EXECUTIVE SUMMARY

# BRANCHING OUT:

## Designing High School Math Pathways for Equity

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JUST EQUATIONS

The high school and college mathematics course sequences that present barriers to opportunity for large numbers of students include difficult math topics that are not relevant to many students' aspirations.

The burdens, which include placement into dead-end high school courses and college remedial courses, fall heaviest on historically disadvantaged students.

Attention to this mismatch is essential in order to improve equity, not only in mathematics outcomes, but in education generally. Despite decades of calls to make math "a pump, not a filter," improvements have been slight. Research shows that existing course sequences fail to prepare as many as two-thirds of students for college, contributing to low college attainment rates. Rather than blame students for this predicament, it's time to acknowledge that traditional math expectations are flawed.

Mathematics courses need to support students' transitions to and through college, whether they're pursuing STEM (science, technology, engineering, and math) disciplines or other promising fields like law, politics, design, and the media. Too many potential STEM students, especially Latinx and African American students, are being filtered out of opportunities. At the same time, too many whites, Asians, Latinxs, and African Americans are being blocked from pursuing other careers by irrelevant math hurdles.

To ensure more equitable outcomes, it's essential to take a tough look at high school math sequences. Though schools typically set out to offer courses in a single pathway leading to calculus, it's a fallacy that students actually pursue a common pathway. Some students successfully navigate the standard pathway, but many more get stuck in detours, repeats, or watered-down versions of STEM pathway courses. Of the 20 most common math pathways pursued by students in a 2012 study, 12 involved retaking a course. When only a few students proceed through a pathway as designed, there must be a problem with the pathway.

Without offering a high quality alternative pathway, schools nevertheless routinely discourage the STEM aspirations of adolescents, especially those from underrepresented groups. Many students who don't successfully navigate the pathway to calculus sink into a bog of remediation and ineligibility.

We need to eliminate barriers to opportunity based on income, race, ethnicity, gender, and any other factors beyond the control of the student, to move from a deficit model to an asset-based narrative. It is time to design high-quality alternatives that work for many more students, preparing them for a postsecondary world that branches into exciting careers, such as journalism, politics, education, marketing, law, and entertainment. We call these BRANCH fields[1].

High schools need to take responsibility for establishing a small set of math pathways that lead to fulfilling opportunities. The challenges—such as the need for initial pathway choices to be made during adolescence, as well as the influence of postsecondary admissions and readiness policies on high school math curriculum—are great. But ignoring them only risks making them more intractable.

Students' options frequently have been limited by traditional tracking policies, as well as by inadequate course offerings. Instead, students can be offered options based on their own aspirations and interests. With appropriate guidance and information, students implementing their own choices may work harder than students who have been placed. Teachers and schools will have to actively support students in developing higher aspirations. Recruiting students from particular backgrounds into STEM fields —students from racial, ethnic, gender, or social class groups not well represented in STEM — is essential.

This also requires deliberate work on the part of educators to address implicit bias, assumptions about student capabilities, and the ways that math traditionally reinforces privilege.

Most systems defer the pathway choice decision until after high school. Delay is not the solution, because this ends up closing opportunities by default, allowing more and more students to flounder with no clear pathway. New pathways beginning in 10th or 11th grade would offer viable pathways for all students, whether or not they are focused on STEM fields. Designs employed by school systems in California, as well as the state of Oregon, where pathways diverge beginning in 11th grade, allow STEM-aspiring students to complete AP Calculus during high school, as some currently desire to do.

The difficulties around the options available to students and the timing of their choices are real. Pathway design must account for such difficulties by:

- creating rigorous pathways that articulate with postsecondary policies and practices and align with a range of student aspirations;
- giving more weight to student aspirations and less to students' perceived preparation levels;

[1] Though BRANCH is not an acronym, we have chosen to use all capitals to signal that these pathways should be comparable and equally rigorous to STEM pathways.

- supporting educators to address the role of bias and privilege in traditional school structures and to dislodge harmful preconceptions about student abilities;
- implementing instructional and support strategies that address uneven prior opportunities and damaged math student identities;
- ensuring that pathway options are communicated early, publicly, and clearly to all stakeholders; and
- establishing summer or semester courses to serve as bridges for students who choose to switch pathways.

Some changes are also needed in postsecondary policies and practices. Admissions policies set strong conditions for high school math pathways, including the pressure for students to take calculus in high school, leading many students to rush through high-priority math topics during middle school and high school. Likewise, readiness policies that require large numbers of students to pass algebra placement tests have fueled large remedial math programs at many community colleges and state universities. Recent revisions to college placement practices have recognized some new math pathways that are not based on Algebra 2, vastly improving the conditions for redesigning high school math pathways. Additional postsecondary reforms would be beneficial, including rethinking the use of AP Calculus as an admissions screen.

Any effective system for moving students through middle and high school mathematics will have the following elements:

- pathways as options that lead to postsecondary opportunities, with some flexibility to switch pathways (from BRANCH to STEM or vice versa);
- relevance of pathway content, expertise, and goals;
- recruitment of students to pathways; and
- support for students within pathways.

In this country, the most practical time for pathways to diverge is in 11th grade, allowing for two versions of the 11th grade course formerly known as Algebra 2—a STEM version that can include much of precalculus and a broader BRANCH version, that emphasizes content such as statistics, game theory, and mathematical modeling. Typically, a high school will be able to offer a STEM pathway and one or two BRANCH pathways that lead to worthwhile postsecondary opportunities.

Components of the new BRANCH pathway should include an initial course suitable for 11th grade, in lieu of traditional Algebra 2; a fourth-year course that goes more deeply into the topics of the initial course; and an honors or AP version of the fourth-year course. Examples of new junior or senior year courses include Introduction to Data Science, Discrete Math, Quantitative Reasoning, and Math and Culture.

Course goals should include development of facility with symbolic notation; use of functions to model real-world situations; development of understanding of visual representations in complicated applications; and development of problem-solving, teamwork, and communication skills.

Schools will also need new recruiting tools and strategies to correct the historic biases of the system. The recruitment of students begins in the pedagogy and culture of the classroom. Math and science teachers have to play a primary role in recruiting students from diverse backgrounds into STEM fields.

Students may require support to succeed in their chosen pathways. Ideally, support begins with the culture of the classroom. Support strategies include pedagogic structures and new approaches to grading and evaluating students' work. Beyond the classroom, supplemental support, such as tutoring or support classes, will be needed by some students.

It is time to ensure that students have rigorous high school math pathway options that lead to postsecondary opportunities that are in line with their career aspirations—and that they are supported to succeed in those pathways. It's also important that factors known at birth—like race, ethnicity, class, and gender—don't predetermine their journeys through math.

Designing and enacting such changes is no simple challenge, given the constellation of systems and agencies with multiple layers of governance that are involved. One key to getting this aggregation of independent institutions to act in concert is to maintain a singular focus on the coherence of students' pathways.

To synchronize change across so many levels, we envision this work taking place in three stages:

**Analysis.** Study current math practices and policies to identify those that create and perpetuate disparate opportunities to achieve.

**Development.** Design and implement new pathway options (and related policies and practices) to reduce disparate opportunities to achieve.

**Refinement.** Evaluate and update new pathways (and related policies and practices) to ensure that they reduce disparate opportunities to achieve.

Multiple players have critical roles to play. Key steps include:

## K-12 SCHOOLS, DISTRICTS, AND SYSTEMS

1. Conduct equity audits of policies and practices—e.g., teacher assignments, classroom practices, grading policies, and bell schedules, including disaggregated student outcome analysis.
2. Shift from tracking students by "ability" to offering pathways as options for students, while implementing professional learning experiences to dislodge preconceived notions of student abilities.
3. Design ninth and 10th grade courses that prioritize content important for BRANCH pathways, while shifting more technical STEM-applicable content into junior and senior year STEM courses.
4. Design junior and senior year BRANCH courses, including an AP mathematics course that seniors can take without accelerating through the curriculum, as well as junior and senior year STEM math courses that prepare students for calculus in high school or college.

## POSTSECONDARY INSTITUTIONS AND SYSTEMS

1. Adopt changes to admissions and placement criteria that support the redesign of high school math pathways (including accepting BRANCH pathway courses and reducing the emphasis on acceleration for AP Calculus).
2. Ensure that prerequisites for general education quantitative reasoning courses are relevant to BRANCH courses and majors.

## RESEARCH COMMUNITY

1. Partner with higher education institutions to evaluate the effectiveness of new postsecondary pathways in preparing students for their chosen fields and in reducing equity gaps in college success, including enrollment disparities in STEM majors.
2. Design, develop, and research practices, tools, and systems to replace mechanisms that widen opportunity gaps.

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