

The Role of Higher Education in High School Math Reform

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A range of schools and organizations are in the process of rethinking high school math course sequences, content, and instruction. This reconsideration of secondary math is the result of widespread concern that many students, especially those who are traditionally underserved by the U.S. education system, encounter math as an obstacle rather than an opportunity to learn and meet their education goals. In many cases, high school students who struggle in math are unable to complete the steps necessary to earn a high school or college degree. What is more, there are serious questions about whether typical secondary math education prepares students for emerging job opportunities. High school and college students are almost universally asked to take courses in the algebra-to-calculus math pathway, whether or not the topics taught in such courses provide them with the knowledge and skills they will need in their future careers.

Many individuals and organizations concerned with secondary math offerings—including those associated with the Launch Years initiative (see box on page 2)—have been inspired by the recent math pathways movement in higher education. At postsecondary institutions that have adopted math pathways reforms, students can select from a variety of pathways to gain the math skills that are best aligned with their education and career goals. Many colleges now offer introductory college-level math courses in subjects such as statistics, data science, and quantitative reasoning, in addition to courses that are part of the traditional algebra-to-calculus pathway (Charles A. Dana Center, 2020).

Enthusiasm about the math pathways movement in higher education has raised questions about math content and instruction at the K-12 level, such as:

- Are there ways to better align high school math coursework with students' planned college majors and/or career goals?
- Could emerging high school math course offerings contribute to a math curriculum that is more relevant and engaging for students?
- Does changing the high school math curriculum improve student success in math, leading to higher rates of high school and college completion, especially among traditionally underserved student populations?



Many students, especially those who are underserved, encounter math as an obstacle rather than an opportunity to learn and meet their education goals.

While there is interest in pathways-aligned high school math reform among secondary education stakeholders, change in high school math depends a great deal on policies, practices, and norms at the higher education level. This report focuses on the role of higher education in influencing (encouraging or deterring) secondary education math reform. To better understand this topic, researchers from the Community College Research Center (CCRC) and the Education Strategy Group (ESG) conducted interviews with representatives from national secondary math education organizations as well as individuals from each of three states participating in Launch Years—Georgia, Texas, and Washington—who are engaged in efforts to reform high school math. We conducted a total of 19 interviews of approximately one hour in length. All interviewees were affiliated with the Launch Years initiative and have extensive knowledge of issues in mathematics education. The interviews were recorded, transcribed, coded, and analyzed for themes, resulting in the findings presented here.

We first present findings on the ways that higher education affects secondary math reform in broad terms, relying on data from our interviews. We do this by describing several domains of higher education practice identified by our interviewees that tend to present challenges to high school math reform. We discuss potential solutions to these challenges and consider ways that higher education can facilitate high school reform efforts. We then present short case studies of secondary math reform efforts in three states (all of which have also undertaken math pathways reforms—at least to some extent—at the college level) with a focus on the influence of higher education in effecting change. We conclude with a brief discussion of an overarching theme that appears to be central to much of this work: the importance of sustained conversation and collaboration between math educators and administrators from both sectors—higher education and K-12—in moving secondary math reform forward.

The Launch Years Initiative

Building on many years of prior work, Launch Years, a three-year initiative (2018–21) led by the Charles A. Dana Center at the University of Texas and funded by the Bill & Melinda Gates Foundation, has worked to change the structure and content of secondary math coursework. Through the Launch Years initiative, the Dana Center sought to help states and school systems remove barriers to math learning and to usher in a new paradigm for college readiness in mathematics that is developed and sanctioned by K-12, higher education, and workforce stakeholders, as well as by equity advocates. In addition, Launch Years aimed to increase the availability of courses (new courses as well as modified existing courses) that better prepare students for higher education math pathways options, that meet the demands of the economy, and that increase equity in student outcomes (Charles A. Dana Center, n.d.-a).

ESG was a strategic partner in this initiative, coordinating state and regional Launch Years task forces in Georgia, Texas, and Washington alongside the Dana Center. These task forces worked to identify state-level policies that could advance high school math reform, and they supported the implementation of two or more new or modified high school courses that are aligned with the Launch Years paradigm. CCRC participated in the Launch Years initiative as an evaluation partner. Working closely with the Dana Center, CCRC has documented the activities and accomplishments of the initiative to provide knowledge that may be useful for refining the work and for informing the broader field about secondary math reform efforts. The Association of Public & Land-grant Universities was also a partner in the Launch Years initiative.

How Higher Education Affects Secondary Math Reform: Challenges and Potential Solutions

Our interviewees identified several domains through which higher education can influence the reform of high school math offerings and instruction. These range from cultural norms and admissions policies to the ways in which teachers are trained in college to teach math. For each domain, we describe challenges identified by our interviewees as well as potential solutions to these challenges. We then discuss ways that higher education can be supportive of secondary mathematics experiences that aim to better prepare students for college and that may improve their educational outcomes. All of the findings we discuss represent the views and understandings of our interviewees.

Culture and Tradition

Challenges. Many interviewees maintained that the education enterprise tends to be hierarchical, with the norms and priorities of those at higher levels affecting processes and curricula at lower levels. At the top of the hierarchy in education are flagship universities and elite liberal arts colleges, which largely establish cultural expectations about what subjects are deemed worthy of study.

The algebra-to-calculus pathway has long held dominance as the preferred course of study in mathematics among elite institutions. Despite the expansion of the math pathways movement, higher education largely views the study of calculus as necessary to a rigorous, well-rounded education, and many high school students take calculus whether or not they expect to use it in further studies or in their careers. Similarly, Algebra 2, the high school course that prepares students for calculus, is widely viewed as essential for all students. As stated by Bressoud (2021) in a recent blog post:

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.

Many college math faculty have long-held beliefs about the primacy of algebra and calculus. Interviewees noted that postsecondary faculty often worry about a “watering down” of the college math curriculum, with students engaging in less rigorous coursework, leading to a lower-quality educational experience. As one interviewee explained:

A lot of math faculty are acculturated in those same systems, right? So even if it's not a formal admissions requirement, they have this notion that Algebra 2 is critical. And then if students don't get Algebra 2, they're not going to be ready for their college-level math class. But faculty haven't really thought necessarily very deeply or specifically about what exactly that means.

Interviewees discussed the ways that these views influence how states, school districts, and secondary schools make decisions about the math courses that secondary students should take. Some considered higher education's influence in these determinations to be a natural state of affairs. Others noted that deferring to elite postsecondary institutions when establishing the content of high school mathematics could negatively affect some students. One interviewee said:

We have these hierarchies, and then we have these assumptions around them. And sometimes the assumptions are closing the doors rather than the students' actual capacities. The selective four-year colleges are driving the conversation kind of unnecessarily, since most students aren't going [to selective colleges] anyway.

Potential solutions. The math pathways movement at the higher education level is making considerable inroads in challenging the assumption that the algebra-to-calculus pathway is best for all students. While it is widely recognized that the study of algebra is valuable—after all, some algebraic concepts are foundational to other math subjects—many are questioning whether it has been overemphasized. As part of math pathways reforms, college students are encouraged to take the math courses that are most likely to be useful to them in the future, depending on their college major and planned career.

Championed by [Carnegie Math Pathways](#) and [Dana Center Mathematics Pathways](#), the math pathways movement at the postsecondary level has been embraced by entire states and systems, as well as by many individual colleges. As of 2018, 15 states had adopted a math pathways approach at the postsecondary level (Charles A. Dana Center, 2019). However, it should be noted that a fundamental equity concern in implementing alternative pathways is that underserved students may be encouraged away from the algebra-to-calculus pathway prematurely or at higher rates than other students, which could limit their opportunities in STEM programs.

Changes to postsecondary culture and norms can also be influenced by the needs of employers. Increasingly, emerging jobs require skills in other mathematical fields such as data science and statistics. As a result, higher education departments are grappling with how to revise college curricula in accordance with these needs. According to one interviewee:

Quantitative courses in higher ed are increasing dramatically. Stanford's data science [field]—students are flocking to it. At [the University of Texas], put the word computational before a major and it draws students like a magnet—computational neuroscience, computational engineering. . . . Calculus is the mathematics of engineering. You're still going to have a lot of students taking calculus, and they should. But there'll be other students taking mathematics for the information domains.

Higher education's shift away from an exclusive focus on the traditional algebra-to-calculus pathway is influencing decisions around math course offerings in K-12. High schools are beginning to offer courses such as statistics and quantitative reasoning instead of, or following, Algebra 2. Interviewees recommended that higher education math faculty and academic leaders consider working with K-12 districts to consider

ways to shift away from traditional assumptions around math that do not serve all students well. Employers could be part of this conversation as well. Questions these stakeholders may want to explore together include:

- Are colleges sharing sufficient information with their K-12 feeder districts about the math pathways that students will encounter at their institutions?
- Is the content in high school Algebra 2 courses preparing students for a range of math pathways in college? If not, what changes should be made?
- How can higher education and K-12 partners collaborate to ensure that high school students are receiving appropriate advising about their math choices?
- What can educators at all levels learn from employers about the quantitative skills and knowledge that students need in the workplace?
- What are the equity implications of new approaches to high school math? What safeguards need to be in place to ensure that changes do not result in unintended consequences that hurt some students?

Admissions Policies

Challenges. According to many of our interviewees, particularly those working at the local or regional level, postsecondary institutions' admissions policies are the most influential factor affecting high school math reform. Any potential change in secondary math course options and sequences must be evaluated in light of how students will be viewed in the college application process. While some colleges enroll virtually all students who apply, others accept a very small proportion of applicants. The most selective colleges, especially public flagship universities, heavily influence what math courses high schools choose to offer. Selective colleges often view the completion of high school algebra and calculus as a marker that students have been able to handle rigorous coursework, and they may use this as a factor in admissions decisions (see box on rigor on page 7). Therefore, secondary math departments seek to offer the courses that are most valued by top-tier universities so that students are not at a disadvantage when applying.

High school guidance counselors also frequently encourage students to take math courses that will not limit their options in the college application process, even if students may not end up applying to a selective college. As one interviewee from Washington said:

Even in places like in Spokane, frankly, where very few of their students wind up going to [the University of Washington] . . . there's this kind of attitudinal thing on the part of high school counselors that if you're not sure, you got to do everything to be ready for UW, just in case.

A similar dynamic occurs in Georgia, according to another interviewee:

[The University of Georgia] is a very selective school. It's looking for students who have taken a challenging curriculum. Let's say a student who otherwise would have taken AP calculus now takes AP statistics. . . . Are those two experiences judged similarly?

Even if some selective colleges are formally willing to accept students with a wide range of high school math backgrounds, fulfilling the formal requirements may not be enough, given the competitive nature of admissions. Parents and students may aim for

the math options that they hope will give them an edge, particularly because it is often not obvious what students really need to have accomplished in order to gain admission to many colleges. Again, high schools are under pressure to steer students toward the courses that are seen as the most rigorous. One interviewee explained how these largely unspoken expectations trickle back to the high school:

There's the idea of whether an admissions requirement becomes just "the floor." [People notice] the academic profiles of prior students that are admitted to certain institutions within a state system, and . . . there's a signal there that goes back to the high school guidance counselor community, and to families.

Potential solutions. Interviewees agreed that selective universities have a great deal of influence when it comes to admissions standards across the postsecondary education ecosystem. Changes made by these institutions are often mirrored by less selective colleges. There are cases in which more selective institutions have decided to revise their admissions standards—for example, by decreasing the importance of the algebra-to-calculus pathway—based on what they consider to be best for students. One interviewee gave an example from California:

[Last year, the University of California] system announced that courses such as data science, statistics, and discrete math would qualify not only as a fourth-year [of high school] course but also could be considered a third-year course, which means a student could take those courses without taking Algebra 2.

Colleges and universities in states or regions where there is centralized control of admissions policies are more limited in what they can do individually. One interviewee described the influence of the governing board in the University System of Georgia:

We are 26 public institutions that are all governed by a certain single governing board entity. And so the fact is that the basic building blocks of admissions are completely determined by the policy that is set by that single governing board.

Decisions made by state or regional policymakers in these settings can be especially influential. State leaders may decide that changes to the high school curriculum could be advantageous to employers, for example, and make relevant changes to college admissions requirements.

In contexts where universities—both private and public—have more institutional control over admissions requirements, there is an opportunity for college leaders to examine institutional data and consider questions such as:

- Are there any admissions policies at our college that are not based on defensible criteria in terms of what admitted students need to succeed in specific programs of study?
- What high school math courses have our admitted students taken? How has this affected their success in college?
- Are our math-related admissions policies leading to equitable opportunities for our students, or can they be improved?

Defining Rigor

As changes to mathematics course offerings increase, both K-12 and higher education leaders will need to grapple with perceptions of “rigor.” Faculty and educators worry that shifting the focus of mathematics curricula away from algebra and calculus may lead to less rigorous courses or coursetaking patterns. Yet the notion of rigor is amorphous, and people may use the term in different ways. Some view courses as more rigorous if they include particular types of content (e.g., covering exponential functions or conditional probability), while some view rigor more generally as engagement with increasingly difficult content. Some view specific courses such as Algebra 2 as rigorous because they lead to degree programs in fields that may be considered inherently rigorous, such as STEM.

To help develop a common definition of rigor, the Dana Center interviewed a number of leaders in the mathematical sciences. Based on these conversations, the Dana Center posited that rigor pertains to students’ ability to “use mathematical language to communicate effectively and to describe their work with clarity and precision. Students demonstrate that what they have done works, when it works, and why the procedure they selected is appropriate” (Charles A. Dana Center, 2019, p. 7).

This definition is not dependent on a specific course; rather, it positions rigor as one component in a broader group of elements that comprise an effective course, including procedural fluency and skills, conceptual understanding, productive persistence, and application. Those who developed this definition argue that rigor can and should be found in all mathematics courses in both K-12 and higher education. A shift toward this view of rigor may be helpful in addressing perceptions that some math courses are intrinsically more rigorous than others.

Placement and Alignment

Challenges. Many students enrolling in college take a mathematics placement test upon entry that determines whether they are considered ready for college-level math courses. In open-access four-year colleges and community colleges, large numbers of students place into remedial or developmental math courses, which are associated with poor college outcomes (Bailey et al., 2010). According to interviewees, a primary reason for students ending up in developmental math courses is a misalignment between the math that is taught in high school and the math that is needed to be successful in college. One interviewee explained:

I think there’s, unfortunately, a huge misalignment in high school exit requirements and college entrance expectations. And, therefore, we have this massive remedial or developmental education population, which is very frustrating for students and leads to a lot of postsecondary attrition.

Interviewees noted that this problem is difficult to address in large part because of differing governance and incentive systems across levels of education, in which little attention is given to alignment of curriculum from high school to college. Colleges are largely held accountable for student enrollment, persistence, and graduation, while K-12 schools are evaluated based on student performance on tests aligned with state mathematics standards. Thus, students who graduate from high school are not necessarily prepared to meet college expectations.

What is more, high schools struggle to know what math concepts and skills colleges expect students to have mastered before they matriculate. High school and college math faculty seldom have opportunities to discuss curricular content or alignment. Indeed, postsecondary institutions themselves do not have uniform ideas about what students should know by the time they get to college. For all of these reasons, high schools are often left without the information needed to make curricular changes that will better prepare their graduates for college-level math.

Potential solutions. Our interviewees noted that national and state efforts to align high school and college curriculum (through, e.g., the Common Core State Standards) have led to improved cross-sector communication about curricular expectations. In addition, there are cases where local or regional high schools and colleges have collaborated to ensure that the high school math curriculum prepares students to graduate ready for college. Through this collaboration, high school faculty become more knowledgeable about college expectations, while college representatives come to better understand the preparation students typically receive in high school. Launch Years has encouraged these kinds of partnerships and has facilitated discussions around aligning high school and college curriculum. Our interviewees emphasized the importance of this dialogue:

I think we need to understand what's being taught in the high schools and earlier, so that when students do come to [the college], we are more prepared to take them from where they are and continue to move them forward.

We are a very active partner in the creation of the new mathematics curriculum that happens in K-12 and to make sure that that curriculum, as it's constructed, really does actually mesh with what it is that we would like students to know when they come to college.

One interviewee noted that states with more centralized higher education systems may be more uniform in their definition of college readiness, making it easier for high schools to know how to prepare students for college. Where this is not the case, it is still possible for groups of faculty or math associations to work toward clearer standards and better communication across sectors.

In addition, as long as this misalignment of curriculum exists, secondary and postsecondary sectors can work together to smooth the transition to college by offering transition courses (see Barnett et al., 2016), summer bridge programs, or other programs that help prepare students for college math.

Local, regional, or state workgroups seeking to improve student readiness and the alignment of curriculum may want to discuss the following questions:

- What do we know about the alignment of high school and college math curriculum in our state/region?
- Are there data available that could provide insights into how students who have taken different high school course sequences are doing in college? Could these data be used to make changes to better prepare students for specific college course offerings?
- Given the state policy context and local constraints, what are the best mechanisms for aligning curriculum from high school to college (e.g., regional coalitions, state curriculum committees, cross-sector councils)?

- How can high schools identify students who may be underprepared for college math earlier in their academic journey? What kinds of interventions would help them become better prepared for college?

Teacher Preparation

Challenges. Higher education is responsible for preparing the teachers who will provide secondary math instruction. Teacher education programs make choices about the math subjects they prepare teachers to teach as well as the teaching methods they emphasize. Some interviewees were concerned about existing systems of teacher preparation and support. One explained:

I don't think we do a very good job [of teacher preparation] in a variety of areas. One is in content. Second is the induction period. . . . And third, I don't think we do a very good job (and, in part, this is a K-12 issue) of providing continuing education. And finally, I'd say I don't think we do a good job of preparing teachers for the classroom dynamics in the kinds of classes they'll be actually instructing.

According to one interviewee, high school math teachers are mainly expected to be able to teach algebra, calculus, geometry, and trigonometry (see also Best Colleges, 2020). They may not have the background or training to teach some of the subjects emphasized in emerging math pathways, such as statistics and data science.

Further, some interviewees believed that postsecondary teacher education typically prepares graduates to handle calculations and algorithms but may not offer them a solid conceptual understanding of math. Thus, they may be more comfortable teaching formulas and procedures rather than helping students to understand the logic underlying different math problems (see, e.g., Wees, 2018). One said:

Remember what they were taught. It's an algorithm. They can't tell you why the quadratic formula is important or significant or what it represents, but they can drill you on it.

Finally, there was a concern among interviewees about expected shortages of teachers, in general and in math specifically.

Potential solutions. Interviewees generally agreed that secondary school teacher preparation in math offered by higher education institutions needs to improve and to align itself with emerging content priorities in higher education and the workplace, as well as with newer pedagogical approaches. They believed that, at a minimum, teachers need to be able to teach probability and statistics along with the more conventional subjects. One interviewee explained:

We have to completely re-envisage the way in which we train the new teachers who are going into the classrooms. So again, teach the mathematics for the future, in the ways that we would like students to be able to understand mathematics.

In addition, one interviewee described a program for math teacher education that was co-created and offered by college and high school faculty. High school teachers

involved with the program have the opportunity to observe college faculty in action, which helps them to better understand how college math is taught.

Those involved in shaping pre-service and in-service teacher preparation programs may want to consider how to better prepare and support high school mathematics teachers. They could discuss the following questions:

- What subjects should all high school math teachers be prepared to teach?
- Are there ways to support high school math teachers in using instructional approaches that help students develop a conceptual understanding of key math concepts?
- How might high school math teachers be helped to continuously update their understanding of emerging approaches to math education?

State Case Studies

Starting in the fall of 2019, the three primary states participating in the Launch Years initiative—Georgia, Texas, and Washington—began convening meetings of their statewide steering committees and regional task forces. Their goal was to discuss their vision for how high school math should be modified to align with math pathways reforms at the postsecondary level. In addition, they aimed to prepare high schools to offer Transition to College Math (TCM) courses¹ starting in the fall of 2020 and to lay the groundwork to pilot modified versions of Algebra 2 and its follow-on courses that include broader curricula. The state steering committees and regional task forces were composed of representatives from both the higher education and K-12 sectors. The groups included state and institutional leaders, high school and college math faculty, district math specialists, and local workforce representatives. The work of these groups was seriously disrupted by the onset of the COVID-19 pandemic starting in March 2020. Despite this setback, all states moved forward with creating a set of recommendations for high school math reform in the state and planning for and implementing TCM courses in the 2020-21 academic year.

In the following case studies, we discuss the challenges and accomplishments of the Launch Years work in these three states, as observed by our interviewees. We also present information and perspectives on higher education’s involvement in high school math reform in each state context, relating to issues such as college admissions, college placement and alignment, teacher preparation, and implications for equity.

Georgia

Georgia’s Launch Years initiative began in 2019 with high-level support from the state’s K-12 agency, postsecondary systems, and the governor’s office. “We were excited because, with some of the pending math changes within the University System of Georgia (USG), we wanted to be better coordinated,” one education leader in the state said. Interviewees highlighted the fact that Georgia’s education landscape is characterized by centralized systems. Participating in Launch Years offered the

opportunity for the state to consider ways to establish high school and college math competencies and pathways that could be realistically implemented statewide.

As both K-12 and higher education representatives were involved in the initiative, Launch Years facilitators “acted as a neutral intermediary, encouraging us to knit our systems together,” one higher education leader said. A driving factor, she continued, was a recognition that:

... leading everyone toward calculus is a very outdated viewpoint. In the world that we live in, statistics, data science—other kinds of mathematics—are not only kind of nice, they’re absolute necessities. Making sure that students are properly prepared for that mathematical journey when they get to college is crucially important, and of course their preparation needs to start in K-12.

Recent reforms within the USG system included implementing learning support corequisite courses to replace standalone prerequisite remedial courses for students who come to college underprepared and a new statistics gateway math course that replaces college algebra for many students, depending on their major. Aligning high school math content with these changes was one goal of the Launch Years work in Georgia.

The Role of Launch Years

When Launch Years started, the Georgia Department of Education was already slated to review and revise its K-12 mathematical standards; it was not clear at that point if or how Launch Years would play a role in this work. However, the state and regional committees formed as part of Launch Years took on an important role in the standards revision process.

A key aspect of Launch Years in Georgia was attempting to connect the work across education levels. As one interviewee explained, “When Launch Years began, it was really about the final two years of high school mathematics—what should we do with it?” But as the work unfolded, there was “a recognition that if you’re going to change [standards for the higher grades], then you need to change the preparation for it.” In the end, according to one higher education interviewee, “we partnered together with the K-12 system and completely reconstructed the math curriculum from kindergarten through 12th grade, preparing students for different threads of the mathematical journey right from the start.” After extensive work by the committees involved, new math standards were drafted; they were approved by the Georgia Board of Education in 2021 and are expected to be launched across the state in 2022.

Among the math reforms to come out of the Launch Years work, the modernization of Algebra 2 is especially notable. The updated course, typically taken in students’ junior year, will embed more non-algebraic concepts that prepare students to choose a fourth-year high school math course that aligns with varied postsecondary math pathways, rather than a course that mainly prepares students for calculus.

Another Launch Years’ contribution to high school math reform work in Georgia is the revised TCM course offered in the fourth year of high school. The course aims to improve math college readiness among students who are not yet college-ready, so

that they are more likely to enroll directly into credit-bearing math when they start college without needing developmental courses or corequisite support.

Further, Launch Years held convenings for college and high school math faculty in one part of the state to create a model for collaboration and to inform state-level conversations on math reforms at both the secondary and postsecondary levels. Georgia Highlands College, traditionally a community college now offering some baccalaureate degrees, worked with a K-12 district in its service area northwest of Atlanta. “The convenings helped us communicate about changes we’ve made at our college and gain a better understanding of how advising works at the high school level,” a leader from Georgia Highlands College said.

Higher Education Perspectives

Participants from higher education associated with the Georgia Launch Years work mentioned the importance of sending clear messages to students in high school about what it takes to be college-ready in math. One college leader said that many Launch Years conversations focused on the expectations colleges have for incoming students. “I think that’s a valuable conversation to have because there have been so many changes in our college and not a lot of time to sit down and brainstorm about what that means for the high school students,” this leader explained.

The work of the Launch Years initiative involves “the kind of long thinking that needs to take place,” another education leader explained.

In the day-to-day of putting out fires, it’s very difficult to [focus on collaboration and alignment], especially across state agencies. Our boards want K-12 and higher education to work together, and the facilitated convenings and discussions we’ve had through Launch Years the past two years have made it happen.

Considerations for Higher Education

The Launch Years work in Georgia revealed the need to better connect math practices in high school to those at the postsecondary level. Given the state’s highly centralized systems, many of the challenges identified through this work could be effectively addressed through policy levers at the state level, though others were better addressed through partnerships between local colleges and school districts.

Admissions policies. USG and the Technical College System of Georgia did not see admissions challenges stemming from the Launch Years work. One interviewee stated:

The reality is, we really didn’t have to change anything. It was already the case that for USG admissions, a graduate from high school had to take Algebra 2 and four years of mathematics; it is still the case that you have to take Algebra 2 and four years of mathematics.

That said, moving forward, policymakers plan to be on the lookout for adverse admissions outcomes for students who do not stay on the algebra-to-calculus

pathway for their fourth math course in high school, particularly for students who hope to attend a selective four-year public institution.

Another interviewee suggested a need for local postsecondary leaders to validate new approaches to math in high school. “There’s a stigma—if you’re good at math, you’re going to take precalculus, and that’s a hard thing to battle,” they explained. “I think it’s going to take higher education saying, ‘These are equally valid tracks in high school with equally valid rigor’” to change those perceptions.

Placement and alignment. Postsecondary leaders in Georgia saw a connection between the state’s efforts to create math pathways from high school through college and the math placement policies at their institutions. “The work we’ve done to make sure that the high school curriculum does actually mesh with what it is that we would like students to know when they come to college is one piece,” a postsecondary leader explained. “But the second part, and it’s yet to be completed, is how to make that journey seamless.” This requires better placement policies. “Right now,” the leader added, “we have well-meaning but somewhat arbitrary rules regarding where students begin in their mathematical journey when they come to college. There is a significant amount of work yet to be done to make it smooth.”

At the regional level, higher education leaders noted that the discussions they had with local high schools through Launch Years gave them a better understanding of advising issues that affect students when they choose a fourth high school math course to align with their academic and career goals. One leader reported hearing high school counselors say that they “simply do not have the time to meet one-on-one with students” because their caseloads are so large.

Teacher preparation. The statewide launch of new math standards in Georgia will require preparing teachers in new mathematical content and pedagogical approaches. “We’ll have to create resources to help teachers understand this new approach—the Algebra 2 class specifically—because we know that for many teachers, it is going to be a big change,” one leader said. In fact, during early Launch Years conversations, some high school math teachers advocated for creating an alternative to Algebra 2 instead of revising the existing course because of concerns about the scale of professional development needed for math teachers across the state to teach a revised course that embeds non-algebraic content such as statistics. The idea was that some teachers could continue teaching the traditional course, while more agile teachers and new teachers could learn to teach the alternative course.

Ultimately, state education leaders decided not to create two separate courses, for fear that one might be seen as “less than” the other. So, to prepare these high school teachers, one higher education leader emphasized, postsecondary institutions “need to be an active participant in the retraining of in-service teachers, making sure they are ready to teach in ways that may be quite different from how they’ve been teaching.” This also applies to the pipeline of incoming teachers. “We have to completely reenvision how we train new teachers who are going into the classrooms—teaching mathematics for the future and doing so in ways that students will really understand mathematics.”

Looking Forward

In addition to the state-level changes to math enacted, Launch Years brought higher education and high school faculty in one region of the state together to jointly discuss and align math practices. Facilitating these kinds of conversations may be important for the future. One participant from higher education observed:

Up until this project, I don't think I had ever really met with a high school math teacher in conjunction with my work as an educator in higher education— maybe at a chamber meeting or something like that—but to really talk about our discipline and what our students are going through, that's just not something that happened. We get so involved in what we're doing here at the college, that we forget that we've got this whole pipeline that we could be working with as well.

Texas

While considerable progress has been made in Texas to institutionalize college-level math pathways,² much less progress has been made on secondary math reform. Much of the work of the Launch Years initiative in Texas was connected to the activities of the Central Texas Math Alliance Taskforce (CTXMAT), an initiative supported by the Dana Center and the E3 Alliance, an Austin-based education organization dedicated to improving the pipeline from K-12 to postsecondary education. Established in 2018, CTXMAT's work brought together representatives from higher education and K-12 to analyze the alignment between high school mathematics course offerings and introductory college-level mathematics with the goal of improving math proficiency levels in Central Texas.

The Dana Center and the E3 Alliance worked to facilitate the Launch Years task force meetings over an 18-month period, during which representatives from K-12 and higher education convened to review data on student progress and identify opportunities to improve alignment. Toward the end of this period, the task force identified and recommended strategies, including the institutionalization of structures to support aligned teaching and learning of mathematics across sectors, a commitment to share higher education data, and steps to address equity gaps in readiness for college mathematics.

The state task force also played an important role in providing support and guidance to the two Texas districts that implemented Launch Years-affiliated TCM courses in the 2020-21 academic year. Despite the challenges of remote teaching during the COVID-19 pandemic, a number of students successfully completed the course. The task force also engaged in discussions about possible alternatives to traditional Algebra 2 courses in the future.

In contrast to Georgia, Texas has highly decentralized K-12 and higher education systems. A Dana Center staff member said that this contributes to a decentralized approach to education reform, noting that there was little appetite at the state level to undertake reforms associated with Launch Years: “Texas is a place that really focuses on regional work and letting it come up from the ground.” At the same time,

Texas has passed important legislation that has influenced math reform decisions. For example, the state's requirement that colleges offer transition courses in math has led to the development of new high school senior year courses such as TCM.

The Role of Launch Years

Across K-12 and higher education stakeholders that we interviewed in Texas, there was a high level of consensus that one of the most significant accomplishments of Launch Years was creating opportunities for dialogue between the K-12 and postsecondary sectors. The involvement of the Dana Center and the E3 Alliance, both respected in the field, contributed legitimacy to the math pathways efforts and brought important stakeholders to the table.

One higher education faculty member observed that when stakeholders from K-12 and higher education come together, there is often a negative power dynamic at play in which K-12 representatives feel defensive and higher education representatives feel an undeserved sense of superiority. They believed that the presence of the Dana Center and E3 Alliance helped to address this dynamic:

Having that third entity really helps to neutralize things and bring down that dynamic. My experience is it really helps to get this conversation started in a very open and honest way. I think it is really difficult otherwise to try to get that started.

One important outcome resulting from this open dialogue was that higher education faculty were able to make explicit the knowledge and skills that high school students need to successfully transition into college-level math. A four-year college administrator noted that setting clear expectations and communicating them explicitly with high school faculty was an important role for higher education to play in the reform movement. They explained:

The conversation that I see that has really been good is that high school teachers are asking the university faculty, "What is it that our students are not coming to you with? And what do they need that we aren't giving to them?" And so our folks at this point are really making those needs very known.

Higher Education Perspectives

Interviewees from both higher education and K-12 shared the perspective that it was time to move away from the old approaches to mathematics education that focus strongly on algebra and calculus. There was a broad recognition that statistics and/or quantitative reasoning would prepare many students better for the demands of their future careers. As one higher education representative noted:

Statistics is becoming a lot more desired for a lot of different majors. Specifically in the medical fields and health sciences, they've really moved towards statistics, and even a lot of medical schools now are wanting statistics. . . . So that's one area where I think students having some exposure or just having some experience with some statistics . . . [could be] a lot more useful than just doing a bunch of algebra.

While the higher education sector in Texas, particularly community colleges, had been engaged in reforms to create multiple math pathways for several years, the recognition of a need for math pathways outside of the algebra-to-calculus pathway had not yet fully crossed over to high schools. Thus, interviewees noted that an important role for higher education was to communicate this change in college math offerings to K-12. One four-year college administrator noted how perspectives on math in higher education were changing:

There's been a much greater willingness of higher ed to look at the fact that everybody doesn't need college algebra; that there are different pathways. . . . And so what we've got now is this cadre of [faculty] that realize that there needs to be a change.

Despite this, interviewees from higher education noted several challenges to implementing math pathways alignment in Texas high schools, including a lack of buy-in from flagship universities whose admissions practices place a premium on the completion of traditional Algebra 2 courses and a lack of understanding of non-algebra math pathways among high school counselors and parents.

While representatives from four-year institutions participated in CTXMAT, several interviewees noted that a barrier to moving the work forward was a lack of full participation from flagship universities in the state, including the University of Texas at Austin and Texas A&M. Although these colleges offer alternative math pathways beyond the algebra-to-calculus pathway, they continue to give preference to the completion of algebra or calculus in high school in admissions. Given that these institutions are among the elite public colleges in the state, their endorsement of alternative math pathways courses has the opportunity to impact public perception of the utility and rigor of those courses.

However, as a higher education representative observed, flagship universities have limited incentives to support the math pathways movement. Given the high level of demand for admission to elite institutions, they have little incentive to reevaluate admissions criteria including the math requirements for a competitive application:

The folks that are probably best suited to be the leaders in the discussion don't really, in many instances, have a motivation to drive that discussion, because their policies are what they are, and nobody's going to make any move to change that.

Limited understanding about the value and outcomes of non-algebra-based high school courses among high school stakeholders posed another barrier, according to interviewees from higher education. A four-year administrator from a college that had implemented math pathways reforms noted that their college planned to reach out to high school counselors to educate them about alternative math pathways.

Considerations for Higher Education

The Launch Years initiative in Texas enabled stakeholders from higher education and K-12 to come together to identify and address barriers in the high school to college

transition in math. This is an ongoing process; a few specific areas requiring further focus from higher education are highlighted here.

Admissions policies. Because the higher education leaders that we interviewed mainly represented less-selective and open-access institutions, the role that new high school math courses such as TCM play in admissions was not a major concern at their colleges. However, one college administrator observed that perceptions of the rigor of new math courses would impact admissions decisions at selective colleges, raising concerns about equity implications at flagship universities. A K-12 district math coach noted that a lack of clarity about specific admissions requirements leads some parents to be cautious about the courses their children take. “I think that sometimes the admissions criteria are a little elusive, and we don’t necessarily know them. And so our parents and our district default to take all of the highest-level courses we can,” she explained.

Placement and alignment. The math pathways reforms in Texas are happening amidst a suite of changes in higher education, particularly in community colleges, regarding placement policies and math remediation, including a movement away from the traditional prerequisite model of remediation. In addition, as a result of the COVID-19 pandemic, many colleges stopped requiring standardized placement tests, at least temporarily. And there is considerable uncertainty about how TCM course grades will be used in the placement process going forward.

Teacher preparation. Several interviewees noted the role that higher education can play in supporting high school math reform through college teacher training programs. A K-12 stakeholder noted that many high school math teachers were trained before the advent of the math pathways movement and therefore may lack the skills needed to teach new math curricula. They made suggestions for higher education going forward, saying, “I see a couple of roles [for higher education, including] making sure that whatever methods classes math teachers are going to take align with current thought and having current information on efforts to align high school and college math.”

Looking Forward

Nearly all stakeholders in Texas felt that the Launch Years initiative played a key role in bringing together a range of stakeholders from K-12 and higher education for honest dialogue about structural barriers that students face in attaining college readiness in math. One four-year college administrator described the importance of cultivating relationships to sustain the math pathways movement:

The human relationships matter. You can have a dialogue, but if you only have it once, it’s probably not going to yield your best outcomes. The work has to be ongoing, and it has to be relationally oriented. And so, building the human relationships is really . . . the underpinning of the work that matters more than anything else.

Moving forward with high school math reform work in Texas, interviewees noted the importance of maintaining structures that bring K-12 and higher education

leaders together to continue these discussions. One benefit of the pandemic was introducing norms around remote meetings that made it easier for these convenings to take place and lowered barriers to participation, a practice that could be sustained in the future.

Washington

Leaders in the state of Washington noted that a culture of local control and governance is a defining characteristic of the state, creating a need for deep engagement and collaboration when implementing education reforms. This is one reason that the state's Office of Superintendent of Public Instruction, the State Board for Community and Technical Colleges, and the Council of Presidents, representing public four-year universities, joined forces in 2019 to participate in Launch Years, with the goal of strengthening mathematics in the last two years of high school. As one state K-12 leader stated:

The work coming out of Launch Years is making sure that we are preparing students for what colleges and universities are looking for. It's very clear that we can't just keep adding math content, and we need to know from higher education what students need to succeed.

Because of the state's culture of local control, there has not been a consistent adoption of math pathways reforms across the state's postsecondary institutions. However, some colleges and universities have adopted these reforms (for more, see Charles A. Dana Center, n.d.-c).

The Role of Launch Years

Three primary outcomes have emerged from Launch Years in Washington. First, the state revised its fourth-year high school transition course, Bridge to College Math, to add statistics concepts earlier in the course and to embed more social-emotional learning to help students become more confident mathematical learners. By exposing students to statistics content earlier in their senior year, the course aims to better prepare students for the statistics math pathways that many community colleges and some universities in the state are implementing for non-STEM students.

Secondly, Washington is midstream in modernizing its Algebra 2 course (typically offered in the junior year of high school) to create options for high schools to customize the course to place more emphasis on math content other than the competencies that lead toward calculus. The vision is that each high school will offer several versions of Algebra 2, but, importantly, all versions will prepare students for any fourth-year high school math course, whether that is precalculus or another subject. "We have to make sure we don't lock students into a particular trajectory, and that's one of the things I really like," one leader said about the new Algebra 2 program, which the state plans to pilot in fall 2022.

Finally, Launch Years convened K-12 and postsecondary math faculty in the Spokane area to strengthen local math practices and alignment between the two sectors. The work builds on long-standing regional collaboration around math through

the Spokane Math Symposium. The focus is on improving mathematics within the region, creating stronger connections among stakeholders, and smoothing math placement policies and practices, which are determined at the local level in Washington. The intention is for the work in Spokane to be a model for other regions in the state.

Higher Education Perspectives

Across the board, education leaders in Washington valued the opportunity that Launch Years provided in creating time and space for collaboration. “I think bringing faculty together, learning from each other, and building those relationships has been a really positive outcome, along with dusting off current pathways and curriculum and looking at them in a new light,” one four-year university leader said.

Navigating conversations between the secondary and postsecondary sectors is not always easy. At the first face-to-face convening in early 2020, “not everyone walked away feeling warm and fuzzy,” one leader said. While everyone wanted to see more clearly defined expectations and alignment, some expressed concern about the Launch Years approach. “It’s very exciting work to modernize Algebra 2,” a participant from higher education said, but she went on to note that it is only part of a student’s math experience, pointing to the years of math content leading up to the course and suggesting the need to revisit math curricula in earlier grades as well.

Meanwhile, other Launch Years participants from higher education saw the entrenched focus on algebra across the education system as a challenge. As one postsecondary leader said, the “operating assumption” that many college faculty have is that every student needs to primarily focus on algebraic concepts in high school. This stems from decades-old research that “correlates Algebra 2 with early college success—but that’s correlational, not causal. I think it’s starting to break down, but there are a lot of faculty still stuck on that perspective,” he explained.

Considerations for Higher Education

The Launch Years work in Washington surfaced important connections and disjunctures between math practices in high school and at the postsecondary level in the state. Higher education and its K-12 partners will need to address the implications of this work, particularly in the following ways.

Admissions policies. Community colleges and most four-year institutions in the state did not see admissions concerns related to changes in high school math. However, several participants noted the key role that the state’s public flagship university, the University of Washington, will ultimately play. Concerns emerged around the variety of Algebra 2 courses to be offered in the new program, which would possibly appear differently on transcripts and could still allow colleges to prioritize the traditional Algebra 2 course in admissions. As one leader said, “In conversations like this, the question always becomes, ‘What is the University of Washington going to do?’” pointing out that if the new Algebra 2 program does not align with University of Washington admissions criteria, parents and advisors may steer students away from new versions of the course when they become available.

Even if the flagship's admissions policies do not preclude admission for students taking alternative courses, it is possible that students, families, counselors, and high school administrators could perceive lower odds of acceptance.

Placement and alignment. Most community colleges and some universities in Washington are moving toward the use of multiple measures for placement, instead of using placement test scores alone, or in some cases are using transcript-based placement policies that look at students' grades and high school courses. Some colleges and universities are also implementing math pathways, moving away from college algebra as the default gateway math course for all students. "We talk a lot about pathways in higher education, so how do we encourage pathways at the high school level so that students are taking mathematics that will be relevant to their eventual studies or jobs?" one community college leader said. He continued:

If we have placement practices that are "one size fits all," then many students will continue to be placed in remediation based on concepts leading to calculus. It makes more sense to place them based on the math pathway they are headed toward in college.

Equity. The Launch Years initiative in Washington has attempted to keep equity at the center of its math reform work because educators want to make sure that all students have opportunities for postsecondary access and completion. About a decade ago, well before Launch Years, the state created its high school Bridge to College Math course to address the fact that many students were going to college and placing into developmental math, costing them additional money and time to get a college degree. Disproportionately, these were first-generation students and students of color. "So equity has always been at the forefront of what it's been trying to address," a community college leader said. However, some education leaders expressed the need for more work on equity in high school math reform. "We need an equity review of the curricular materials, so that's on the table for future work," another leader said.

Another equity issue is ensuring that the new Algebra 2 course does not become a means to track students. "How do we make sure that all the options are robust mathematically and are great alternatives for students?" one leader said. "How do we make sure that somebody is not being sent a certain way based on how they present mathematically?" This is important to higher education as well: Any tracking that disadvantages students of color in high school negatively impacts their preparation for postsecondary math pathways.

Looking Forward

Educators in Washington were quick to point out that, while progress has been made in high school math reform, the work is ongoing. "When I look at the work in the state of Washington over the last 20 years, I see iterations, but we're not there," one leader said. "We need to continue to think about what kinds of math experiences high school students should have and what kinds of support math teachers in high school need to be able to provide those experiences." Another interviewee added this advice for other states considering similar work: "Vertical conversations are incredibly important; there needs to be more connections up and down the ladder."

Conclusion: The Importance of Collaboration

The interviews we conducted with representatives of national secondary math organizations and high school math reform participants in three states make it clear that collaboration between K-12 and higher education systems and institutions is essential to high school math reform. Much of this collaboration aims at providing legitimacy and value to alternative math pathways, in part by illustrating their importance for today's careers.

A long tradition that gives primacy to the algebra-to-calculus pathway still dominates or at least makes itself felt in both sectors. To varying degrees, it remains resonant in official college admissions criteria, informal college admissions practices and preferences, college placement policies and definitions of college readiness, and teacher training—even in colleges and states that have adopted math pathways reforms. Our interviewees suggest that selective colleges set trends in practice that less-selective colleges and the secondary education sector tend to follow. Thus, the willingness of these colleges to examine and make changes to their practices—especially in admissions—may be essential for substantial change to occur in secondary mathematics.

Broadly, our interviewees stressed the need for greater conversation and collaboration across education sectors as well as between educators and other stakeholders such as employers and intermediary organizations. They pointed to ways that facilitated conversation has led to the development of specific plans and goals in some settings. Collaboration has occurred within states (e.g., in Maryland's PK-16 Council and in states participating in the Launch Years initiative) and across state lines (e.g., through the Conference Board of Mathematical Sciences' [CBMS] project on math alignment³). Collaboration has also taken place at the local or regional level, such as in Spokane's Math Symposium, held by a regional coalition of educators who focus on improving math instruction across K-12 and higher education.

Interviewees also said that state-level action can be influential in supporting high school math reform in situations where there are entrenched norms that might otherwise make such reform difficult. For example, Texas' requirement that colleges offer transition courses in math has led to the development of new courses as well as discussions about the design of the K-12 and higher education math curriculum. California and Florida have enacted legislation that enables the majority of high school graduates to enroll in college-level math courses upon matriculation into college.

Finally, real-life examples of innovative and effective practice in math reform can make a difference in generating movement toward change in both secondary and higher education settings. Efforts such as those facilitated by Launch Years provide examples of what math reform can look like on the ground and how it can be implemented.

Endnotes

1. TCM courses are usually developed jointly by secondary and postsecondary faculty and offered no later than 12th grade to students at risk of being placed into remedial math programs in college. They are typically a semester to a year in length.
2. According to the Dana Center, all 50 community colleges and a number of universities in Texas were involved with the Dana Center's Math Pathways initiative as of 2016 (Charles A. Dana Center, n.d.-b).
3. The CBMS project, High School to College Mathematics Pathways, is co-led by the Dana Center. Teams from 23 states are participating in a series of forums to discuss improving the secondary-postsecondary math pathways in each state (see CBMS, n.d.).

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