Rethinking Middle School Math Acceleration

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i-Ready Classroom Mathematics

For many years, school districts have been offering options to accelerate students through middle school mathematics.

These options often include skipping grades or combining the standards from multiple grades into compressed courses. Even with the change to college- and career-ready standards, many school districts have continued to offer the same acceleration options without asking themselves if they need to be adjusted in the context of more rigorous standards—or if the accelerated courses are working.

Throughout this paper, we will examine the research and best practices for middle school mathematics. We will also follow the journey of Oregon's Springfield Public Schools, a much-studied district that examined its acceleration practices and took bold steps to enact changes that led to improved student learning and greater preparedness in math.

Middle School Acceleration: One District's Results

In 2017, members of Springfield Public Schools attended a Curriculum Associates presentation to rethink acceleration practices that started the educators on a journey to change the paradigm in the district. Although everything seemed fine with their accelerated mathematics program, a closer look at the district's data painted a very different picture. Springfield was shocked to find that Grade 6 students who had been accelerated in a compressed 6–7–8 course were not taking math classes as juniors or seniors in high school.

Having earned enough math credits for graduation, students stopped math learning after their sophomore year. Furthermore, the accelerated course was only available at one of the district's four middle schools, raising questions of equity. The other three schools were accelerating students via "skipping" a grade level to get to Algebra I in Grade 8. Not surprisingly, the district found that these students also did not continue accelerated paths in high school.

Like many districts across the nation, Springfield offered acceleration options in middle school to enable students to take high school courses in Grade 8—the idea being that when students stay on the accelerated path through high school, they can take the college-level course of AP Calculus I (AB), as shown in Figure 1.

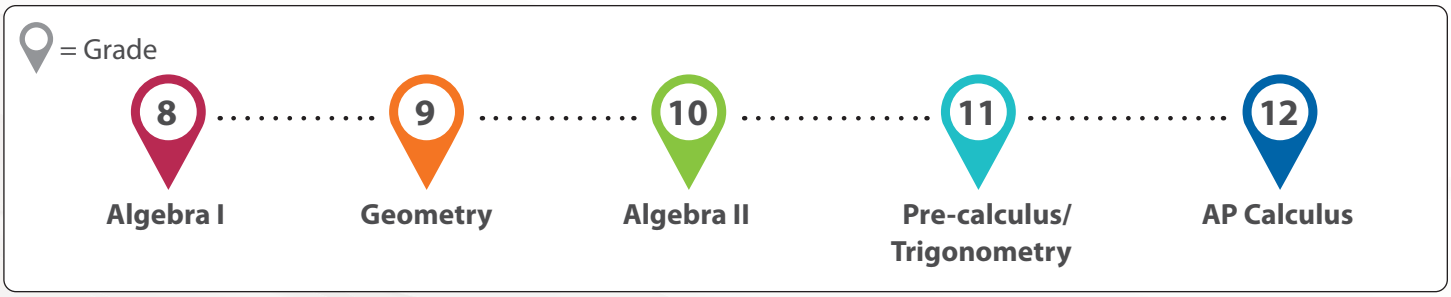
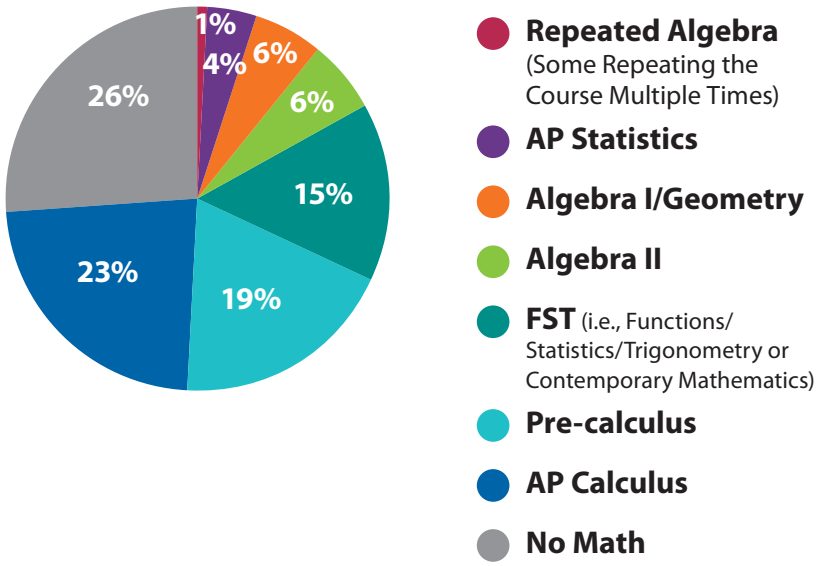


Figure 1. Acceleration in middle school was created to allow students to take an advanced course in high school.

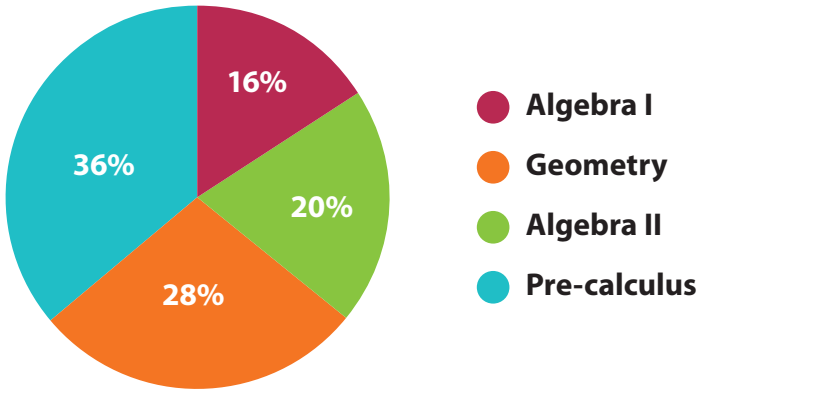
Springfield was shocked to find that Grade 6 students who had been accelerated in a compressed 6–7–8 course were not taking math classes as juniors or seniors in high school.

Figure 2. High School Trajectory of Grade 8 Students in Geometry, Springfield Public Schools, Oregon (2017)

Senior Year:



Regularly Repeated Classes by Accelerated Students:



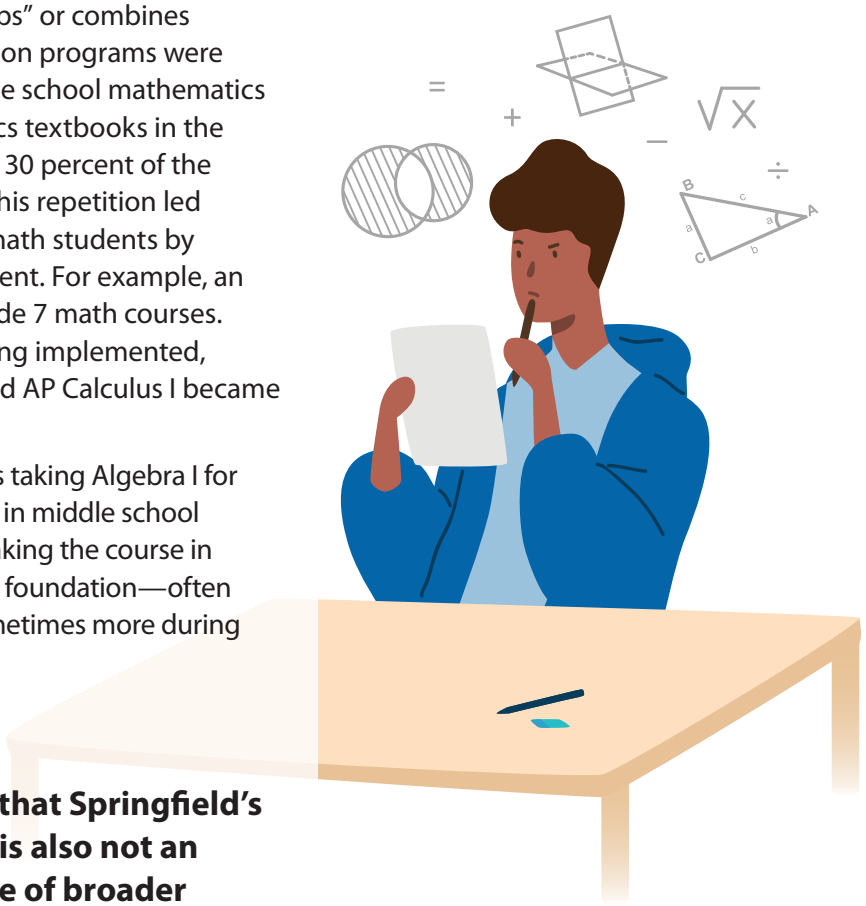
Another Springfield course that compressed the standards for Grades 6–8 into one year opened a pathway for students to take a second year of Calculus (i.e., Calculus II) in their senior year. However, this is not what was happening. When district officials looked at the data (see Figure 2), they realized that many students had fallen off the accelerated path, with 44 percent of students repeating Algebra I and Geometry. Rather than enroll in AP Calculus I or II, a higher percentage of students decided they would not take any math course at all in their senior year.

Research shows that students who take no math course at all in their senior year or who repeat lower-level courses are at risk for needing remedial math in college (Achieve, 2013 in NCTM, 2018). Springfield realized that by accelerating students who were once mathematically strong, it was not only negatively affecting students' attitudes toward mathematics, but it was also hindering their success in high school and college mathematics.

The Effects of Middle School Acceleration on Students' Success in High School and College Mathematics

An acceleration program like Springfield's that "skips" or combines grades is not uncommon. These types of acceleration programs were put in place prior to 2010, when much of the middle school mathematics curriculum was repetitive. In a study of mathematics textbooks in the 1980s, it was estimated that by Grade 8 only about 30 percent of the material contained new content (Flanders, 1987). This repetition led schools and districts to often accelerate stronger math students by allowing them to skip or combine grade-level content. For example, an incoming Grade 6 student was often placed in Grade 7 math courses. With local and state policies of "Algebra for all" being implemented, completing Algebra I in Grade 8 became a goal, and AP Calculus I became the desired senior-year course.

The results of multiple studies suggest that students taking Algebra I for the first time in Grade 9—having a solid foundation in middle school mathematics—are more successful than students taking the course in Grade 8. The accelerated students have a less stable foundation—often repeating Algebra I at least once in Grade 9 and sometimes more during their high school years.



Several large longitudinal studies show that Springfield's tale of middle school math acceleration is also not an isolated story. Rather, it is representative of broader national trends:

- The National Assessment of Educational Progress (NAEP) **math scores for Grade 8 from 2000 to 2007 show growth in every group except those students who were accelerated** (Loveless, 2008).
- As more students were placed into Algebra I courses in Grade 7 or 8, **the pass rates of Algebra I declined, and the students were significantly less likely to pass Geometry and Algebra II** (Clotfelter, 2012).
- **44 percent of Grade 8 students who took traditional Algebra I had to repeat it** with mixed results in improvement among groups (Fong, Jaquet, & Finkelstein, 2014).
- **30 percent of the students in a large California study had to retake Algebra I at some point between Grades 7–12** and made very little improvement in proficiency the second time. When students take Algebra I is less important than whether they are ready to take it. (Finkelstein, Fong, Tiffany-Morales, Shields, & Huang, 2012).

Springfield realized that by accelerating students who were once mathematically strong, it was not only negatively affecting students' attitudes toward mathematics, but it was also hindering their success in high school and college mathematics.

The more rigorous and coherent national and state college- and career-ready standards provide an opportunity for school districts to investigate their acceleration practices and their effect on students. Unlike the repetitive nature of middle school standards prior to 2010, the college- and career- ready standards are built on progressions of learning, and instruction based on the standards at one grade level is not repeated in another grade level. The critical topics of ratios and proportional reasoning addressed in the standards for Grades 6 and 7 provide a good example of a "progression." In Grade 6, students develop an understanding of unit rate and then extend that learning in Grade 7 as they think of a unit rate as a constant of proportionality. Students in Grade 8 use this understanding of unit rate to define the slope of the graph of a proportional relationship.

This progression, shown in Figure 3 on the next page, leads to the high school Functions standard HSF.LE.A.1, in which linear relationships have a rate of change of "equal differences over equal intervals." These middle school standards also impact Geometry understanding of trigonometric ratios (CCSS, 2010). The topics in each grade build to develop a foundation for topics in Algebra. Skipping these or racing through these topics in an accelerated pathway does not provide the coherence of learning that will help students have the foundations to be successful in mathematics. If a student skips Grade 6 or 7, or if exposure is "compressed" to the point where there is not enough time to develop understanding, the important trajectory of learning toward Algebra, Geometry, and Pre-calculus/Trigonometry is disrupted and compromised. In a 2016 position statement, NCTM warned that "no critical concepts be rushed or skipped" when considering opportunities for acceleration.

Access and Equity

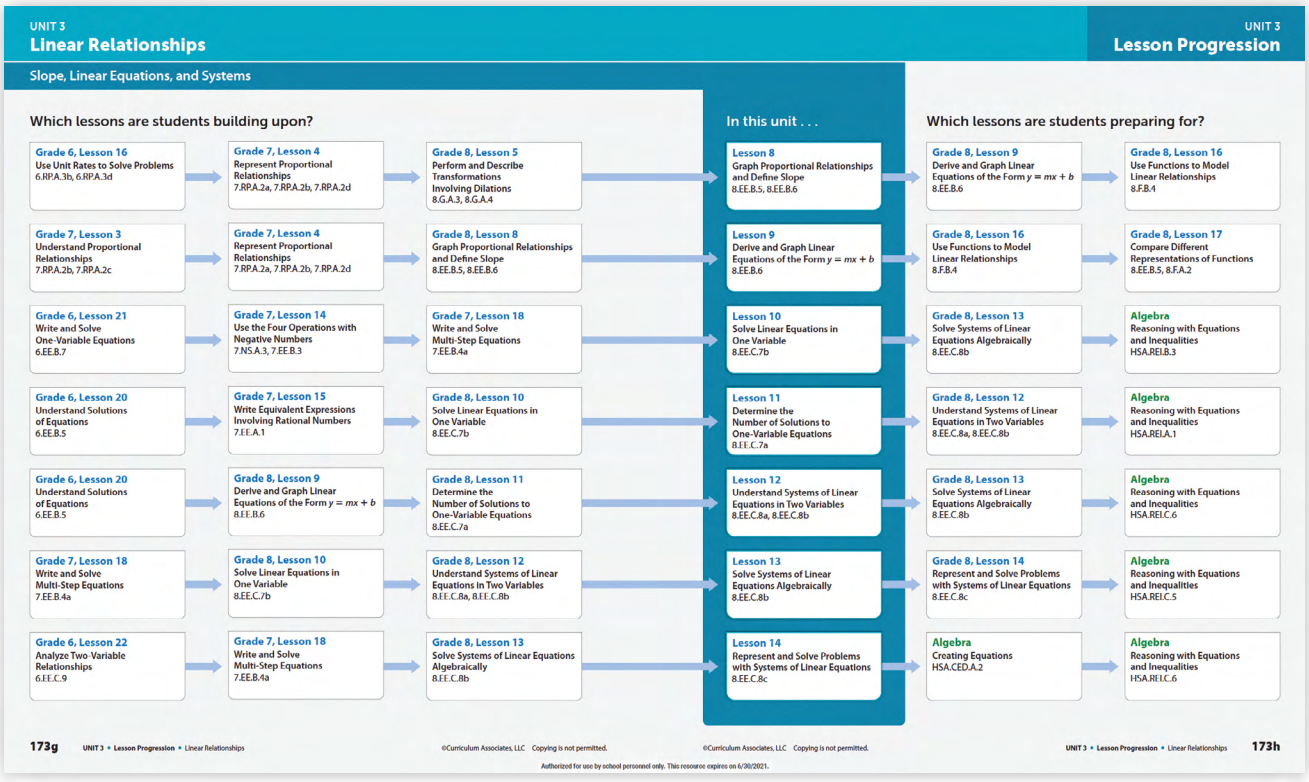
Pushing students to take Algebra I in middle school and Calculus in high school has contributed to inequities (NCTM, 2018; 2020). When high numbers of students are accelerated into a course that they are not prepared for, it harms not only those students, but also the students who are in the "regular" class. For example, if an acceleration policy has 50 percent of students taking an "accelerated" math course, this inadvertently creates a more homogeneous "regular" class of the "lowest" 50 percent with limited access to rigorous learning. This is one reason why accelerating high numbers of students is not recommended (NCTM, 2020).

Policies that omit acceleration or limit it to a small percentage (i.e., 10–15 percent) of students will improve access and equity for all students. Despite fears that de-tracking will harm students, studies show the opposite. When students are de-tracked in middle school, all student groups perform better in high school—even the high achievers (Boaler, 2000). Several recent studies show that successful students do just as well in de-tracked settings as they had in tracked settings, and all students in more equitable mathematics programs benefit (NCSM, 2019). All students benefit from seeing multiple strategies, engaging in mathematics discussions with peers, and defending their thinking and justifications.

Middle school concepts and number sense are cited by professors as being the most needed for success in college mathematics courses (ACT, 2012). As Finkelstein et al. point out, "doing well in seventh grade math is highly predictive of enrollment in more advanced courses in high school" (2012).

A solid foundation in middle school mathematics and Algebra I better prepares a student to take an advanced course (i.e., beyond Algebra II) in high school, improving their likelihood for success in four-year college-level courses (ACT 2009; 2012). A lack of a solid foundation results in gaps in learning and requires remediation when entering college. Nationally, about 40 percent of first-time postsecondary students across the country enroll in remedial mathematics courses (US Department of Education, 2012; Chen, 2016).

Figure 3. Concepts are no longer repeated in middle school, but rather the concepts build upon one another, as shown in this progression of work with unit rate, constant of proportionality, and slope.



A Path toward Change

Springfield Public Schools administrators sprang into action when they saw the dismal results of their analysis in 2017. District leadership created an Acceleration Advisory team and used the guide for **Analyzing and Rethinking Acceleration Practices** (see Resource B on page 14) to take steps in revising their program. The Acceleration Advisory team met regularly to review data, share data with their constituents, and bring ideas back to the Advisory team to formulate a plan. Based on data they reviewed, they made five key decisions:

1. **Eliminate the compressed course combining standards from Grades 6–8.** The principal of the middle school, Brandi Starck, commented that the community of parents and teachers did not push back on this decision because she was able to show them the data that only 50 percent of students were staying on this track in middle school, and a very small percentage of students were reaching upper-level courses in high school. As a parent of students who had been in the accelerated course, Starck said she had watched her own children's confidence and love of math wane as they progressed through high school. She had first-hand experience in the necessity to alter the district's acceleration program.

2. **Eliminate any acceleration in Grades K–5 (including Talented and Gifted (TAG) students, except in very rare situations).** The TAG representative worked with elementary teachers to deepen students' understanding of grade-level content, rather than move into content that would be taught in the next grade level.

3. **Develop middle school courses that do not skip or compress standards.** In 2019–2020, the Springfield Acceleration Advisory team developed a course of study that included all of the standards and still allowed students to take Algebra I in middle school.

4. **Use Diagnostic data and state assessment results to determine which students belong in accelerated courses.** Instead of only using teacher recommendations, the Advisory team used *i-Ready Diagnostic* data, Smarter Balanced test results, and the students' willingness to do the advanced work to identify who should enroll in the accelerated courses.

5. **Limit the number of students enrolled in accelerated courses.** In Springfield, the enrollment in the accelerated courses was limited to only 10–15 percent of the students.

As a result of redesigning acceleration in this way, Springfield's math students now have a higher course completion rate than with previous acceleration practices. Within two years, all four middle schools were using the same data-driven criteria to determine which students to accelerate, and in 2020–2021, all four middle schools had the same acceleration option.

The work of the Springfield Acceleration Advisory team is not done. Future work will include addressing the new high school standards, de-tracking high school courses, and looking at different acceleration options that will include college- and career-focused pathways such as Quantitative Math, Statistical Math, and Calculus (McKinley, Starck, & Pifer, 2020).

The Process for Rethinking Middle School Acceleration

It's important for districts to use data and research results to help ensure the best mathematical success for their students, particularly those being accelerated in middle school. This section provides a process for analyzing data to determine if your district should rethink some or all of its middle school math acceleration practices.

Step 1

Bring together an advisory group that includes representation from key stakeholders, including middle school math teachers and principals, high school math teachers and principals, elementary and middle school gifted teachers, high school counselors, and parent/family members or a family liaison.

Step 2

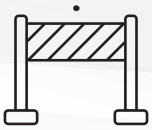
Look at longitudinal data. Are students in the accelerated middle school program taking accelerated courses in high school? Do they take four years of math in high school? What percentage of students are repeating at least one mathematics course in high school? What percentage of students are taking Calculus I in high school? If a significant percentage of students are repeating courses, not taking four years of math in high school or falling off this track, it is time to rethink acceleration practices.

Step 3

Design pathways that offer choices desirable to stakeholders and create placement criteria that makes selection more objective (see the Alternative Acceleration Practices in Resource A on page 11). Consider changing the name of an honors course to a name that more accurately describes the nature of the course. For example, in a course called "Math 7 Plus," the students would be expected to do all the Grade 7 standards plus a significant amount of Grade 8 standards.

Step 4

Create a multiyear rollout plan, including a communication plan to all stakeholders.



Why the Rush?

A solid K–8 foundation in mathematics is critical, yet it is often compromised in the rush to Calculus. Only about five percent of the working population uses Calculus regularly, yet many parents and educators consider it important for their students to take this college-level course in high school—even if it means skipping or compressing learning (NCEE, 2013). It is difficult to justify this approach when looking at high school longitudinal data and college enrollments. Although there has been a dramatic increase in the number of students in high school Calculus, enrollment in Calculus II at college has remained relatively unchanged (Bressoud, 2004; 2009). Many students who have taken Calculus in high school are arriving unprepared for Calculus in college, and studies show that most students who take AP Calculus in high school do not go on to take a second Calculus course in college (Rosenstein, 2014; Bressoud, 2016).

In a large study of 14,000 students in 213 colleges, high school students who scored less than a 3 on the AP Calculus exam had the same grade distribution as students who were taking Calculus for the first time in college. Rushing unprepared to a high school Calculus course showed no benefit (Bressoud, 2015). A survey of college professors found they would rather have students with a solid foundation in number sense, statistics and pre-Calculus (Peyser, Schrock, Martinie, 2018). In a joint statement made in 2012 by the NCTM and the Mathematics Association of America, the goal of K–12 mathematics should not be to get students to Grade 12 Calculus, but rather to be college and career ready. Yet sadly, the students who are rushed through mathematics content without a deep understanding are the very ones who drop out when they have the chance (Boaler, 2016 in NCTM, 2018).

Alternative options such as AP Statistics and high school courses aligned with career goals will remove the misguided rush to Calculus so K–8 learning is not compromised. College admissions vary, but most colleges require three or four years of mathematics from a list of acceptable high school courses. K–12 mathematics should be opening doors for further study, rather than hampering choices. In fact, in a 2016 statement by the University of California school system, the Board of Admissions and Relations with Schools "strongly urges students not to race to Calculus at the cost of full mastery of the earlier math curriculum." Acceleration policies and courses that nurture the development of K–8 mathematical knowledge are critical (Johnsen & Sheffield, 2013).

"Having the data from i-Ready that shows exactly where our students are mathematically has made conversations with parents much easier. It is hard to argue that your eighth grader should be accelerated when they are consistently testing at a seventh grade level."

—Erica Pifer, Secondary Mathematics Teacher on Special Assignment, Springfield Public Schools

Conclusion

Many students who are placed in accelerated programs do not end up taking advanced math in high school as intended. In fact, many repeat courses or take remedial courses in college. As a result, we need to be more judicious in deciding which students are placed in accelerated middle school math sequences and rethink whether middle school acceleration should be done at all.

Data from school districts around the country, such as that shared by Springfield, indicate that accelerating students through the middle school curriculum does not always have positive results. Frequently, students develop negative attitudes toward mathematics, need to repeat high school math courses, and stop taking rigorous math courses prior to their senior year.

The idea of middle school acceleration was formulated when the curriculum in Grades 6–8 contained only 30 percent new content (Flanders, 1987). With college- and career-ready standards, the curriculum contains 100 percent new content, including key Algebra concepts and foundations for success in future courses. Skipping or rushing through this content is no longer recommended for most students.

Districts need to take time to analyze the data for students participating in middle school acceleration programs and rethink their middle school acceleration practices to bring them more in line with college- and career-ready expectations. We need to change the mindset of educators and people in the community about large numbers of students taking Algebra in Grade 8, often with the goal of taking Calculus in high school. These practices require acceleration that compromises the coherence of the mathematics curriculum and does not give students appropriate foundations for mathematical understanding and future success. This has led to high percentages of students taking less math in high school and higher enrollments in remedial math courses in college. Shifting the focus to maintaining the coherence in the curriculum will allow for the development of courses that provide the right mathematical foundations to allow all students to be college and career ready.

Resource A

Alternative Acceleration Practices

There are several alternatives to current middle school acceleration practices. Here are some options to consider.

Options for Eliminating Acceleration in Middle School

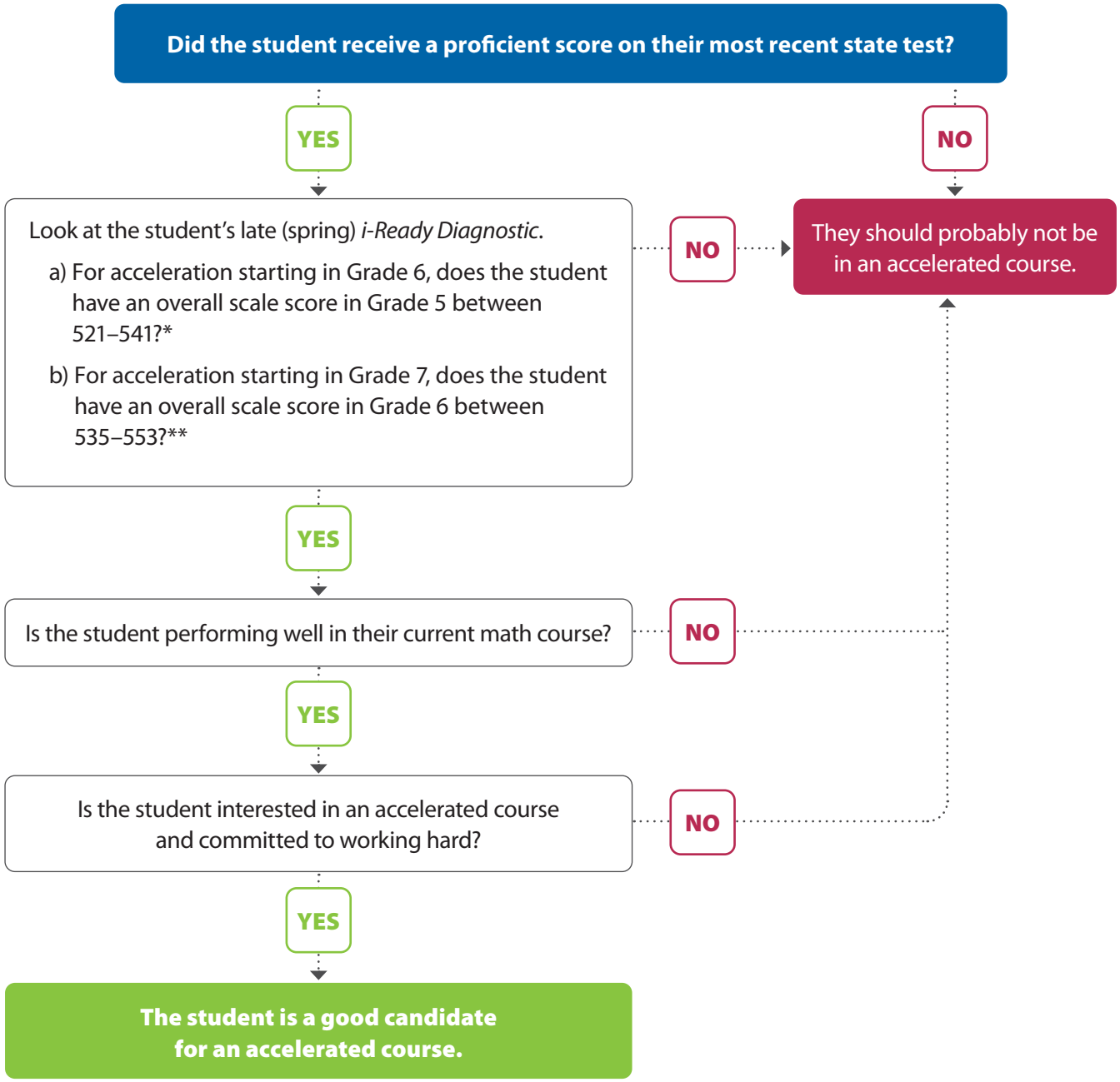
1. Delay acceleration by offering a rigorous middle school curriculum that equally emphasizes conceptual understanding, problem solving, and procedural fluency.
2. Consider high school options from Appendix A of the CCSS (CCSS Initiative, 2010). One solution is for students to take two math courses, such as Geometry and Algebra II, concurrently.
3. Consider creating compacted courses in high school. High school courses are built with standards from conceptual categories, not by grade level like the Grades K–8 standards. Districts can build courses that meet all the standards in any way they choose. They could build an accelerated high school pathway of courses that compacts the standards in a way that leaves the fourth year for AP Calculus, Statistics, or other courses.
4. Consider offering AP Statistics. It is a very useful college-level course that does not require compromising the integrity of Grades K–8 mathematics.

Considerations When Offering Accelerated Middle School Courses

1. While Appendix A of the CCSS does not recommend compacting below Grade 7, it does offer a pathway that combines 70 percent of Grade 8 standards into a Grade 7 course, and the other 30 percent of the Grade 8 standards into an Grade 8/Algebra I course. This is referred to as a "3–2 compaction"—students will have completed three courses of standards (i.e., Grade 7, Grade 8, and Algebra I) over two years of time.
2. Accelerated courses generally cover 1.5 times the amount of math content in a typical class period. As a result, enrollment in accelerated courses must be limited to a small percentage of students. Using questions like those in the Placement Criteria Questionnaire (see Figure 4 on the next page) can help determine whether middle school math acceleration is appropriate.
3. Evaluate students' success in accelerated courses early in the sequence. Identifying struggling students and moving them to a parallel non-accelerated course will be paramount to helping them develop a coherent understanding of mathematics. Questions to consider after a unit or two of the accelerated sequence are shown in the Continuation of Acceleration Questionnaire (see Figure 5 on page 13).
4. Unlike previous years, the middle school standards include topics that were previously taught at higher grade levels, which means the courses are already "accelerated" (Peyser, Schrock, & Martinie, 2018). Communicate the challenging nature of the middle school standards to parents, students, and others in the community. The examples below can be used to illustrate some of the content shifts.
   - Topics formerly only taught in Algebra I are now taught in Grade 8, including the concepts of slope, functions, systems of equations, and statistical analysis of scatter plots, to name a few.
   - Topics considered "pre-Algebra" are now part of the Grade 7 standards: computation with signed numbers and solving multi-step equations, including variables on both sides.
   - Fraction computation is predominantly mastered in elementary grades, not in middle school.

Figure 4. Placement Criteria Questionnaire

Questions to Consider **before** Placing a Student in an Accelerated Middle School Mathematics Course

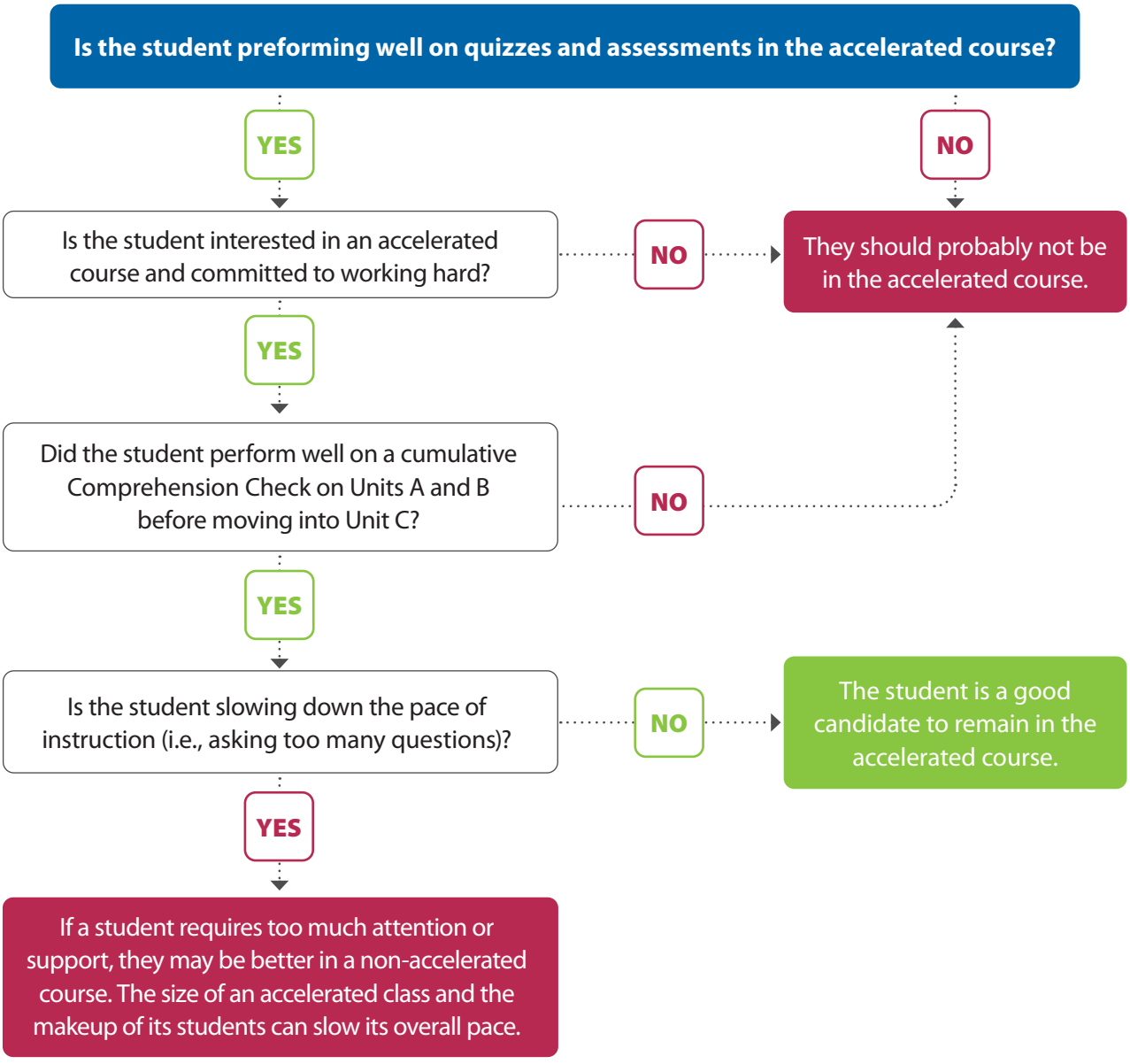


*A scale score of 521 at the end of Grade 5 will include the greatest number of students, a scale score of 527 is standard, a scale score of 534 will be more exclusive to who is in the course, and a scale score of 541 will result in the fewest number of students in an accelerated course starting in Grade 6.

**A scale score of 535 at the end of Grade 6 will include the greatest number of students, a scale score of 541 is standard, a scale score of 547 will be more exclusive to who is in the course, and a scale score of 553 will result in the fewest number of students in an accelerated course starting in Grade 7.

Figure 5. Continuation of Acceleration Questionnaire

Questions to Consider When Deciding Whether a Student Should **Stay** in an Accelerated Middle School Mathematics Course



Resource B

Analyzing and Rethinking Acceleration Practices

Create an Advisory Committee

Recommended representation should include middle school and high school math teachers, principals, curriculum departments, elementary TAG educators, high school counselors, and parent liaisons.

Gather Your Data

Gather the following information for as many years as possible for students who have participated in middle school acceleration courses in your school/district. You may need to work with the high school to access some information.

- What math courses have students taken from middle school through high school?
- What grades did accelerated students get in their math courses, including high school courses?
- What was the highest level of math course taken (for those who have completed high school)?
- What does student data from the *i-Ready Diagnostic* for Mathematics indicate about students' level of proficiency overall, by domain, and by growth?
- How many students in your school/district are currently taking accelerated mathematics courses in middle school? How are they performing?
- What are students' attitudes about mathematics? Consider interviewing students who participated in an accelerated sequence about their confidence in and feelings about mathematics. On a scale of one to 10, how strongly do they like math? (Include high school students who participated in accelerated middle school courses.)

Analyze Your Data

- What is your data telling you about the math courses students have taken?
- What do students' grades in those courses tell you about their mathematical understanding?
- What percentage of students are taking Calculus in high school? What percentage of students is taking less than four years of mathematics? What percentage of students are taking less rigorous mathematics courses?
- What does your Diagnostic data indicate about students who participated in an accelerated program? Has their level of mathematical knowledge and understanding increased at expected rates?
- Is there any data for special groups of students that should be analyzed?
- Based on your data, do you think your acceleration practices need to be examined further and/or changed? If students are staying on the accelerated path through high school and completing AP Calculus I, there is probably no need to change direction. However, if a high percentage of students are falling off this track, it is time to change.

Examine Acceleration Practices

- What other options for acceleration are there besides accelerating in middle school? Look at the recommendations for acceleration in CCSS Appendix A and the Alternative Acceleration Practices in Resource A (found on page 11).
- What criteria do you currently use to determine which students take accelerated courses? Should that be revised to be more exclusive? (See Figure 4 on page 12.)
- Design pathways that offer choices desirable to stakeholders. Consider changing the name of an honors course to a name that more accurately describes the nature of the course, such as "Math 7 Plus." In this course, students are expected to do all the Grade 7 standards plus a significant amount of Grade 8 standards.
- If you eliminate or significantly decrease participation in middle school acceleration courses, what impact does that have on course offerings and enrollments in both middle school and high school?
- Is it possible to offer doubling-up options in high school, where the students might take a concurrent second math class as an elective?
- Will students who have already started in your current acceleration program continue that path, or will you make modifications to their course sequence?
- Create a multiyear rollout plan, including a communication plan to all stakeholders.

Communicate Your Findings and Plan

- Who are the stakeholders who should be included in receiving this information? Are there any program leaders who need to be included?
- When and how will you share the data with stakeholders (e.g., principals, teachers, and parents)?
- What is the best way to display the information?
- What research, such as the sources in this paper, will help you share information with stakeholders?

Roll Out and Communicate Course Changes

- What will be the phases of your "rollout"?
- How will all phases of the rollout be communicated?

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Elizabeth Peyser is a national director of content and implementation at Curriculum Associates. She specializes in training K–12 educators to interpret progressions in the mathematical standards. Prior to her current position, Liz was vice president of the Kansas Association of Teachers of Mathematics, a K–12 math coordinator for Wichita Public Schools, and a trainer for the Kansas State Department of Education. During Kansas's transition to the Kansas College and Career Ready Standards, Liz developed math clinics for teachers that became the statewide training program. She has been a frequent speaker at NCTM and NCSM conferences.

Danielle Curran

Danielle Curran has more than 30 years of experience working in mathematics education. As Curriculum Associates' associate vice president of mathematics instruction and implementation, she is committed to supporting educators in using effective and equitable teaching practices that engage all students in meaningful discourse and deeper learning. Over the course of her career, Danielle has taught mathematics to students ranging from preschool to college age, and she has had opportunities to work with some of the top leaders in mathematics education in the United States and in Singapore. Danielle obtained her original teaching certificate and bachelor's degree in mathematics from the University of Michigan and is an avid Michigan football and basketball fan. She holds a dual master's degree in mathematics and curriculum and instruction from Boston College. She is a frequent speaker at regional and national conferences, including NCTM conferences.

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