverse, substitution) to simplify algebraic expressions		Alg I / CC HS
Translate real-world problems into expressions using variables to represent values		Alg I / CC HS
Identify the effect on mean, median, mode, and range when a set of data is changed		Alg I / CC HS
Find the probability of a simple event		Alg I / CC 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 / CC 8th
Use construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors		Geo / CC HS

In similar fashion, we mapped the math required for career readiness by mapping the implicit or explicit curriculum embedded in the industry training materials against the math Tasks, math courses/CCSS levels. We found that the math for achieving career readiness was found within the same math curriculum. Our analysis showed 17 ACT Standard-Associated Tasks at the Algebra I middle school course level, 10 at the high school Algebra I course level and 19 in high school Geometry. The summary table for the college and career ready math is found in Appendix A. Career ready math for the individual occupations is found in Appendix B.

Our third research question was to determine if the math required for graduating both college and career ready were the same. The comparison of the math needed to score a 22 on the math portion of the ACT exam with the math required for entry into the middle-skill occupations is summarized in Table 4. Although, the math required to be college ready and the math required to be career ready is located in the same courses (with two career math exceptions), in aggragate the level of math for career readiness is *higher* than that required for college math.

Our analysis shows that there were 39 additional ACT Standard-Associated Tasks linked with career readiness. These tasks are primarily located in the Algebra I and Geometry courses. Two tasks were located in Algebra II.

Table 4

Number of ACT Standard-Associated Tasks needed to be College and Career Ready

	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*

There is variability among the different career entrance requirements. For example, we found that the occupations of plumbing, survey technician, and telecommunications junior technician did not require knowledge of any skills taught in Algebra I at the high school level. Other occupations, such as HVAC, require math skills learned in Algebra I and II. Of the 12 Algebra I math skills needed to enter the field, 8 can be learned in eighth-grade Algebra I, and just 4 can learned in high school Algebra I. (see Appendix B for a complete list of skills by occupation and course).

Discussion

The intent of this study was to answer two research questions related to generating a fuller, more realistic understanding of the meaning of college and career readiness with respect to mathematics. We focused on mathematics because of the barrier it often represents to successful college entry, as well as the importance math is given in many discussions of workforce development policy (e.g., Achieve, Inc., 2007; 2012; Carnevale, Smith, & Strohl, 2010; NGA CEBP & CCSSO, 2010). As we discussed in this paper, and is described in a much more detailed fashion elsewhere (see Stone & Lewis, 2012), much education policy is driven by flawed assumptions about how much math is needed to prepare students for college, as well as how much math is needed to prepare students for careers. Cultivating a richer understanding of college and career readiness is important because as states continue to add courses to their already academically challenging graduation requirements, the curriculum space available for other courses that have been shown to engage students in high school (e.g., art, career and technical education [CTE], music) is greatly reduced, if not eliminated altogether.

Our analysis of ACT's math standards and a non-random set of occupational tests associated with a selection of O*NET Zone 3 occupations strongly suggests that the math skills required to be considered college ready and career ready are similar—and may largely be addressed by the 10th grade, or by taking Algebra I and Geometry. In fact, many of these skills are taught in middle school. Although college readiness and career readiness may be similar, our analyses also suggest that the math skills associated with successful entry into careers include more and higher-level math skills—again, however, these skills are largely taught in just two years of high school math. Because so few students graduate from high school able to demonstrate competency in these areas, we suggest that increasing math course requirements for graduation may be a misguided policy. Instead, we propose that we need to rethink how math is taught and place greater emphasis on applied math skills, especially in the later years of high school.

One such evidence-based approach to applied math learning was developed by the National Research Center for Career and Technical Education (NRCCTE; Stone, Alfeld, & Pearson, 2008). In an experimental study, CTE courses were infused with contextual mathematics related to the occupational curriculum. Students enrolled in the CTE courses in which math-enhanced lessons were taught significantly outperformed students who received the standard CTE curriculum on the Accuplacer and Terra Nova exams.

A similar approach builds on the NRCCTE model but extends it to include a focus on project-based learning. The Southern Regional Education Board's (SREB, 2012) Advanced Careers (AC) curriculum draws on the results of multiple research studies to offer hands-on team-centered projects in which students explore career fields and learn rigorous math, science and literacy skills. In both of these approaches, students don't merely pass math tests; instead, they learn to use math to solve complex work or career-related problems. Through this process, they move toward deeper learning and true college and career readiness.

We conclude with two important caveats. Success in college and success in the workplace requires more than a passing math score. Employers have more complex needs than just a basic level of academic (e.g., math) preparedness. Career-ready graduates—and good employees more generally—must possess academic, technical, and soft skills to succeed. The importance of non-cognitive or soft skills has topped employer requirements since at least the 1990s (Murnane & Levy, 1996, Carnevale, Gainer, & Meltzer, 1990; Hamilton & Hamilton, 1997; the Secretary's Commission on Achieving Necessary Skills [SCANS], 1991). More recently, the Partnership for 21st Century skills—a collaboration of the Conference Board and three industry partners (Casner-Lotto, Barrington, & Wright, 2006)—examined the skills gap and found that although basic skills (the so-called 3-Rs: reading, writing, and arithmetic) are still critically important, applied skills, such as teamwork and critical thinking, are just as important to workplace success.

The second caveat draws from data that shows the majority of students who enter 9th grade will not complete a two or four-year college credential despite nearly 30 years of a college for all focus in K-12 education (Stone & Lewis, 2012). This reality is captured by Barton (2006) who reminds us that for all students, high school is the last education opportunity paid for wholly by the public. The purpose of high school must, therefore, be to provide all students the skills or foundation necessary to enter into adulthood.

Math is an important skill for success in education and work. The need for math differs greatly depending on the career pathway one pursues. This analysis suggests that the true common core for all students is captured in middle school and two years of high school math. This understanding should guide education policy as states and districts grapple with the right course mixture to prepare students to be both career and college ready.

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Appendix A

Mathematics Skills Needed for College and Career Readiness

ACT Score	Course / Common Core	ACT Standard-Associated Task	College Ready	Career Ready
13-15	Alg I / CC HS	Simplify ratios	X	X
16-19	Alg I / CC 8th	Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators	X	X
	Alg I / CC HS	Use rational numbers to demonstrate knowledge of additive and multiplicative inverses	X	X
20-23	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)	X	X
	Alg I / CC 8th	Give the domain and range of relations and functions	X	X
	Alg I / CC 8th	Evaluate functions at given values	X	
	Alg I / CC HS	Apply algebraic properties (e.g., commutative, associative, distributive, identity, inverse, substitution) to simplify algebraic expressions	X	X
	Alg I / CC HS	Translate real-world problems into expressions using variables to represent values	X	X
	Alg I / CC HS	Identify the effect on mean, median, mode, and range when a set of data is changed	X	X
	Alg I / CC HS	Find the probability of a simple event	X	
	Geo / CC 8th	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)	X	
	Geo / CC HS	Use construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors	X	X

24-27	Alg I/ CC 8th	Identify, formulate, and obtain solutions to problems involving direct and inverse variation		X
	Alg I / CC HS	Solve formulas for a specified variable		X
	Alg I/ CC 8th	Solve single-step and multistep equations and inequalities in one variable		X
	Alg I/ CC 8th	Graph linear inequalities in one variable on the real number line to solve problems		X
	Alg I/ CC 8th	Use scientific notation when working with very large or very small quantities		X
	Alg I/ CC 8th	Write and graph linear equations and inequalities from real-world situations (e.g., a constant-rate distance/time problem)		X
	Alg I/ CC 8th	Recognize the concept of a slope as a rate of change and determine the slope when given the equation of a line in standard form, the graph of a line, two points, or a verbal description		X
	Alg I/ CC 8th	Graph a linear equation using a table of x- and y- intercepts, slope-intercept form, and technology		X
	Alg I/ CC 8th	Find rational number square roots (without calculators) and approximate irrational square roots (with and without calculators)		X
	Alg I/ CC 8th	Evaluate and simplify radical expressions		X
	Alg I/ CC 8th	Translate between different representations of relations and functions: graphs, equations, sets of ordered pairs, verbal descriptions, and tables		X
	Alg I/ CC HS	Write linear equations in standard form and slope-intercept form when given two points, a point and the slope, or the graph of the equation		X
	Alg I/ CC HS	Add and subtract polynomials		X
	Alg I/ CC HS	Multiply monomials, binomials, trinomials, and polynomials		X
	Alg I/ CC HS	Distinguish between independent and dependent events		X
	Geo/ CC HS	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)		X
	Geo/ CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles		X
28-32	Alg I/ CC 8th	Interpret data from line, bar, and circle graphs, histograms, scatterplots, box-and-		X

		whisker plots, stem-and-leaf plots, and frequency tables to draw inferences and make predictions		
	Alg I/ CC 8th & HS	Use properties of exponents (including zero and negative exponents to evaluate and simplify expressions.		X
	Alg I/ CC 8th	Solve systems of two equations using various methods, including elimination, substitution, and graphing with and without technology		X
	Alg I/ CC 8th	Solve equations that contain absolute values		X
	Geo / CC HS	Use various methods to prove that two lines are parallel or perpendicular (e.g., using coordinates, angle measures		X
	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.		X
	Geo / CC HS	Apply properties and theorems of parallel and perpendicular lines to solve problems		X
	Geo / CC HS	Use cross sections of prisms, cylinders, pyramids, and cones to solve problems		X
	Geo / CC HS	Find the lateral area, surface area and volumes of prisms, cylinders, cones, and pyramids in mathematical and real-world settings		X
	Geo / CC HS	Find the surface area and volume of a sphere in mathematical and real-world settings		X
	Geo / CC HS	Define trigonometric ratios and solve problems involving right triangles		X
	Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles		X
	Geo / CC HS	Find the lateral area, surface area, and volume of prisms, cylinders, cones, and pyramids in mathematical and real-world settings		X
	Geo / CC HS	Use cross sections of prisms, cylinders, pyramids, and cones to solve volume problems		X
	Geo / CC HS	Describe and draw cross sections of prisms, cylinders, pyramids, and cones		X
	Geo / CC HS	Identify similar figures and use ratios and proportions to solve mathematical and real-world problems (e.g., finding the height of a		X

		tree using the shadow of the tree and the height and shadow of a person)		
	Alg II/ CC HS	Use the fundamental counting principle to count the number of ways an event can happen		X
33-36	Geo/ CC HS	Identify and define line segments associated with circles (e.g., radii, diameters, chords, secants, tangents)		X
	Geo/ CC HS	Find segment lengths, angle measures, and intercepted arc measures formed by chords, secants, and tangents intersecting inside and outside circles		X
	Geo/ CC HS	Use definitions, basic postulates, and theorems about points, segments, lines, angles, and planes, to write proofs, and to solve problems		X
	Geo/ CC HS	Determine the measure of central and inscribed angles and their intercepted arcs		X
	Alg II/ CC HS	Use unions, intersections, and complements to find probabilities		X

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth grade level.

Appendix B
Occupational Test Maps

Auto Tech		
Course / Common Core	**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	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	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	Translate real-world problems into expressions using variables to represent values	20-23
Alg I / CC HS	Solve formulas for a specified variable	24-27
Alg I / CC HS	Identify the effect on mean, median, mode, and range when a set of data is changed	20-23
Geo / CC HS	Use various methods to prove that two lines are parallel or perpendicular (e.g., using coordinates, angle measures)	28-32
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 construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel	20-23

	and perpendicular lines, perpendicular bisectors, and angle bisectors	
Geo / CC HS	Apply properties and theorems of parallel and perpendicular lines to solve 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

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

Electrical Apprentice		
Course / Common Core	**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	Solve single-step and multistep equations and inequalities in one variable	24-27
Alg I / CC 8th	Graph linear inequalities in one variable on the real number line to solve problems	24-27
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	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	Write and graph linear equations and inequalities from real-world situations (e.g., a constant-rate distance/time problem)	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	Solve systems of two equations using various methods, including elimination, substitution, and graphing with and without technology	28-32
Alg I / CC 8th	Graph a linear equation using a table of values, x- and y-intercepts, slope-intercept form, and technology	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	Use rational numbers to demonstrate knowledge of additive and multiplicative inverses	16-19
Alg I / CC HS	Simplify ratios	13-15
Alg I / CC HS	Apply algebraic properties (e.g., commutative, associative, distributive, identity, inverse, substitution) to simplify algebraic expressions	20-23
Alg I / CC HS	Translate real-world problems into expressions using variables to represent values	20-23
Alg I / CC HS	Write linear equations in standard form and slope-intercept form when given two points, a point and the slope, or the graph of the equation	24-27
Geo / CC HS	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)	24-27
Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles	24-27
Geo / CC HS	Define trigonometric ratios and solve problems involving right triangles	(28-32)
Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles	(28-32)
Geo / CC HS	Identify and define line segments associated with circles (e.g., radii, diameters, chords, secants, tangents)	(33-36)
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)

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

HVAC		
Course / Common Core	**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 8^{th} & 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

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

Nursing		
Course / Common Core	**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	Graph linear inequalities in one variable on the real number line to solve problems	24-27
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	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	Give the domain and range of relations and functions	20-23
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	Use rational numbers to demonstrate knowledge of additive and multiplicative inverses	16-19
Alg I / CC HS	Simplify ratios	13-15
Alg I / CC HS	Add and subtract polynomials	24-27
Alg I / CC HS	Multiply monomials, binomials, trinomials, and polynomials	24-27
Alg I / CC HS	Solve equations that contain absolute value	28-32
Alg I / CC HS	Solve formulas for a specified variable	24-27
Alg I / CC HS	Distinguish between independent and dependent events	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

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

Plumbing		
Course / Common Core	**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	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
Geo / CC HS	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)	24-27
Geo / CC HS	Identify and define line segments associated with circles (e.g., radii, diameters, chords, secants, tangents)	33-36
Geo / CC HS	Find segment lengths, angle measures, and intercepted arc measures formed by chords, secants, and tangents intersecting inside and outside circles	33-36
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

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

RESNET Field Inspector		
Course / Common Core	**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	Find rational number square roots (without calculators) and approximate irrational square roots (with and without calculators)	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	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	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)	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	Define trigonometric ratios and solve problems involving right triangles	28-32
Geo CC HS	Identify and define line segments associated with circles (e.g., radii, diameters, chords, secants, tangents)	33-36
Geo CC HS	Use construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors	20-23
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	Describe and draw cross sections of prisms, cylinders, pyramids, and cones	28-32
Geo CC HS	Find the surface area and volume of a sphere in mathematical and real-world settings	28-32

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8th = Common Core at the eighth-grade level

Survey Technician		
Course / Common Core	**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	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
Geo / CC HS	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)	24-27
Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles	24-27
Geo / CC HS	Use definitions, basic postulates, and theorems about points, segments, lines, angles, and planes to write proofs and to solve problems	33-36
Geo / CC HS	Use various methods to prove that two lines are parallel or perpendicular (e.g., using coordinates, angle measures)	28-32
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	Define trigonometric ratios and solve problems involving right triangles	28-32
Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles	28-32
Geo / CC HS	Determine the measure of central and inscribed angles and their intercepted arcs	33-36
Geo / CC HS	Find segment lengths, angle measures, and intercepted arc measures formed by chords, secants, and tangents intersecting inside and outside circles	33-36
Geo / CC HS	Use construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors	20-23
Geo / CC HS	Apply properties and theorems of parallel and perpendicular lines to solve problems	28-32
Geo / CC HS	Identify similar figures and use ratios and proportions to solve mathematical and real-world problems (e.g., finding the height of a tree using the shadow of the tree and the height and shadow of a person)	28-32

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8th = Common Core at the eighth-grade level.

Telecommunications Junior Technician		
Course / Common Core	**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	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 II / CC HS	Use the fundamental counting principle to count the number of ways an event can happen	28-32
Alg II / CC HS	Use unions, intersections, and complements to find probabilities	33-36

Note. Alg I = Algebra I; Alg II = Algebra II; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth-grade level.

Appendix B

Mathematics Skills Needed for College and Career Readiness

ACT Score	Course / Common Core	ACT Standard-Associated Task	College Ready	Career Ready
13-15	Alg I / CC HS	Simplify ratios	X	X
16-19	Alg I / CC 8^{th}	Add, subtract, multiply, and divide rational numbers, including integers, fractions, and decimals, without calculators	X	X
	Alg I / CC HS	Use rational numbers to demonstrate knowledge of additive and multiplicative inverses	X	X
20-23	Alg I / CC 8^{th}	Set up and solve problems following the correct order of operations (including proportions, percent, and absolute value) with rational numbers (integers, fractions, decimals)	X	X
	Alg I / CC 8^{th}	Give the domain and range of relations and functions	X	X
	Alg I / CC 8^{th}	Evaluate functions at given values	X	
	Alg I / CC HS	Apply algebraic properties (e.g., commutative, associative, distributive, identity, inverse, substitution) to simplify algebraic expressions	X	X
	Alg I / CC HS	Translate real-world problems into expressions using variables to represent values	X	X
	Alg I / CC HS	Identify the effect on mean, median, mode, and range when a set of data is changed	X	X
	Alg I / CC HS	Find the probability of a simple event	X	
	Geo / CC 8th	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)	X	
	Geo / CC HS	Use construction techniques, including straightedge and compass, to bisect and trisect segments and to create parallel and perpendicular lines, perpendicular bisectors, and angle bisectors	X	X

24-27	Alg I/ CC 8th	Identify, formulate, and obtain solutions to problems involving direct and inverse variation		X
	Alg I / CC HS	Solve formulas for a specified variable		X
	Alg I/ CC 8th	Solve single-step and multistep equations and inequalities in one variable		X
	Alg I/ CC 8th	Graph linear inequalities in one variable on the real number line to solve problems		X
	Alg I/ CC 8th	Use scientific notation when working with very large or very small quantities		X
	Alg I/ CC 8th	Write and graph linear equations and inequalities from real-world situations (e.g., a constant-rate distance/time problem)		X
	Alg I/ CC 8th	Recognize the concept of a slope as a rate of change and determine the slope when given the equation of a line in standard form, the graph of a line, two points, or a verbal description		X
	Alg I/ CC 8th	Graph a linear equation using a table of x- and y- intercepts, slope-intercept form, and technology		X
	Alg I/ CC 8th	Find rational number square roots (without calculators) and approximate irrational square roots (with and without calculators)		X
	Alg I/ CC 8th	Evaluate and simplify radical expressions		X
	Alg I/ CC 8th	Translate between different representations of relations and functions: graphs, equations, sets of ordered pairs, verbal descriptions, and tables		X
	Alg I/ CC HS	Write linear equations in standard form and slope-intercept form when given two points, a point and the slope, or the graph of the equation		X
	Alg I/ CC HS	Add and subtract polynomials		X
	Alg I/ CC HS	Multiply monomials, binomials, trinomials, and polynomials		X
	Alg I/ CC HS	Distinguish between independent and dependent events		X
	Geo/ CC HS	Manipulate perimeter and area formulas to solve problems (e.g., finding missing lengths)		X
	Geo/ CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles		X
28-32	Alg I/ CC 8th	Interpret data from line, bar, and circle graphs, histograms, scatterplots, box-and-		X

		whisker plots, stem-and-leaf plots, and frequency tables to draw inferences and make predictions		
	Alg I/ CC 8th & HS	Use properties of exponents (including zero and negative exponents to evaluate and simplify expressions.		X
	Alg I/ CC 8th	Solve systems of two equations using various methods, including elimination, substitution, and graphing with and without technology		X
	Alg I/ CC 8th	Solve equations that contain absolute values		X
	Geo / CC HS	Use various methods to prove that two lines are parallel or perpendicular (e.g., using coordinates, angle measures		X
	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.		X
	Geo / CC HS	Apply properties and theorems of parallel and perpendicular lines to solve problems		X
	Geo / CC HS	Use cross sections of prisms, cylinders, pyramids, and cones to solve problems		X
	Geo / CC HS	Find the lateral area, surface area and volumes of prisms, cylinders, cones, and pyramids in mathematical and real-world settings		X
	Geo / CC HS	Find the surface area and volume of a sphere in mathematical and real-world settings		X
	Geo / CC HS	Define trigonometric ratios and solve problems involving right triangles		X
	Geo / CC HS	Find the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles		X
	Geo / CC HS	Find the lateral area, surface area, and volume of prisms, cylinders, cones, and pyramids in mathematical and real-world settings		X
	Geo / CC HS	Use cross sections of prisms, cylinders, pyramids, and cones to solve volume problems		X
	Geo / CC HS	Describe and draw cross sections of prisms, cylinders, pyramids, and cones		X
	Geo / CC HS	Identify similar figures and use ratios and proportions to solve mathematical and real-world problems (e.g., finding the height of a		X

		tree using the shadow of the tree and the height and shadow of a person)		
	Alg II/ CC HS	Use the fundamental counting principle to count the number of ways an event can happen		X
33-36	Geo/ CC HS	Identify and define line segments associated with circles (e.g., radii, diameters, chords, secants, tangents)		X
	Geo/ CC HS	Find segment lengths, angle measures, and intercepted arc measures formed by chords, secants, and tangents intersecting inside and outside circles		X
	Geo/ CC HS	Use definitions, basic postulates, and theorems about points, segments, lines, angles, and planes, to write proofs, and to solve problems		X
	Geo/ CC HS	Determine the measure of central and inscribed angles and their intercepted arcs		X
	Alg II/ CC HS	Use unions, intersections, and complements to find probabilities		X

Note. Alg I = Algebra I; Geo = Geometry; CC HS = Common Core at the high school level; CC 8^{th} = Common Core at the eighth grade level.