Decades Later, Problematic Role of Calculus as Gatekeeper to Opportunity Persists

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The Launch Years Initiative hosted a policy forum in 2021 on how state, K–12, and postsecondary leaders can design and implement policies consistent with the recommendations proposed in the Launch Years report. The forum provided a powerful case for the critical role that state and postsecondary policy leaders—and community voices representing the perspectives of Black, Latinx, Indigenous, Asian American and Pacific Islander (AAPI), and other minoritized communities—must play to ensure that mathematics is seen as a vehicle for achieving greater educational equity, rather than as a barrier to it.

This is part of a blog series inspired by that forum.

- Blog 1: The Role of State-Level Education Policy in Ensuring Equitable Access to Postsecondary Pathways
- Blog 2: Decades Later, Problematic Role of Calculus as Gatekeeper to Opportunity Persists (read below)
- Blog 3: Those Closest to Reform Must Be Included in its Creation and Implementation
- Blog 4: Working on Big "P" Policy to Advance Launch Years Work
- Blog 5: Advancing Mathematics Pathways: What it Takes and What is Next

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One of the great benefits of being the director of the Conference Board of the Mathematical Sciences is the opportunity to work intimately with the 19 professional societies in the mathematical sciences. I have been able to learn from the expertise of mathematicians teaching at all levels who are working to make mathematics instruction more equitable.

Mathematics education and access to calculus in the United States is inequitable

Unfortunately, the structure of mathematics education in the US—and the opportunities it affords today's students—is highly inequitable. The very conscious decision made in the 1950s and 1960s to emphasize calculus at the postsecondary level in order to prepare engineers and physicists has profoundly shaped mathematics instruction in high school.

The seemingly singular goal of high school mathematics became the preparation of students for college calculus. As a result of these decisions, we now have a system that for over half a century has put all students on a track headed for calculus, until they run out of steam, hit a wall, or, for a select few who are lucky enough, manage to pass and have the entire field of mathematics open up to them at the postsecondary level.

Even back in the sixties, educators realized that the system was being geared toward a very homogeneous group of students—white, middle-class, and male. You can go back and read papers from those who created this system who saw that there might be problems down the road as a larger and more diverse population of students enrolled in postsecondary education.

A major source of inequity in mathematics education is access to calculus in high school. Of U.S. public high schools where Black and Latinx students make up the majority of enrollment, only 38% offer calculus.

The ubiquitous importance, yet inequitable availability, of calculus in high school has become a serious problem. Over 75% of students enrolled in a typical first calculus course in college have already taken it in high school. As a result, the remaining 25% of students who have never seen calculus before have to compete with students who are retaking a course they have already completed. Students who have not been exposed to the difficult concepts in calculus, who have not been introduced to the basic terminology or to the big ideas, are at a considerable disadvantage.

The inequity is heightened by higher education's continued reliance on calculus as a gatekeeper

Another problem is the common perception in our colleges and universities that calculus should still serve as a filter that makes sure students who are "not worthy," are not allowed to proceed on a STEM path.

I have been amazed to discover that across the country it is typical that 25 or 30% of students who take their first calculus course in college fail. It seems to be a national expectation that a significant percentage of students will be lost—indeed, *should* be lost—from a STEM pathway after taking college calculus. Given those high course failure rates, it is not hard to see that the 25% of college calculus students who never took calculus in high school are at a tremendous disadvantage.

When you look at the data by race, ethnicity, and socioeconomic status, the current calculus-as-gatekeeper system becomes even more problematic. White high school students take calculus at over twice the rate that Black high school students do. Further, 38% of high school students in the top quartile of socioeconomic status take the course in high school, compared to only 15% of high school students in the two middle quartiles. Only 7% of high school students in the bottom quartile take calculus in high school.

The College Board's Advanced Placement program is generally considered the gold standard for preparing students for college mathematics, but access to AP Calculus is highly inequitable. Given the patterns of inequitable access to advanced mathematics coursework in high school, the data is not surprising. White students take AP Calculus at over twice the rate of Black students. In addition, white students are three times more likely to take the AP Calculus exam than are Black students. And white students are six times more likely to get a passing score, typically a three or higher, on the AP Calculus exam, than are Black and Latinx students.

Success in high school calculus does not equate to success in college-level calculus

While there is undoubtedly tremendous inequity in the opportunity to study calculus while in high school, it is not at all clear that the course *as taught in high school* is resulting in a significant number of students who enter and succeed in a calculus sequence in postsecondary education. About 800,000 U.S. public high school students take calculus each year, which is about twice the number of students who take Calculus I at either a two-year college or a four-year college each year.

If the goal of taking calculus in high school is to pass out of Calculus I and enroll in the next course in the sequence, the data does not correspond:

- Only about one in five students who take calculus in high school actually skip over the first course in college.
- About 3 in 10 students who take calculus in high school will retake that course in college.
- About two-thirds of students who took calculus in high school and then retake Calculus I in college get an A or B in the college course.
- One in three students who took calculus in high school, however, get a C or lower, even though they are repeating a course in which they have already succeeded.
- Most disturbing of all, upward of 30 to 35% of students who successfully complete calculus in high school then go on to an assessment at the postsecondary level that places them into a precalculus course or a college algebra course. Some even wind up in remedial mathematics.

The existing high school course sequence, built to prepare students for calculus, remains problematic

We need far more flexibility in both high school and college programs so that students can choose paths that are right for them, while building their mathematical knowledge and abilities. But then we also need better pathways and supports so that students can successfully navigate a change of direction as their aspirations mature.

In short, we need to strengthen and reconceptualize mathematics education in grades 10 to 14 so that it serves all students.