From Middle School To High School

Mathematics Course Sequence for the CCSS-M

Introduction

Students and their families need clear course sequence options to guide their decisions and ensure academic success and future opportunity given the new expectations of the Common Core State Standards for Mathematics (CCSS-M). Decision-making about course enrollment should be put in the hands of students and families in collaboration with teachers, counselors, and other advocates. What follows is our recommendation for a course sequence that will provide a structure to support learning experiences for all students based on the defining shifts of the CCSS-M: focus, coherence, and rigor. The recommendation answers this question:

With the transition to the CCSS-M, what course sequence options should be available to support college readiness for all students?

Framing the Issue

Implementation of the CCSS-M requires each student to have a focused, coherent, and rigorous learning experience in mathematics that makes sense to students as they move from course to course, and that ensures students are college-ready by the end of high school. Focusing deeply on fewer concepts allows students to gain strong foundational conceptual understanding, and developing coherence across grades allows students to build upon deep conceptual understanding from earlier years so that each standard is not a new event, but an extension of previous learning. The CCSS-M define rigor to mean that all students in every grade are enrolled in courses that balance conceptual understanding—the ability to access concepts from multiple perspectives and apply them to new situations—with procedural skill and fluency.

According to Phil Daro, one of the CCSS-M authors, analyses of current student course-taking patterns show students are progressing through a wide variety of course sequences, with a significant population of students repeating courses, especially underserved students, while other students skip courses. Many secondary schools separate students into different courses, resulting in tracks where students have unequal opportunities to learn and unequal access to meaningful opportunities beyond high school. In California, the move to have all 8th graders take Algebra has increased the number of students who fail and repeat Algebra, and this adversely affects underserved students (see studies cited by the California Department of Education and SFUSD CST performance data in “Supporting Evidence for Recommendations” in the Appendix).

As we move into a time of dramatically increased rigor and alignment in the K–12 math sequence, we need to make the necessary adjustments to ensure every student has access to an aligned course sequence in which high-quality teaching and learning are the norm. Historically, rigor has meant doing higher grade-level material at earlier grades, and equity has meant providing all students equal access. The CCSS-M require a shift to seeing rigor as depth of understanding and the ability to communicate this understanding, and to seeing equity as providing all students equal success.

Our Position

In addition to the Standards for Mathematical Practice, the CCSS-M content standards are organized by grade level in Grades K–8 and by conceptual category in high school (number and quantity, algebra, functions, geometry, probability and statistics, and modeling), showing the body of knowledge students should learn. We have the responsibility to ensure that the courses we make available to students meet the rigor of the CCSS-M, and we must provide students clear options for pursuing course sequences that will prepare them for post-secondary success. The recommendation presented here embodies our best thinking about what the most coherent course sequence for our district students.

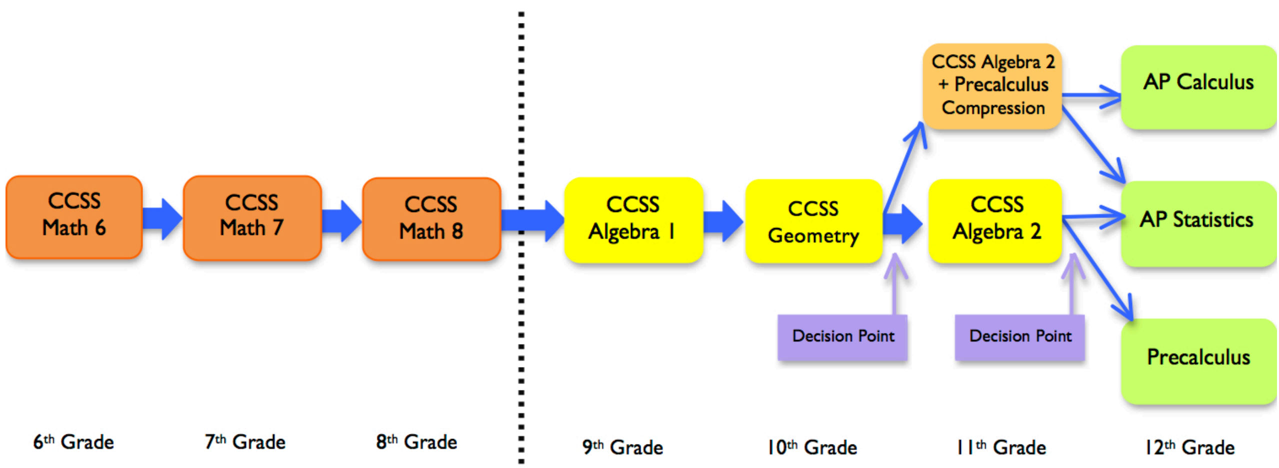
Guiding Principles

The recommendation that follows is based on our belief that:

- All students can and should develop a belief that mathematics is sensible, worthwhile, and doable.
- All students are capable of making sense of mathematics in ways that are creative, interactive, and relevant.
- All students can and should engage in rigorous mathematics through rich, challenging tasks.
- Students' academic success in mathematics must not be predictable on the basis of race, ethnicity, gender, socioeconomic status, language, religion, sexual orientation, cultural affiliation, or special needs.

Recommendation

All secondary schools provide all students the same course sequence aligned to the CCSS-M.



We recommend that the Board of Education endorse a core course sequence for all middle and high schools. This course sequence ensures a solid middle-grades foundation that supports all students to successfully meet the UC "c" requirement and prepares them for college mathematics.

Having one core sequence provides focus and coherence as schools and teachers implement the CCSS-M and supports equity by creating one path for all students to experience rigorous mathematics. Therefore, we explicitly recommend that secondary schools do not separate their students into an honors track and a regular track—or into other tracks based on perceived ability—until students choose course pathways at the end of 10th grade (see the introduction of "Heterogeneous Classrooms" by Maika Watanabe in the Appendix to read more about tracking). This recommendation is in line with the SFUSD 2013-15 Strategic Plan, which includes the design principle of Response to Instruction and Intervention (RTI^2) to meet the needs of all students.

The CCSS-M content standards describe a progression of algebra from Kindergarten through Grade 8 that leads to the CCSS Algebra 1 course in high school. The standards that defined Algebra 1 under the old California standards are now divided between CCSS Math 8 and CCSS Algebra 1 (see "FAQs about Common Core State Standards for Mathematics in SFUSD Middle Schools" in the Appendix). CCSS Math 8 introduces extensive new mathematics content traditionally taught in high school—linear functions, transformational geometry, and bivariate statistics—and is not a course that can be skipped. CCSS Algebra 1 does not repeat content from CCSS Math 8, but rather builds on the content students learn in CCSS Math 8, and should therefore be the core course for 9th graders in high school.

For students who would like to complete an AP course, this course sequence allows them to do so by compressing CCSS Algebra 2 with Precalculus in high school. Unlike the earlier practice of having students accelerate in math by skipping a course, the CCSS-M necessitate that acceleration only occur by course compression. This means that students learn standards from more than one year during a regular class period over one year. The option for compression supports students who wish to graduate from high school prepared for specialized studies in STEM in university settings. Significantly, we recommend that *students, together with their families,* make this choice at the end of their sophomore year. More generally, students and their families make choices about which mathematics courses to enroll in at the end of their sophomore and junior years (labeled as Decision Points in the diagram on the previous page).

Acknowledgements

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Appendices

- Additional Considerations
- Supporting Evidence for Recommendation
- FAQs about Common Core State Standards for Mathematics in SFUSD Middle Schools
- Introduction of “Heterogeneous Classrooms” by Maika Watanabe
- References

Additional Considerations

In addition to the guiding principles listed on page 2, we the following statements describe what we believe to be inherent in the CCSS-M and thus undergird our recommendation:

- A district's mathematics program must preserve the focus, coherence, and rigor of the CCSS-M as demanded by the UC a–g requirements.
- The content in the middle grades CCSS-M standards and in the conceptual categories of high school CCSS-M represents a logical progression—of procedural fluency, conceptual understanding, and strategic thinking—inherently coherent and designed to prepare students for college and career.
- Mathematically proficient students reason about concepts, make sense of and mathematize situations, and connect skills and concepts to solve problems by utilizing the eight Standards for Mathematical Practice as stipulated in the UC a–g requirements.
- Mathematically, each CCSS-M content standard is an essential building block for future learning; therefore no mathematics content or grade level can be skipped.
- Middle school students who successfully complete CCSS-M Math 6, Math 7, and Math 8 consecutively will have the right preparation for high school mathematics.
- Compression is better in later years because students are more mature, they are better able to commit to their choices, and their teachers may have more experience teaching higher-level mathematics and/or deeper content knowledge.
- Students in the 10th grade should be able to make informed and authentic choices about which courses to take, choices that match their goals for college and career.
- Building a coherent learning experience for students requires teachers to collaborate within and across sites around content and pedagogy. Such collaboration is more likely to occur when instruction is aligned to the same Scope and Sequence, so that teachers teach the same units at roughly the same time of year.

Supporting Evidence for Recommendations

- From California Department of Education
  http://www.cde.ca.gov/ci/ma/cf/documents/aug2013apxacourseplace.pdf

CCSS-M Math 8 is rigorous, should not be skipped as in the past, and is an important year for coherence of course-taking and progression of learning.

The CCSS-M Grade 8 standards are of significantly higher rigor than the Algebra 1 course that many students have taken while in 8th grade. The CCSS-M for Grade 8 address the foundations of algebra by including content that was previously part of the Algebra 1 course, such as an in-depth study of linear relationships and equations, a more formal treatment of functions, and the exploration of irrational numbers. For example, by the end of the CCSS-M for Grade 8, students will have applied graphical and algebraic methods to analyze and solve systems of linear equations in two variables. The CCSS-M for Grade 8 also include geometry standards that relate graphing to algebra in a way that was not explored previously. In addition, the statistics standards presented in the CCSS-M for Grade 8 are more sophisticated than those previously included in middle school and connect linear relations with the representation of bivariate data.

- From draft California Department of Education acceleration options
  http://www.cde.ca.gov/ci/ma/cf/documents/aug2013apxacourseplace.pdf

Over the last decade, there has been a dramatic increase in the number and proportion of eighth grade students enrolled in Algebra 1 in California. Williams et al. (2011) report that, between 2003 and 2009, the percentage of eighth grade students taking Algebra 1 increased from 32 percent to 54 percent. While the increase in eighth grade enrollment in Algebra 1 resulted in greater percentages of eighth grade students achieving either Proficient or Advanced on the Algebra 1 California Standards Test, it also led to larger numbers of eighth grade students achieving Far Below Basic or Below Basic on the test (Williams et al. 2011). Williams et al. (2011) conclude that the practice of placing all eighth graders into Algebra 1, regardless of their preparation, sets up many students to fail.

A recent longitudinal analysis based on California statewide assessment data revealed that California's students that fail the state exam for algebra in grade 8 have a greater chance of repeating the course and failing the exam again in ninth grade compared to their peers who pass the state exam for general math in grade 8 (Liang, Heckman, and Abedi, 2012).

Common Core Standards for grades 6–8 are comprehensive, rigorous, and non-redundant. Acceleration will require compaction and not the former strategy of deletion. Therefore, careful consideration needs to be made before placing a student into higher mathematics coursework in middle grades.

1. *Decisions to accelerate students into the Common Core State Standards for higher mathematics before ninth grade should not be rushed.* Placing students into an accelerated course sequence option too early should be avoided at all costs. It is not recommended to compact the standards before grade seven to ensure that students are developmentally ready for accelerated content.

2. *Decisions to accelerate students into higher mathematics before ninth grade must require solid evidence of mastery of prerequisite CCSS-M*. “Mathematics is by nature hierarchical. Every step is a preparation for the next one. Learning it properly requires thorough grounding at each step and skimming over any topics will only weaken one’s ability to tackle more complex material down the road” (Wu 2012). Serious efforts must be made to consider solid evidence of a student’s conceptual understanding, knowledge of procedural skills, fluency, and ability to apply mathematics before moving a student into an accelerated course sequence option.

- California data from EdSource

In 2009, only an estimated 34% of African American 11th graders and 35% of Latino 11th graders had reached at least Algebra 2, compared with 52% of white 11th graders and 78% of Asian 11th graders.

- SFUSD CST performance data:

8th Graders 2011–2012 CST (about 90% took Algebra CST)
Percent of students **not** proficient or above

All	51%
African American	82%
Latino	78%

9th Graders 2011–2012
Percent of students with grades of **D** or **F** in Algebra (most of whom are repeating)

African American	53%
Latino	53%
Chinese	28%
White	35%

SFUSD matched student Algebra 1 CST data from 8th graders in 2009–2010 to the Algebra 2 CST data of same students as 10th graders in 2011–2012. (These data do not include students who transferred into SFUSD in high school, moved away, or dropped out.)

	Students scoring proficient or above on Algebra 1 CST in 8th grade (2010)	Of those proficient in 8th grade, students who took Algebra 2 CST in 10th grade (2012)		Students scoring proficient or above on Algebra 2 CST in 10th grade (2012)		Of those proficient in 8th grade, those scoring proficient in 10th grade
	Number	Number	Percent	Number	Percent	Percent
All	1,348	939	70%	591	63%	44%
African American	29	16	55%	7	44%	24%
Latino	85	62	73%	21	34%	25%

African American and Latino students were extremely underrepresented in the 8th grade cohort of students scoring proficient or above. Less than half of all students, and only a quarter of African American and Latino students, scored proficient two years later. Increasing the number of students who take Algebra 1 in 8th grade has increased the number of students who were unsuccessful in Algebra and had to repeat it, and decreased the success rate of underserved students.

FAQs about Common Core State Standards for Mathematics in SFUSD Middle Schools

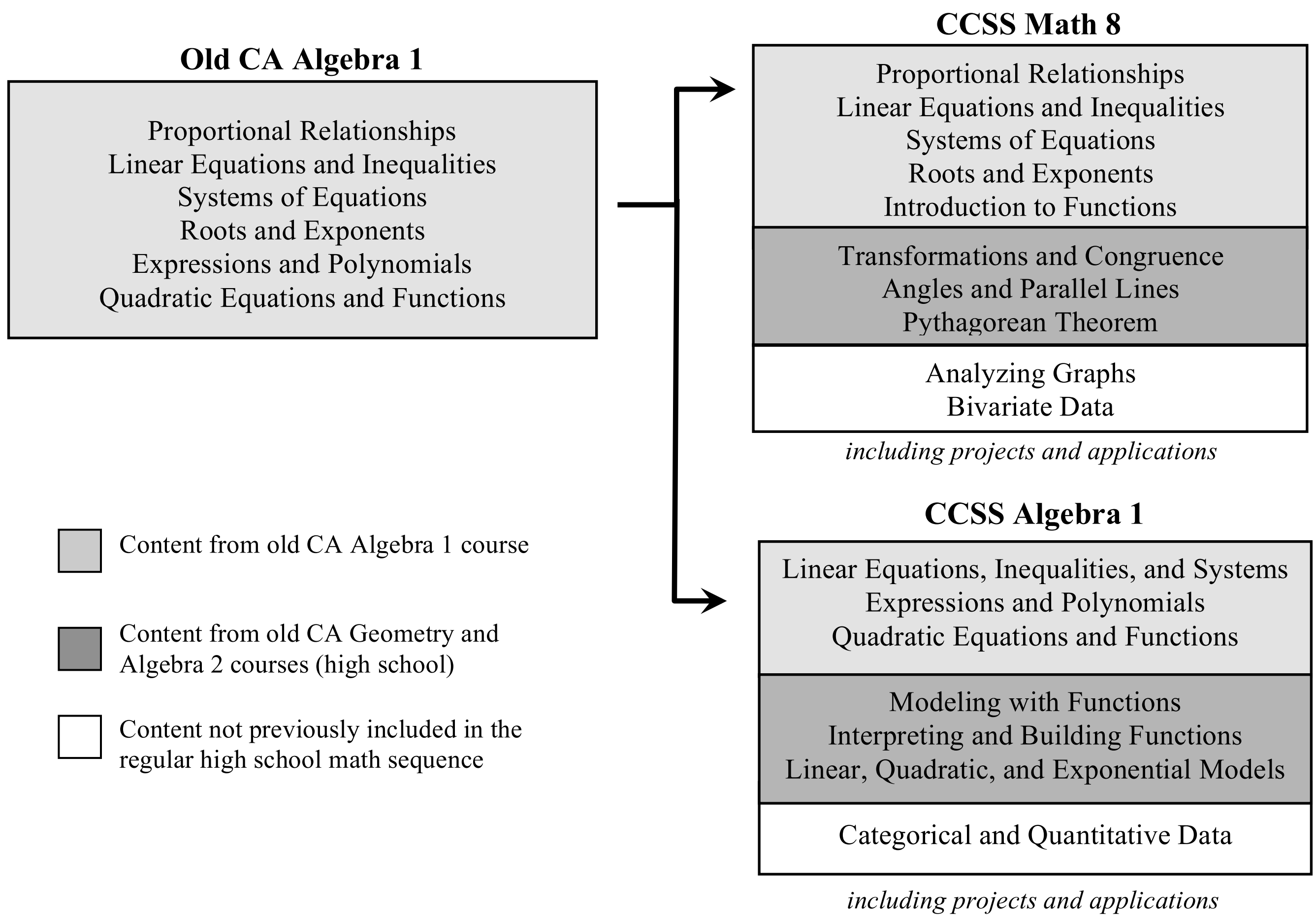
What are the Common Core State Standards?

The Common Core State Standards (CCSS) for Mathematics are a more coherent, focused, and rigorous progression of mathematics learning from Kindergarten through Advanced Algebra.
At the middle school level, they define a three-year course sequence that includes many algebra, geometry, and statistics topics traditionally taught in high school. Each of the middle school courses (CCSS Math 6, CCSS Math 7, CCSS Math 8) contains extensive new mathematics that are critical for student success in all future math courses in high school as well as college.

The Common Core State Standards are the result of a national initiative launched by the National Governors Association and the Council of Chief State School Officers to create unified standards for English Language Arts and Mathematics based on researching the standards of high-achieving countries. They are voluntary for states to adopt, and at this point California and forty-four other states have adopted them.

How do the CCSS Math 8 and CCSS Algebra 1 courses compare to the old Algebra 1 course?

The standards that defined an Algebra 1 course under the old California standards are now divided between the CCSS Math 8 course and the CCSS Algebra 1 course, as shown below. CCSS Math 8 and CCSS Algebra 1 courses also include content from more advanced high school courses and concepts not previously taught in high school math, especially statistics.



Is CCSS Math 8 the same as the old 8th grade Pre-Algebra course?

No. CCSS Math 8 is *much more* rigorous than the 8th grade math courses of the past, and covers many standards that used to be part of Algebra 1. The old Pre-Algebra course primarily reviewed standards taught in earlier grades—fractions, decimals, and percents, ratios and proportions, equations, and geometric measurement—which remain the focus of Common Core courses in earlier grades. CCSS Math 8 is composed of standards drawing from the three major domains: Algebra and Functions (about 65%), Geometry (about 25%), and Statistics (about 10%).

Algebra and Functions (about 65%) Proportional Relationships Linear Equations and Inequalities Systems of Equations Roots and Exponents Introduction to Functions Modeling with Functions
Geometry (about 25%) Transformations and Congruence Angles and Parallel Lines Pythagorean Theorem
Statistics (about 10%) Analyzing Graphs Bivariate Data

Can students skip CCSS Math 8 and go straight into CCSS Algebra 1?

No. CCSS Math 8 introduces extensive new mathematics content and is *not* a course that can be skipped. The content of the middle school course sequence (CCSS Math 6, CCSS Math 7, and CCSS Math 8) is essential for preparing students for *both* CCSS Algebra 1 and CCSS Geometry in high school. The authors of the Common Core developed an intentional vertical connection of algebraic and geometric topics from middle school through high school. CCSS Algebra 1 builds on the content students learn in CCSS Math 8 and *does not repeat* content from CCSS Math 8.

CCSS Algebra 1 is also much more rigorous than the old CA Algebra 1. It assumes students have already worked with linear equations and functions and then extends their study of non-linear functions to include quadratic and exponential functions—topics that were introduced in Algebra 2 in the past. CCSS Algebra 1 also includes a significant focus on statistics and applying algebraic tools to solve complex, real-world problems.

Will students still be able to take AP Calculus in high school?

Yes, by compressing courses in high school. Due to the essential nature of all CCSS courses, students can no longer accelerate in math by skipping a course. The current district plan includes the option to accelerate in high school by compressing CCSS Algebra 2 with Precalculus into a one-year course. The authors of the Common Core generally do not recommend compressing courses in middle school, and *if* so, only for a *very small* number of students who are prepared to take on the demanding workload required to learn the content of two courses in one year.

CCSS Math 8 is designed for students to have time to develop deep conceptual understanding and reasoning around linear functions, solving linear equations, the Pythagorean Theorem, similar shapes, and geometric transformations. In CCSS Algebra 1 and CCSS Geometry, students build on this conceptual foundation to deepen their understanding, work with concepts more abstractly, and apply their understanding to prove algebraic and geometric relationships.

Introduction of "Heterogeneous Classrooms" by Maika Watanabe

Why Should I Care About Detracking? What's Wrong with Tracking?

There are three main problems with tracking. First, research consistently demonstrates that students in lower-tracked classes are not afforded the same quality of instruction as students in higher-tracked classes. They get the least-experienced teachers, they do work that does not exercise critical thinking skills, and they experience low expectations, even from well-meaning teachers (Finley, 1984; Oakes, 2005; Page, 1991). The gaps in skills and content knowledge across tracks grow over time, making movement from low- to high-tracked classes virtually impossible without additional support.

Secondly, the assignment practices are very problematic. Many researchers argue that tracking plays a central role in perpetuating race- and class-based inequality in American society as students of color and/or students from low socioeconomic backgrounds are disproportionately assigned to the lower academic tracks, irrespective of academic achievement (Mickelson, 1999; Lucas, 1999). There are also studies that document how privileged parents use their power to place their children in higher tracks even when these students did not qualify, undermining the pedagogical rationale for tracking (Wells & Serna, 1996).

Third, many researchers question traditional notions of ability and intelligence that underlie the tracking assignments. How can educators assign students to tracks when ability is not fixed, innate, unidimensional, or easily assessed (Oakes, Wells, Jones, & Datnow, 1997)? When should the assignment practice start, and should "late bloomers" be relegated to inadequate educational opportunities in the low track? Research reporting that it is extremely rare for students to move up tracks once they are assigned to the lower tracks compounds the impact of placement decisions (Lucas, 1999).

Defenders say that problems with tracking lie in ineffective implementation. They say that educators need to improve the quality of instruction across tracks and implement fair assignment practices (Hallinan, 1994). Students in my teacher education courses often ask me if I would support tracking if the quality of low-tracked classes was better, and if the assignment practices were fair. My answer: No. It would be better, but it would still result in inequitable instructional opportunities. The hierarchical nature of grouping practices always privileges one group of students over another, and students internalize and meet teacher and peer expectations for student performance. In addition, efforts to improve tracking practices have been tried and more often than not failed in typical public schools.

Why Is Detracking Math and Science Important?

Algebra and Chemistry/Physics Are Gate Keepers to College. Taking algebra in eighth or ninth grades and chemistry or physics before graduating from high school is essential for students to complete the advanced math and science sequence of courses that fulfill college prerequisite requirements. While students in the high track take these courses and continue with an advanced course of study in math and science, less proficient students in the low track often start a math sequence that begins with pre-algebra or other remedial math course and end their high school careers with at best two years of college preparatory math (Burris, Heubert, & Levin, 2004). In addition, these students often do not take more than one year of laboratory science (Blank & Langesen, 2005). This lower-level sequence precludes these students' opportunities to enroll in four-year institutions of higher education, which require at least three years of college preparatory mathematics (Algebra 1, Geometry, Algebra 2) and two years of laboratory science (biology, chemistry, or physics). An especially troubling aspect of this bifurcated curriculum is that Black and Latino students and students from low socioeconomic backgrounds are disproportionately underrepresented in the college-bound sequence of courses (Blank & Langesen, 2005).

Detracking Increases Enrollment in College-bound Math and Science Classes. Researchers report that detracking has led to a dramatic increase in the percentage of students successfully completing the college-preparatory math and science sequence of classes at the high school level with gains for all groups of students—including initial low and high achievers as well as

Table 1.1. Groupworthy Task Features in Teachers' Lessons

Groupworthy Task Features	Physics of Music	Perimeter Challenges	The New Swimming Pool	Inter-molecular Forces
Big Idea	X	X	X	X
Multiple Ability	X	X	X	X
Open-Ended	X	X	X	X
Interdependence	X	X	X	X
Individual Accountability		X	X	X
Assessment	X	X	X	X

Figure 1.1. Features of a Groupworthy Task

Big Idea: Is the organizing concept or big idea—a big idea indeed? How do you know? How central is the concept to the discipline?

Multiple Abilities: Do the resources incorporate multiple representations/ways of understanding/ways of presenting information? Is there a tight connection between the resources and the activity? What are the multiple intellectual abilities called upon to access and/or to complete the task?

Open-endedness: What is the problem to be solved in the activity? Is there a right or wrong answer, or an "expected" answer? (Is the answer "It depends?") Are there different ways of arriving at a possible solution?

Interdependence: Is there enough to do for a group? Is the activity rich and complex? Is there a group product? What is the relationship between the group product and the discussion questions? What is the relationship between the group product and the resources? Are there group data collected among members? How is the group discussion essential for producing a quality product?

Individual Accountability: Are individual reports included in the activity? Are they tightly connected to the activity and/or to the big idea/central concept? How will the group discussion become critical for a student completing the individual report?

Assessment: Are there clear evaluation criteria for group product and group process? How are they stated? How will you assess what students are learning as they complete this activity?

Source: Lotan, R. (2007). [Features of a Groupworthy Task.] Unpublished Handout.

students of diverse racial and socioeconomic backgrounds. Burris, Heubert, and Levin (2006) offer compelling research evidence that detracking helps all students. In a 6-year longitudinal study of students in the Rockville Centre School District in New York, these researchers compared the math achievement of three sixth-grade cohorts who learned math in a tracked setting with three sixth-grade cohorts who learned in a detracked setting. They report a statistically significant increase in the percentages of students who took math courses beyond Algebra 2 in high school for every subgroup: students from low socioeconomic backgrounds (32% to 67%), Black and Latino students (46% to 67%), initial low achievers (38% to 53%), average achievers (81% to 91%), and high achievers (89% to 99%). The mean standardized test scores of high-achieving students who learned in the detracked setting were statistically indistinguishable from comparable students learning in the tracked environment. In addition, more high-achieving students who learned in the detracked environment took the AP Calculus exam and scored higher than their counterparts in the tracked environment. These results led these researchers to conclude that not only are high-achieving students performing better in mathematics, but that more students have become high achievers.

Dr. Carol Burris, scholar and visionary principal of South Side High School, and her dedicated team of teachers and administrators gradually expanded the school district's detracking efforts across different subjects at the high school level. The year-of-entry 2001 cohort was the first cohort to be heterogeneously grouped in all subjects, including math and science, in the ninth grade. During the 2005–2006 school year, heterogeneous grouping was extended into the tenth grade. Burris, Welner, Wiley, and Murphy (2008) compared three tracked cohorts with three detracked cohorts in their attainment of two diplomas (International Baccalaureate and New York Regents) that require rigorous course-taking and assessments far beyond those required for the local high school diploma. Most 4-year universities recognize International Baccalaureate (IB) courses as equivalent to or exceeding Advanced Placement (AP) coursework. Racial and socioeconomic demographic data remained stable across this time period. The researchers found that

> being a member of a detracked cohort was associated with an increase of roughly 70% in the odds of IB diploma attainment and a much greater increase in the odds of Regents diploma attainment—ranging from a three-fold increase for White or Asian students, to a five-fold increase for African American or Latino students who were eligible to receive free or reduced price lunch, to a 26-fold increase for African American or Latino students not eligible for free or reduced-price lunch. Further, even as the enrollment in IB classes increased, average scores remained high. (Burris et al., 2008, p. 572)

Detracking led to an increase in the numbers of students overall who successfully completed advanced-level high school classes, and who thereby fulfilled or exceeded 4-year university admission requirements. Subsequent research into the Class of 2009, which was the first detracked cohort in all subject areas through the end of the tenth grade, showed that 85% of the students elected to take IB English and IB math (Garrity & Burris, 2007). The approach of school-level leaders in the district was more rigor with support, not remediation through tracking.

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