



RE-THINKING MATHEMATICS ACCELERATION PRACTICES

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Introduction

The landscape in K-12 mathematics has changed with the advent of new standards, new expectations and new research. This necessitates a response by educators to ensure that students are receiving a complete and viable curriculum, while allowing for options to meet the needs of all students. The importance of *uncompromised K-8 mathematics* cannot be overlooked, and the idea that acceleration calls for skipping standards must be eliminated. All college and career decisions have a basis in K-8 mathematics understanding. Schools and districts must review current mathematics acceleration practices to prevent gaps in learning. Furthermore, districts must ensure access to all concepts and skills within the Kansas College and Career Ready Standards for Mathematics (KCCRSM) in order to provide a solid mathematics foundation for all students.

The development of the KCCRSM began with research-based learning progressions detailing what is known today about how students' mathematical knowledge, skill, and understanding develop over time. The KCCRSM have been designed to provide focus (attending to fewer topics in greater depth), coherence and rigor. The structure of the standards is streamlined to form coherent trajectories of learning from grade to grade, and students attend to rigorous mathematics through a balance of conceptual understanding, procedural fluency and meaningful applications (Kansas College and Career Ready Standards for Mathematics, 2010). In this new landscape of mathematics, these three shifts dictate a change in approach to acceleration, in order to provide students a comprehensive mathematics education.

History to Current Reality

In the latter half of the twentieth century the primary purpose of junior high schools was to prepare students for high school. In elementary school, mathematics content was regularly repeated across grade levels. In addition, most of middle school mathematics was a repeat of elementary school mathematics with the percent of new material decreasing each year through eighth grade. In a study of mathematics textbooks in the 80's, it was estimated that by 8th grade only about 30% of the material was new content (Flanders, 1987). As a result of the repetition it became common practice to accelerate students to traditional Algebra 1 by skipping the 7th or 8th grade mathematics course. This no longer makes sense as our current standards are designed to build from one grade level set of standards to the next (Common Core Standards Writing Team, 2013). Therefore, if students are accelerated in middle school by skipping grades they will miss major content and building blocks necessary for success in higher level mathematics.

Previously, rigor was misinterpreted as doing higher grade-level mathematics at earlier grades. In reality, the expectation to balance conceptual understanding, fluency and application is lost when students independently forge ahead. According to a survey by ACT (2012), topics from middle school and Algebra 1 are rated as more important by college faculty than advanced topics for college preparation. Thus, there is a necessity for students to take the time needed to master fundamental number, algebra, and geometry topics addressed in the middle school level standards, with a depth of understanding and the ability to communicate this understanding.

Furthermore, teachers at the secondary level often assume they need to cover a broad range of topics in advanced mathematics courses, while teachers at the post-secondary level are more concerned that high school students receive a rigorous and in-depth coverage of the fundamental mathematics topics such as number sense and algebra (Chait & Venezia, 2009). A solid foundation in middle school mathematics and Algebra 1 better prepares a student to take an advanced course (beyond Algebra 2) in high school, improving their likelihood for success in 4-year college level courses (ACT 2009; 2012). Course offering aside, the absence of focus on mathematical understanding or inconsistency in the level of rigor still leaves students ill-equipped for the challenge of college mathematics (ACT, 2005).

In light of these shifts in the mathematics landscape, retaining the status quo of current acceleration is not working. Research supports *delaying acceleration in mathematics until high school*. When students were de-tracked in middle school, all student groups performed better in high school, even the high-achievers (Boaler, 2000). The National Assessment of Education Progress (NAEP) of 8th grade math scores from 2000 to 2007 show growth in every group except those students who were accelerated (Loveless, 2008). Research indicates prior to the adoption of new standards, as more students were placed into a 7th or 8th Algebra 1 course, the pass rates of Algebra 1 declined and the students were significantly less likely to pass Geometry and Algebra 2 (Clotfelter, 2012). In another study 44% of 8th graders who took traditional Algebra 1 had to repeat it with mixed results in improvement among groups (Fong, et al, 2014). In a third study, 30% of student sample had to retake Algebra 1 between the 7th and 12th grade, with very little improvement the second time (Finkelstein, et al, 2012). These studies suggest that students taking Algebra 1 as a 9th grader with a solid foundation would be more successful than students taking the course as an 8th grader with a shaky foundation and repeating it as a 9th grader.

Data from a large urban Kansas district mirrors the results of these studies. Of the approximately 30% of 8th graders that were accelerated to Algebra 1, only one-sixth of the students accelerated were in Calculus four years later. Over 80% of the accelerated students were repeating Algebra 1, Geometry or Algebra 2 in their senior year, or were not taking a 4th year mathematics course. Not taking a 4th year of math puts a student's college success at risk (ACT, 2012), these students had not only fallen out of the accelerated path, but the path toward college mathematics altogether.

Another push in education over the past couple decades has been the race to Calculus and the belief that this path is necessary for a student to succeed in advanced math courses in college. 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 for the last two decades (Bressoud, 2004; 2009). Many students who have taken Calculus in high school are arriving unprepared for Calculus in college (Bressoud, 2007). According to a study at Rutgers University, only 5.4% of students who take a high school Calculus course followed with Calculus 2 in college (Rosenstein, 2014). Studies inform 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, 2007).

Middle school concepts and number sense are cited by professors as being the most needed for success in college (ACT, 2012). “Doing well in grade-7 math is highly predictive of enrollment in more advanced courses in high school.” (Finkelstein, et. al., 2012). The goal of K-12 mathematics should not be to get students to 12th grade Calculus but rather to be college and career ready (NCTM and MAA, 2012). There are many paths to STEM careers, either with Calculus in high school, or if the student chooses the path at a later stage of development (Cannady, et al, 2014). Districts need to re-think acceleration policies that are based on high school Calculus as the main goal. Determining the preferred pathway should be based on the student goals for the future and where the mathematics needs to take them. The best way to reverse this trend is to develop acceleration policies that nurture the development of K-8 mathematical knowledge, including gifted students (Johnson & Sheffield, 2013). We recommend school districts commit to developing a solid middle school mathematics foundation by appropriate implementation of KCCRS and limiting acceleration options to high school.

Where do we go from here?

With differences in staff, student, and community resources; there is no single solution that will work in all schools and districts. However, there are some guiding principles that everyone can use as they make local decisions about whether or not to accelerate, making sure that students do not miss content regardless of the systems that are implemented. First and foremost the KCCRS represent a radical shift in content organization, calling for a much greater depth of understanding and reducing the amount of overlapping content between grade levels. Any plan for accelerating students must take this into account. Students should be provided extension and enrichment of content, striving for greater rigor and deeper understanding, before acceleration is considered. This is especially true in early grades, where acceleration is almost never the solution and deeper understanding can reap huge benefits for students as they move forward.

If the decision is made to accelerate students who are genuinely ready for it, care must be given to ensure the success of those students and avoid some of the negative impacts seen in some acceleration practices that place students in courses they are unprepared for, leave students missing pieces of content that they have never had the opportunity to learn, or push them into difficult situations where they are not motivated to succeed. A lack of a solid foundation results in gaps in learning and requires remediation when entering college. Nationally, 42.2% of first-time postsecondary students enroll in remedial mathematics courses (US DOE, 2012). In Kansas 30.9% of community college students, and 12.6% of students entering four year colleges take remedial mathematics (KBOR, 2015). Any plan for acceleration must make certain that individual students do not miss content, by compacting rather than skipping learning. Appendix A of the CCSS Mathematics Standards offers many acceleration options at the high school level, which can be obtained from a solid K-8 foundation (CCSS, 2010)

Additionally, placement of students in acceleration needs to be based on multiple measures, both of student achievement in mathematics and their personal motivation to put forth the effort necessary to be successful. In terms of content measures, speed of calculation alone is not an indicator of understanding, and a triangulation of data should be used to demonstrate that the student has the ability and preparation to be successful. A student’s motivation to learn, though easily overlooked in the decision making process, can be crucial to their success in an accelerated curriculum, and therefore must be addressed in the decision-making process. Student placement in accelerated mathematics should not be dependent on or guided by their placement in advanced study in other subject areas. Many students will demonstrate varying levels of preparation, ability, and motivation between different content areas and their course placement should reflect all of those factors.

Related to student motivation, is the consideration of future student study in mathematics. Programs for acceleration should be used to motivate students to study more mathematics, through all four years of high school and into college. In particular, three areas need to be addressed. First, students must have a firm background in algebraic concepts, including the content leading up to algebra, in order to be successful in more advanced mathematics and any acceleration program must provide a high level of understanding in this area. Second, students benefit greatly from taking meaningful mathematics for all four years of high school, and acceleration programs should not be used to encourage students to stop taking mathematics prior to graduation. Finally, programs must address college entrance requirements, including acknowledging that most universities prefer students with a greater depth of understanding over students who have taken multiple higher level courses. Having every student complete Calculus in high school is not necessarily the desired outcome for college preparation. In short, acceleration should only be an option for students genuinely ready for it, and if a significant level of rigor and depth of knowledge can be maintained in all mathematics content.

The shifts in the standards and their impact on student placement are not something that the general public is likely to intuitively understand. In fact, many educators have not had the opportunity to explore the impact of the Kansas College and Career Ready Standards. In addition to the need to provide information to parents and students about the challenge of accelerated learning in mathematics, which has always existed, as districts move forward to write or revise policies regarding acceleration, a great deal of time and consideration needs to be given to providing information about how the changing educational climate impacts acceleration policies. Acceleration of students in mathematics should be the exception for a small percentage of students, and always proceeded thoughtfully without compromising the K-8 mathematics foundation. This solid foundation will allow for high school compaction, doubling-up of math classes or other high school acceleration possibilities outlined in Appendix A (Common Core State Standards Initiative, 2010) and the accompanying Math Pathways document.

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You can also access the Kansas State Department of Education Math Website at:
<http://community.ksde.org/Default.aspx?tabid=6038>