

High School Mathematics Standards in Maryland: Challenges and Consequences of Policy Implementation

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June 2014

Over the past decade, educators and government officials in Maryland have conceived and enacted a number of significant new educational policies aimed at improving readiness of high school graduates for college and careers. Maryland has joined with over 40 states in a compact to develop and implement Common Core State Standards (CCSS)^[1] and with 15 of those states in the Partnership for Assessment of Readiness for College and Careers (PARCC)^[2].

The Common Core State Standards prescribe specific goals for K-12 education in both mathematics and English language arts. Maryland educators and legislators have paid particular attention to the goal of college readiness in mathematics, and the 2013 General Assembly enacted three significant changes in standards for mathematics course taking and achievement of high school graduates.^[3]

- Beginning with the 2014 freshman class, every Maryland high school student will be required to enroll in a mathematics course in each school year.
- Beginning with the 2015-2016 school year, all students in the 11th grade will be assessed to determine whether they are ready for college-level coursework in mathematics, using acceptable college placement cut scores.
- The Maryland State Department of Education (MSDE), in collaboration with local school systems and public community colleges, will develop and implement, by the 2016-2017 school year, transition mathematics courses or other instructional opportunities to be delivered in the 12th grade to students who have not achieved college and career readiness by the end of the 11th grade. These transition courses will include a reassessment of college readiness after completion of the course.

Those policy initiatives reflect a decades-long national trend of significant escalation in mathematical expectations for high school graduates, and each legislative action has a plausible rationale. Mathematics faculty from post-secondary institutions frequently argue that students who take no mathematics during their senior year of high school get 'rusty.' So they pushed for the adopted policy that requires all students, even those who have completed high school graduation requirements and possibly advanced placement courses, to study nontrivial mathematics in their last year of high school. Assessing student readiness for college mathematics in time to provide appropriate remediation in high school also seems like a logical policy and practice.

As with many broad policy mandates intended to solve significant problems, the devil is in the details. The MSDE Workgroup on Transition Courses, charged with planning implementation of the new

graduation policies, discovered a number of such devilish challenges, including defining appropriate mathematical prerequisites for success in college and career, creating and staffing effective transition courses for 12th grade students, and assuring equitable treatment of all students. The Workgroup's recommendations^[4] leave critical questions unanswered. The aim of this commentary is to identify some of those questions, review the relevant policy and empirical research literature, and recommend actions the state could take to improve implementation of its new high school mathematics requirements.

What does it mean to be 'college and career ready'?

The phrase 'college and career ready' has been the mantra of recent national efforts to establish Common Core State Standards. Over the past several decades, schools have been urged to prepare all K-12 students for post-secondary education that would qualify them for good jobs in the emerging knowledge economy. The Preamble to the new Maryland high school graduation requirements makes that case explicitly in claiming, "By 2018 two-thirds of all jobs in Maryland will require some post-secondary education."

Most people understand 'college ready' to mean 'prepared to succeed in credit-bearing college courses.' But it is very hard to construct a list of mathematical concepts and skills that are necessary and sufficient for all students. The typical response to this challenge is to argue that all students should master prerequisites for success in courses at or above the level of College Algebra. But students heading to majors that use little mathematics or that emphasize quantitative reasoning based on concepts and methods of probability, statistics, and discrete mathematics could argue persuasively that readiness for the traditional College Algebra course is an inappropriate goal for college preparation.

As the MSDE Workgroup discovered, the challenge of defining 'career ready' is even more vexing. In their March, 2014 report the Workgroup proposed, "Career readiness means being ready to enter a career field with the prospect of advancement."^[4, p. 3] At one point in their report, the Workgroup suggested, "To achieve [career readiness], students must earn an industry license or national certification and a certain grade point average in their high school program."^[4, p. 5] Not surprisingly, college faculty on the Workgroup team balked at this kind of requirement for all students. They argued that the aim of Common Core State Standards is to get all students 'college ready,' so the career readiness criterion is irrelevant. In response, the Workgroup recommended that, "definitions and assessments for College and Career Readiness (should) be changed to College and/or Career Readiness, since there is a distinct difference between college readiness and career readiness."^[4, p. 5]

It is natural to suspect that when most people hear or read the phrase 'college and career ready' they instinctively make the 'and/or' interpretation, thinking that a fair number of high school graduates are interested in careers that don't require advanced mathematics. But the new Maryland high school graduation requirements do not appear to allow for this nuanced interpretation. In fact, the instruments proposed for assessing college readiness require knowledge of very demanding content in the traditional Algebra I/Geometry/Algebra II curriculum track, and the regulations call for **all high school students** to aim at mastery of content in that track.

As the MSDE Workgroup pointed out in their March, 2014 report, careful consideration of the phrase 'college and career ready' and its implications for high school course taking and graduation requirements would be a useful precursor to full implementation of the latest regulations. Neither the 11th grade assessment nor curricula for the transition courses can be developed without a clear and coherent

interpretation of what it means to be ‘college and career ready.’

What should a transition course look like?

In Fall of 2016, Maryland will identify the first group of students required to enroll in a transition course because of low performance on the 11th grade test assessing their readiness for college mathematics. That timeline suggests a generous window of opportunity to design and develop materials for the required course or courses. But the challenge is significant.

The MSDE Workgroup suggested several possible formats for remedial instruction, ranging from enrollment in the next regular credit-bearing high school course (which could be calculus) to hybrid courses delivered with online components, targeted ‘recovery’ modules, courses with content tailored to specific remedial needs revealed by testing, or courses following the syllabus of a community college’s highest level developmental mathematics course.

With the exception of enrolling in the next credit-bearing high school course, each of these suggestions involves moving standard college remedial instruction strategies down into the high school. Most college level remediation courses do not have a remarkable record of getting students into and successfully through subsequent credit-bearing courses.^[5] Remedial courses also generally enroll the least enthusiastic of mathematics students, so efforts to make the new transition courses especially engaging seem essential.

One model of new thinking about remediation that has proven highly successful at the University of Maryland is a hybrid course that blends essential remediation with content of a regular finite mathematics course, so students emerge from the semester with certification of basic skills and college credit. High school transition courses that blend remedial work with appealing content from economic literacy,

statistics, mathematical modeling, quantitative reasoning, or technical fields might have real promise.

A similar blended curriculum strategy has been developed by the Carnegie Foundation for the Advancement of Teaching through its Community College Pathways project. Statway is a one-year pathway focused on statistics, data analysis, and causal reasoning that combines college-level statistics with developmental math. Quantway is a pathway focused on quantitative reasoning that fulfills developmental requirements with the aim of preparing students for success in college-level mathematics.^[5] The Carnegie Pathways project does more than provide innovative curriculum content.

The strength of Pathways is not just in its curriculum ... Pathways help students to see themselves as capable of mathematical success through interventions focused on non-cognitive factors and the development of language and literacy skills. In addition, Pathways instruction utilizes a pedagogical model that supports ambitious mathematics learning. Through the Advancing Quality Teaching component of the Pathways, faculty are supported to develop these pedagogical practices using innovative approaches to faculty engagement and development.^[5]

Design of appealing transition courses will not be a trivial task, so getting creative teachers to work quickly seems advisable. According to statistics cited in the Preamble to the new regulations, “Nearly two-thirds of high school graduates who enroll in community college and one-quarter of students who enroll in four-year colleges require remediation in mathematics.”^[3, p. 1] There is likely to be a very large audience for the coming high school transition courses.

Who will teach the transition courses?

A number of Maryland school districts already require all students to take four years of high school mathematics, and some others require four high school mathematics credits for a college prep diploma track. However, several of the largest Maryland school districts currently require only three high school mathematics credits for graduation (though many of their students enroll in a fourth year of mathematics to prepare for college).

The Workgroup planning implementation of new Maryland graduation standards in mathematics recognized the potential need for quite a number of additional mathematics teachers to staff the new transition courses. The Workgroup collected data about those projected staffing requirements and called for analysis of the data to guide implementation planning. What the Workgroup does not appear to have considered is where the new teachers will come from. Highly qualified mathematics teachers are already in short supply. The long-standing pattern is for affluent suburban schools to satisfy their need for more mathematics teachers by hiring the best qualified, most experienced teachers from less affluent schools and districts. This leaves the other districts to meet their staffing needs with less qualified and inexperienced teachers, potentially lowering student achievement in under-resourced, high needs schools.^[6]

The group planning implementation of new Maryland graduation requirements should study carefully the needs for new mathematics teachers implied by those requirements and track hiring patterns to see how the new courses are being staffed. Schools and systems should also consider incentives that encourage highly qualified teachers to work in settings where their expertise is most needed.

Are we aiming at the right target?

The new Maryland standards for high school graduation essentially apply standards for admission to University System of Maryland (USM) institutions^[7] to all Maryland high school students—four years of mathematics reaching the goal of “competency in Algebra II.” For some students, the senior year mathematics course might be Algebra II. But the new graduation standards also require students who have completed Algebra II prior to twelfth grade to enroll in a mathematics course that “utilizes non-trivial algebra” during their senior year. The USM admissions criteria define ‘non-trivial’ as concepts and problems that are, “at least as sophisticated as those that relate to problems appearing in the Achieve ADP Algebra II test.” The specifications for that American Diploma Project exam^[8] and the PARCC end of year Algebra II test that is poised to replace it emphasize a very traditional agenda of symbol manipulation procedures that can be used to transform algebraic expressions into equivalent forms and solve equations. There are at least three significant reasons to question use of that Algebra II course syllabus as the standard for mathematics achievement of all Maryland high school graduates.

First, a recent report from the National Research Council analyzes prospects for developments in mathematics during the coming decade and argues:

(M)ajor expansion in the uses of the mathematical sciences has been paralleled by a broadening in the range of mathematical sciences ideas and techniques being used ... New educational pathways for training in the mathematical sciences need to be created—for students in mathematical sciences departments, for those pursuing degrees in science, medicine, engineering, business, and social science, and for those already in the workforce needing additional quantitative skills ... Most mathematics departments still

tend to use calculus as the gateway to higher-level coursework, and that is not appropriate for many students.^[9, p. 10]

While the symbol manipulation techniques at the heart of traditional Algebra II courses are certainly critical for success in traditional calculus courses, it is not clear that those topics serve all college-intending students well, much less the substantial number of high school graduates who will not go on to post-secondary education.

Second, when the National Center for Education and the Economy analyzed actual mathematical requirements of initial credit-bearing community college courses in nine of the most popular and diverse academic programs, they concluded:

Only one program in one college required entering students to have mastered the content of Algebra II before enrolling in that program ... Many community college career programs demand little or no use of mathematics. To the extent that they do use mathematics, the mathematics needed by first year students in these courses is almost exclusively middle school mathematics.^[10, pp. 1-2]

These findings certainly raise questions about the validity of a high school graduation requirement that expects all students to master the mathematics of traditional Algebra II courses.

Third, the most common response to questions about why students need to learn mathematics they are unlikely to need in future studies and work is, 'You never know when your educational or career path might require mathematical understanding and skill; if you don't have the required knowledge, your options will be limited.' But this argument in support of a skill-focused Algebra II course is challenged by dramatic changes in the technological environment for work^[11] and for

mathematical reasoning and problem solving in particular.

Powerful tools that assist users in processing visual and quantitative information with mathematical methods are now ubiquitous in American life ... If it is possible to simply ask your cell phone, tablet, or desktop computer to perform any of the routine calculations taught in traditional school arithmetic, algebra, and calculus courses, what kind of mathematical learning remains essential?^[12, p. 489]

The Common Core State Standards for Mathematics recommend helping students learn to "use appropriate tools strategically." But curricula and teaching in school and college mathematics departments are only beginning to respond to the profound implications of information technology. In the meantime, Maryland high school graduation requirements direct all students to study serious mathematics in their senior year so computational skills in algebra won't atrophy from disuse.

It may be that the mathematical expectations expressed in new high school graduation requirements are the best way to make students 'college ready' in Maryland today. However, in light of emerging developments in applied mathematics and technologies for assisting mathematical reasoning and calculation, it makes sense to reconsider the 'Algebra II for all' standard in current regulations with an eye on progressive change in the high school mathematics curriculum.

Wouldn't earlier be better?

Since the principal objective of the new Maryland high school graduation requirement is assuring that students are ready for college mathematics, it makes sense to look at their mathematical competence as they near the transition point between high school and college. But recent work by the Chicago

Consortium for School Research (CCSR) suggests that efforts focused on a different critical transition point might pay even bigger dividends.

In 2007 ... leadership at the Chicago Public Schools (CPS) began a new targeted approach to reducing course failure in the ninth grade. The research suggested that the transition between eighth and ninth grade played a critical role in shaping students' long-term outcomes ... Schools across Chicago initiated new strategies to improve that transition ... (The On-Track effort) moved an entire system, including many traditional neighborhood high schools that had been condemned as dropout factories. ^[13, p. 2]

The Chicago On-Track initiative had dramatic positive effects that have been sustained into upper high school grades.

Success of the new Maryland high school graduation policy could be enhanced by special attention to keeping student mathematics achievement on-track in earlier grades.

Will the new graduation policies affect equity in Maryland education?

One of the most troubling problems in American mathematics education is the persistence of significant gaps in participation and achievement between impoverished and wealthy students and between students from different racial/ethnic groups. When changes in educational policy raise requirements for progress in and graduation from K-12 schooling, it is natural to ask how those changes might affect economically disadvantaged or minority students in particular. The recent changes in Maryland high school graduation requirements certainly raise those concerns.

One common argument in support of raising educational expectations for all students

contends that schools and teachers have too long expected too little of African-American and Hispanic students and students who live in poverty. The argument is, 'If expectations are raised, students will rise to the challenge.' There is some evidence (from recent results in Montgomery County, Maryland, for example), that initiatives such as requiring all students to enroll in Algebra I in grade 8 and urging schools to make college preparatory and advanced placement mathematics courses open to more students can lead to increases in the number of African-American and Hispanic students who successfully complete those courses.

However, many mathematics educators will look at the new Maryland high school graduation requirements and argue that high expectations, without exceptional support for students to meet them, are unrealistic. They will suggest that the new high standards will probably discourage economically disadvantaged and minority students, in particular, from persisting to high school graduation and on into college. There is some evidence to justify that concern.

For example, between 2003 and 2009, a period of intense national concern about 'leaving no child behind,' the Averaged Freshman Graduation Rate (AFGR) in Maryland increased slightly for African-American students (69.4 percent to 71.8 percent) and White students (83.6 percent to 85.6 percent). But the AFGR for Hispanic students actually declined (84.6 percent to 76.8 percent).^[14]

A 2013 study by Hemelt and Marcotte^[15] found that introduction of high school exit exams increased dropout rates for students in 12th grade, with especially large effects for African-American students. Dropout effects were uniformly larger in states that did not provide alternative pathways to receive a diploma or alternative credentials for students who did not pass exit exams. Given concerns raised earlier in this policy commentary about the appropriateness of algebra-intensive graduation

requirements, it would be truly unfortunate if the new Maryland standards in mathematics had disproportionate negative effects on economically disadvantaged and minority students.

Because of potential for the new requirements in mathematics to exacerbate gaps between participation and achievement of students from different economic and racial/ethnic groups, it will be important to initiate empirical studies that can inform future evaluations of the policies.

Conclusions and Recommendations

Changes in Maryland policy for K-12 education over the past decade have had the admirable goal of improving prospects for graduates in their future studies and work careers and in their roles as citizens of a democratic society. But broad policies require thoughtful implementation plans. Conditions that shape the design of a policy for one time and context generally change over time and in different contexts, requiring ongoing analysis and reconsideration of the policy. Policies have consequences. Thus it seems advisable for Maryland educators and government officials to pay close attention to the implementation and effects of recently enacted changes in high school mathematics graduation requirements.

- The meaning of ‘college and career readiness’ must be clarified before appropriate expectations for mathematical achievement of high school graduates can be set.
- Development of attractive and effective transition courses is a critical challenge to successful implementation of the new graduation requirements, so work on that task should begin immediately and be supported generously by MSDE.
- The staffing of transition courses by highly qualified teachers is likely to be a challenge for many Maryland school systems. MSDE should monitor closely the process by which

systems manage that task and provide professional development support for teachers of the critical new courses.

- The graduation standards in mathematics at any point in time should be viewed as living documents, subject to on-going analysis and change so they always reflect best current thinking about the subject.
- Ultimate success of the new graduation policy might well be enhanced significantly by efforts to monitor student progress in earlier grades of high school and by providing timely support to students at risk of failure and dropping out.
- Because increased mathematical requirements for high school graduation have the potential to disproportionately discourage economically disadvantaged and minority students from persisting to high school graduation and into college, MSDE should immediately begin collection of baseline data that will inform future judgments about the policy’s equity consequences.

Effective mathematics education for all students will provide great benefit to the economic and civic life of Maryland and its citizens. Thoughtful attention to the challenges and opportunities of the revised educational policies addressing high school mathematics course taking and achievement will be an important investment.

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About the Maryland Equity Project

The Maryland Equity Project seeks to improve education through research that supports an informed public policy debate on the quality and distribution of educational opportunities. It conducts, synthesizes, and distributes research on key educational issues in Maryland and facilitates collaboration between researchers and policymakers. The Maryland Equity Project is a program in the Department of Teaching and Learning, Policy and Leadership in the College of Education at The University of Maryland.

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This publication should be cited as: Fey, J. T. (2014). *High school mathematics standards in Maryland: Challenges and consequences of policy implementation*. College Park, MD: Maryland Equity Project, The University of Maryland.

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