



TEACHERS COLLEGE, COLUMBIA UNIVERSITY

## **A Changing Paradigm in High School Mathematics**

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November 2020

**CCRC Working Paper No. 125**

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Funding for this research was provided by the Charles A. Dana Center at The University of Texas at Austin through the Launch Years Initiative (see inside front cover).

## Abstract

In the United States, the prevailing high school mathematics course sequence begins with a year of Algebra I, followed by a year of geometry and a year of Algebra II. Educators and others have raised concerns about the extent to which this sequence, which prioritizes the mastery of algebra, is appropriate for the longer-term education and career goals of students who do not intend to pursue STEM degrees in college. These concerns have impelled educators and policymakers to reexamine the prominence of algebra in high school mathematics curricula and to consider new approaches that provide students with more mathematics course options better aligned with their academic and career goals. In this paper, we explore existing approaches to high school mathematics curricula as well as new developments in the field. To start, we discuss a range of high school mathematics course sequences that are currently offered across the country and look at some of the systemic challenges embedded within the traditional paradigm. Then we explore federal and state changes to the provision of high school mathematics in the early 21st century, which we follow with a look at the influence of postsecondary institutions on high school math curricula. We then introduce short case studies of innovative high school math reforms that are occurring in five states. We conclude the paper by considering the Charles A. Dana Center's new initiative, Launch Years, and how this project works to reimagine high school mathematics and its relationship to postsecondary education and careers.

### About Launch Years

Launch Years is an initiative led by the Charles A. Dana Center at The University of Texas at Austin—in collaboration with Community College Research Center, Education Strategy Group, and the Association of Public and Land-grant Universities—focused on addressing systemic barriers that prevent students from succeeding in mathematics and progressing to postsecondary and career success. Leveraging work within states, the initiative seeks to modernize math in high school through relevant and rigorous math courses as well as policies and practices leading to more equitable outcomes for all students.

**Learn more at: [utdanacenter.org/launch-years](https://utdanacenter.org/launch-years).**



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## 1. Introduction

In the United States, the prevailing high school mathematics course sequence begins with a year of Algebra I, followed by a year of geometry and a year of Algebra II. First established by the National Education Association Committee of Ten in 1892 (Berry & Larson, 2019; Dossey, McCrone, & Halvorsen, 2016), this pathway became the norm across the country in the mid-20th century following the 1957 launch of the Soviet satellite Sputnik, which spurred reforms in U.S. science and engineering education in order to increase the nation's technological capacity (Burdman, 2015). Although the sequence sometimes begins in eighth grade or earlier, this three-course sequence is the standard for most students in the majority of high schools throughout the country (Berry & Larson, 2019; Dossey et al., 2016).

This approach to mathematics, which prioritizes mastery of algebra, works well for a subset of students, particularly those who plan to attend college and pursue STEM fields (Burdman, 2019). However, for the majority of students, who do not intend to pursue STEM in college, the traditional high school mathematics course sequence has been associated with a range of concerns and challenges. Studies have shown that a course sequence focusing on algebra can impede student progress in mathematics and even jeopardize successful completion of high school (Kim, Kim, DesJardins, & McCall, 2015; Orihuela, 2006). Other studies have argued that algebra functions as a “gatekeeper,” or barrier, to progression to higher levels of education in fields other than math (Douglas & Attewell, 2017; Kim et al., 2015). Indeed, a growing discourse contests the relevance of algebraic course content to many students' postsecondary goals and career aspirations (Boaler et al., 2018). Moreover, the traditional algebra-focused mathematics sequence is associated with varied effects on student outcomes by racial/ethnic and socioeconomic background, raising the need to examine challenges specific to minoritized and low-income students (Lubienski & Shelley, 2003).

These concerns have impelled policymakers and educators to reexamine the prominence of algebra in the current high school mathematics course sequence and to consider new approaches that provide students with more mathematics course options better aligned with their academic and career goals.

This paper explores existing approaches to high school mathematics as well as new developments that seek to improve students' experiences in mathematics courses, increase student success, and advance more equitable opportunities and outcomes. We begin by presenting a survey of high school mathematics course sequences that are currently offered across the country and discuss some of the systemic challenges embedded within the traditional paradigm. Next we describe federal and state-level changes to the provision of high school mathematics that have taken place in the early 21st century and consider the influence that higher education reforms have had on high school math curricula. We then present very short case studies of innovative high school math reforms from five states to explore how they have changed high school mathematics courses and sequencing. Lastly, we conclude by considering how the Charles A. Dana Center's new initiative, Launch Years, builds on and extends several prior reforms and discuss how this project (in which CCRC functions as an evaluator) is working to reimagine high school mathematics.

## **2. Current High School Mathematics Course Offerings and Sequences**

Students nationwide are typically required to complete between two and four years of math before they graduate high school (Macdonald, Zinth, & Pompelia, 2019). As noted above, most schools use a single, common math sequence, or pathway, wherein nearly all students take the following courses in sequential order: (1) Algebra I, (2) geometry, and (3) Algebra II.<sup>1</sup> This traditional math sequence, beginning as early as eighth grade and completed often by 11<sup>th</sup> grade, aims to prepare students for calculus and direct entry into postsecondary STEM programs (Jimenez & Sargrad, 2018).

Although most high school students do not intend to pursue a postsecondary credential in STEM, a majority of states currently require students to complete a version of this sequence (Daro & Asturias, 2019), which we consider the traditional high school math pathway. One reason schools require this pathway is that they want to avoid limiting the subjects students will be able to study once they arrive in college. Moreover,

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<sup>1</sup> Some states offer an integrated approach to math that combines concepts from different math courses into a single course. For example, students may enroll in Integrated Math I, Integrated Math II, Integrated Math III, and Integrated Math IV.

many colleges and universities require the completion of Algebra II for admission. In many cases, high school students are permitted to enroll in alternative math courses, such as statistics or quantitative reasoning, only after completing the traditional course requirements (Fong, Perry, Reade, Klarin, & Jacquet, 2016). For example, although computer science courses can be taken to fulfill high school math requirements in 29 states (Zinth, 2018), these courses still require the completion of Algebra II as a prerequisite, which only reinforces the prevalent course-taking sequence.

While the traditional math pathway remains dominant, states are increasingly offering course alternatives to Algebra II during the third year of high school that may better align with students' academic and career goals. For example, several states, including New Jersey, New Mexico, and Washington, offer financial literacy courses that incorporate topics from Algebra I, geometry, and Algebra II (Macdonald et al., 2019). Likewise, students pursuing career and technical education (CTE) tracks may be able to complete career-based math courses instead of Algebra II. Indeed, at least 10 states currently allow students to replace one or more required math courses with approved integrated, applied, interdisciplinary, occupational, or technical courses (Macdonald et al., 2019), though many states stipulate that these courses must include content that aligns with the state's core math standards.

Interestingly, more advanced students, including those pursuing honors diplomas or those who satisfy high school graduation requirements at an accelerated pace, are most likely to have opportunities to take courses outside of the traditional pathway, through Advanced Placement (AP), International Baccalaureate (IB), or dual enrollment math courses. These courses, which generally meet high school math requirements, cover a broader range of topics than those typically offered in the standard curriculum, and can include advanced courses in statistics, economics, or engineering (Macdonald et al., 2019).

### **3. Challenges Arising From the Current Paradigm of High School Mathematics**

The current structure of high school mathematics puts an overwhelming emphasis on the mastery of algebra, considering it the K-12 mathematics subject that best prepares

students for postsecondary education (Achieve, 2020). However, focusing on algebra for college preparation has several drawbacks. First, this approach may not prepare students well for non-college or community college alternatives, such as workforce development programs and/or more immediate employment. Second, the approach does not align with recent changes made in postsecondary education, in which there is an increasing use of multiple mathematics pathways that encourage students to take courses relevant to their degree and career aspirations (Rutschow, Cormier, Dukes, & Cruz Zamora, 2019). Finally and relatedly, there are emerging college majors that require math courses other than algebra, which students may not be prepared to pursue under the current paradigm of high school mathematics (Charles A. Dana Center, 2020; Daro & Asturias, 2019).

In addition, the current algebra-dominant paradigm is associated with poor rates of student achievement, suggesting that it is failing many students. Several factors may contribute to these poor rates, such as certain pedagogical practices, poor alignment between instruction and standardized testing, and the use of single instruments to measure student achievement (Berry, 2003; Cullinan et al., 2018; English & Steffy, 2001; Resnick, Rothman, Slattery, & Vranek, 2004; Sanders & Rivers, 1996). Ngo and Velazquez (2020) tracked high school math course sequences taken by students matriculating to a large, urban community college from a feeder public high school in California. They found that more than 50% of students who completed Algebra II in high school with a B were placed into Algebra I or pre-algebra upon entry to community college based on their placement test performance (Melguizo & Ngo, 2020). These students were placed one to two levels below the math they had completed in high school; they therefore experienced a loss of “math mobility” and a decreased likelihood that they would progress to higher-level math courses in college (Ngo & Velasquez, 2020).

The equity implications of the current (traditional) high school mathematics paradigm are also important to consider. A single course, such as Algebra II, is generally divided into two tracks, or sections, based on students’ perceived ability (Gamoran, 2010). This practice disproportionately places lower-income and minoritized students in lower tracks, which limits their access to rigorous coursework that can better prepare them for college or the workforce (Banerjee, 2016; Schudde & Meiselman, 2019; Siegle,

McCoach, Gubbins, Callahan, & Knupp, 2015; Solórzano & Ornelas, 2002). High school tracking can also disadvantage underserved students in relation to admissions criteria and placement mechanisms used at many postsecondary institutions (Charles A. Dana Center, 2020). Indeed, when entering postsecondary institutions, Black and Latinx students, as well as students from low-income backgrounds, are deemed not college-ready at higher rates compared to their peers, and are in turn overrepresented in developmental education courses. As traditional postsecondary developmental math sequences are associated with lower chances of completing basic college requirements and increased rates of student attrition, this pathway into developmental education at the beginning of college contributes to socioeconomic and racial/ethnic gaps in rates of transfer and bachelor's degree attainment (Chen & Simone, 2016; Crisp & Nunez, 2014; CUNY Task Force on Developmental Education, 2016; Hodara, 2019).

The challenges associated with the traditional high school math paradigm highlight the need for new high school math pathways that students can pursue based on their educational and career aspirations, rather having all or most students follow a single algebra-focused pathway that many do not succeed in (Charles A. Dana Center, 2020; Daro & Asturias, 2019). A range of reforms, including the introduction of new pathways, have been undertaken to address these challenges, a number of which are discussed in the sections that follow.

#### **4. Federal Influences on the Provision of High School Mathematics**

Two prominent federal reforms in the early 21st century sought to influence how mathematics is taught in high schools across the country: No Child Left Behind and the Common Core State Standards.

The No Child Left Behind (NCLB) Act was passed in 2002 in response to concerns that U.S. students were falling behind students in other countries (Klein, 2003). One of its goals was to improve math outcomes for traditionally underserved groups of students, such as minoritized students, English language learners, and students in poverty. States were not required to abide by the policy reform, but they risked losing federal Title I funds if they opted out (Ladd, 2017). NCLB required teachers to be highly qualified,

which led to a dramatic increase in teachers attaining their master's degrees (Ladd, 2018). However, NCLB also spurred an increase in standardized testing, which has been linked to a more narrow, procedural approach in the teaching of algebra (Scogin, Kruger, Jekkals, & Steinfeldt, 2017; Smith & Kovacs, 2011). This not only led to student fatigue but also caused many teachers to “teach to the test” in order to meet accountability standards, which critics have argued emphasizes rote memorization rather than the comprehensive understanding of subject matter and the practice of abstract thinking. (Cawelti, 2006; Menken, 2006; Phelps, 2011; Schoen & Fusarelli, 2008; Smyth, 2008).

Introduced in 2010, the Common Core State Standards Initiative emerged in concert with other national initiatives, such as the American Diploma Project, that were concerned with low rates of college and career readiness among high school graduates. The fact that many young people graduated from high school but failed to meet benchmarks of college readiness raised concerns about variation among states in how college and career readiness was defined and measured (Rothman, 2011). The Common Core sought to create standards for English and math anchored in a common definition of college and career readiness (Barnett & Fay, 2013; Conley, 2014; Rothman, 2011). The National Governors Association and the Council of Chief State School Officers led the development of the Common Core State Standards, with 49 states initially volunteering to participate in the process and adapt their curriculum to align with the standards (Schmidt & Houang, 2012).

The Common Core math standards focused on teaching a more limited number of mathematical topics in greater depth, emphasizing conceptual understanding along with procedural fluency, and applying math concepts in different problem-solving contexts (Conley, 2014). Despite the desire to build cross-sector consensus on a definition of college and career readiness in mathematics, the implementation of Common Core failed to catalyze an alignment of expectations for college readiness in math between high schools and colleges (Barnett & Fay, 2013).

Beyond these two prominent federal reform efforts, a range of national groups has called for additional reforms to high school math education, often with a focus on equity, particularly on the racial/ethnic and socioeconomic gaps in postsecondary attainment (Domina & Saldana, 2012). In 2018, the National Council of Teachers of Mathematics

(NCTM) released a report arguing that changes to improve equity are needed in high school mathematics and that a focus on standards alone is insufficient. The NCTM (2018) contended that it is important to remove structural barriers to student progress in math, including the practice of tracking students into lower-level, terminal mathematics pathways “that are not mathematically meaningful and do not prepare [students] for any continued study of fundamental mathematics or effective participation in democratic society” (p. 4). Additionally, the organization Transforming Postsecondary Education in Mathematics named the creation of multiple math pathways in lower-division high school mathematics among its top priorities; the aim is to better align secondary coursework with students’ college programs of study and thus increase college completion rates (Transforming Postsecondary Education in Mathematics, n.d.).

### **5. State- and Local-Level Changes in the Provision of High School Mathematics**

States and localities have also implemented policies and practices intended to make sure that students graduate high school prepared for college-level work in mathematics. This has taken several forms, including mandating particular approaches to algebra instruction, changing the number of math courses required to graduate from high school, developing transition courses to improve college readiness, and increasing student interest in STEM education.

Some localities have implemented “algebra for all” models, which mandate that students who were slated to take remedial math in ninth grade enroll in Algebra I instead, thereby increasing algebra enrollment across schools. However, studies have found that such initiatives do not improve math learning as intended, most likely due to flaws in their theories of action that presume that students have developed sufficient K-8 mathematical background needed to benefit from instruction in algebra (Allensworth, Nomi, Montgomery, & Lee, 2009). To address this concern, “double-dose algebra” was developed to overcome the shortcomings of algebra for all by requiring students who scored below the national median on an eighth-grade math test to take two class periods of algebra in ninth grade: the regular Algebra I course and a remedial course designed to provide support and build foundational math skills (Nomi & Raudenbush, 2016).

Studies have shown that while algebra for all decreased the segregation of classrooms based on students' math test scores, double-dose algebra showed the opposite effect, intensifying the sorting and tracking of students by their perceived math ability (Nomi, 2012; Nomi & Allensworth, 2013). The Consortium on Chicago School Research at the University of Chicago Urban Education Institute reported that this "form of ability grouping" based on incoming math skills benefited all students: those in double-dose classes gained from extra instructional time and teacher support, while those in single-dose algebra benefited from "stronger classroom environments with less time spent on in-class remediation" (Durwood, Krone, & Mazzeo, 2010). Likewise, Cortes, Goodman, and Nomi (2013) found that double-dose algebra increased the proportion of students earning at least a B in Algebra I by 9.4 percentage points, to more than 65%. The initiative, however, did not impact overall passing rates in Algebra I, or in geometry (taken in 10<sup>th</sup> grade). Long-term effects were positive, showing that double-dosing algebra increased four- and five-year high school graduation rates by 8.7 and 7.9 percentage points respectively. Double-dosed students were 8.6 percentage points more likely to enroll in college within five years of starting high school (Cortes, Goodman, & Nomi, 2013).

Some states have deviated from the traditional and most common three-year math sequence required to graduate from high school. While the majority of states require three years of high school math (namely Algebra I, geometry, and Algebra II), 17 states now require four, and a few states require only two (Burdman, 2018). California, for example, requires two math courses, and it does not require Algebra II (Macdonald et al., 2019). Changes in high school graduation requirements, however, do not necessarily line up with college admissions requirements. A study of high school graduation requirements in 48 states from the Center for American Progress found that only 23 states had math requirements that were aligned with those needed for college admission, while eight states were not aligned, and 16 states could be aligned depending on student course-taking choices (Jimenez & Sargrad, 2018).

Another means to address low levels of college readiness has been the development of high school transition curricula. Transition courses are typically co-created by K-12 and college partners and taken by high school seniors identified as not on track to be college-ready in math upon graduation. These courses have been

proliferating over the past ten years. In 2017, CCRC conducted a national scan of transition courses in all 50 states and found that they were offered as part of secondary school programming in 39 states—an increase of 10 states since 2012–2013, when a similar scan was done (Barnett, Chavarín, & Griffin, 2018). Some transition curricula are aligned with mathematics pathways offered at colleges and may be paired with other college readiness interventions, such as dual enrollment programs (Barnett, Chavarín, & Griffin, 2018).

There are also state-level efforts to increase interest in STEM and improve student outcomes in these subjects (ACT, 2017). A number of these initiatives involve partnerships with business and industry and include a focus on technology. For example, New Jersey has undertaken a STEM initiative that includes a partnership with Math for America in which fellowships are offered to teachers to help them use innovative teaching practices that lead to the flexible problem-solving skills required for continuing STEM education and careers (State of New Jersey, Office of Governor Phil Murphy, 2019).

## **6. The Role of Postsecondary Institutions in Shaping High School Mathematics**

As noted, the majority of colleges and universities require that students successfully complete Algebra II for admission (Dounay, 2006). Many higher education institutions have been reluctant to change this requirement, believing that passing Algebra II is a good indicator of the level of rigor students have achieved in math and their ability to succeed in college, an assumption that has been questioned by scholars and practitioners (Burdman, 2019; Charles A. Dana Center, 2020). So long as these institutions continue to require Algebra II for admissions, high school leaders and educators are not likely to change their mathematics course offerings and requirements, as they do not want to limit students' options for postsecondary education.

In addition, college placement practices discourage high schools from changing the types of high school math courses offered. Colleges use national college placement tests, primarily ACCUPLACER, or similar local or state tests, to determine whether students should enter remedial or college-level math courses. As existing college

placement tests focus on knowledge of algebra, they also reinforce the idea that all students need Algebra II (Charles A. Dana Center, 2020).

On the other hand, the movement to reform higher education mathematics pathways is opening the door to the idea that students may benefit from having more math options in high school. The Dana Center Mathematics Pathways (DCMP) initiative is a postsecondary mathematics pathways reform designed to deliver mathematics courses that are more relevant to college students' academic and career goals (Bickerstaff & Moussa, 2020). By enrolling in pathways that focus on statistics or quantitative reasoning, for example, students in non-STEM programs can bypass college algebra and take a mathematics course that better aligns with the quantitative skill needs of their programs of study (Rutschow, Sepanik, et al., 2019). Development of these alternative pathways has involved the recognition that college algebra, which has traditionally been the default transferable mathematics requirement, has been a major stumbling block for student success in college (Bickerstaff & Moussa, 2020; American Mathematical Association of Two-Year Colleges, 2014; National Council of Teachers of Mathematics, 2018).

The higher education math pathways movement has also emerged partially in response to a refined understanding of the types of math skills that employers are seeking in college-educated employees (Charles A. Dana Center, 2020). Increasingly, there is a range of jobs that involve data science (encompassing statistics, computer science, and domain-specific knowledge) and data analytics (extracting information from data). Existing fields, such as education, social work, and nursing, for example, are increasingly relying on data-driven analyses to inform decision-making among practitioners. Another similar set of skills increasingly sought is related to mathematical modeling, in which math is used to represent phenomena and make data-informed predictions. Postsecondary educators are increasingly aware of these workforce needs and are beginning to structure college curricula accordingly.

An approach to mathematics reform emphasizing different math pathways is starting to appear in secondary education as well, suggesting that such an approach can challenge the status quo and extend backward from higher education to K-12 to create a

more seamless pipeline of relevant and rigorous mathematics courses. The Launch Years initiative, described at the end of this report, builds upon this framing.

## **7. Examples of Innovative High School Math Reforms**

This section offers five mini-case studies that describe innovations in high school mathematics in Ohio, California, Oregon, Texas, and Washington. These states are profiled because they present interesting examples of secondary mathematics reform. Although some of these reforms have shown promise in improving student outcomes, not all of the reforms have been formally evaluated, and more causal impact and longitudinal studies are needed to measure their effectiveness. Studies on the impacts of each innovation are included in the case studies when available.

### **7.1 Ohio**

In 2014, Ohio's state legislature enacted a new policy that requires all students to complete a fourth year of high school math in order to graduate. Fourth-year math courses could include pre-calculus, statistics, transition-to-college algebra courses, computer science, AP mathematics courses, trigonometry, and quantitative reasoning (Ohio Department of Education, 2019).

The policy also allows students who have entered high school on or after July 1, 2015, and who are pursuing a CTE pathway to replace the Algebra II requirement in their third year with a career-based mathematics course (Ohio Department of Education, 2016). The aim of this policy is to provide CTE students with courses that directly connect the high school mathematics they learn to the math they will need in the workforce. These courses must also be highly contextualized and incorporate real-world problems that encourage the effective use of mathematical notation, vocabulary, and reasoning. As of now, this reform has not been studied for its effectiveness.

Another innovative practice is permitted under the Ohio statute that mirrors successful remediation practices in higher education. High school students in Ohio who need extra help to be successful in math can sign up for a regular math course along with a companion support course designed to help students keep up with the rigor and pace of the regular math course, similar to how the corequisite remediation model is offered in

colleges and universities. The Ohio statute allows students to receive credit for two math courses (the regular math course and the companion support course) toward the four courses required for graduation.

## **7.2 California**

Relative to other states, California has minimal math requirements for high school graduation, though students expecting to enter the University of California or California State University (CSU) system must meet higher standards. For high school graduation, students are generally required to take two math courses, including Algebra I and an elective math course. To increase the number of students prepared for college, CSU worked with the State Board of Education and the California Department of Education to develop the Early Assessment Program (EAP), designed to help students in their junior year of high school better understand their readiness for college-level English and mathematics and facilitate opportunities to improve their skills during their senior year.

In 2008, 70% of students decided to take the optional EAP test to determine whether or not they were on track to place into credit-bearing courses in college (CSU, 2019). Those who passed the test would automatically qualify to take credit-bearing courses at a CSU campus. Those who did not pass had their entire senior year to address deficiencies prior to high school graduation and college enrollment. Using administrative records from CSU, the City of Sacramento, and the California Department of Education, Howell, Kurlaender, and Grodsky (2010) found that those who participated in EAP lessened their probability of needing a developmental mathematics course in college by 4.1 percentage points.

There is also interest in California in offering new math options in high school. According to Jones (2018), about 30 schools are offering data science courses, in some cases as an alternative to Algebra II. These courses were developed through a grant to the Los Angeles Unified School District and the University of California, Los Angeles, from the National Science Foundation. Incorporating a blend of statistics and computer programming, the courses help students learn how to use large data sets to identify patterns and trends, a skill increasingly needed in the workplace. The schools are also interested in using these courses to help students become more informed about the world and more civically engaged.

### 7.3 Oregon

Established in 2018, the Oregon Math Project (OMP) was designed to transform secondary math education and to increase postsecondary readiness and success. The OMP brings together secondary and postsecondary stakeholders to develop policy, curricula, and assessments and share best instructional practices. It is connected with larger teacher networks in Oregon and across the country (Oregon Department of Education, 2018).

Within the OMP, high school and higher education faculty develop and endorse high school standards, course frameworks, and multiple math pathways options. The OMP also shares resources with faculty across the sectors to improve math pedagogy, with an emphasis on student-directed learning. This faculty engagement is intended to institutionalize a culture of math proficiency among students that instills life-long critical thinking and problem-solving skills. The work is also intended to create a culture of equity, in which marginalized students become as well prepared for postsecondary success as their more advantaged peers.

The OMP represents an important shift that involves aligning secondary and postsecondary coursework through faculty engagement. If this work is successful, students will experience a more seamless transition from high school mathematics to the college mathematics of their choice. As of now, there is no research on the impacts of this initiative.

### 7.4 Texas

In a 2013 legislative session, Texas policymakers changed high school graduation requirements for all students, allowing those who are not aiming for STEM majors and careers to skip Algebra II and take an alternative advanced mathematics course instead (H.B. 5, 2013). The program, which began in the 2014–2015 academic year, was designed to have three stackable tiers leading to graduation. Students on the *foundation* track, or first tier, are required to take three mathematics courses: Algebra I, geometry, and an advanced course such as statistics. For the second tier, students must build on top of the foundation curricula and earn an *endorsement* in one of five areas: STEM, business and industry, public services, arts and humanities, and multidisciplinary studies. These endorsements require students to take an additional advanced math course relevant to

each subject (for a total of four mathematics courses). STEM is the only track that requires students to take Algebra II for their advanced course, or third course after geometry. In the third tier, for students to graduate with a *distinguished level of achievement*, they must complete a total of four math courses. This includes the foundation program with an endorsement, and all students (regardless if STEM or not) must take Algebra II as their advanced course (Texas Education Agency, 2016).

Texas has also been proactive in developing new math courses that expand student options. The Charles A. Dana Center at the University of Texas at Austin and the Texas Association of Supervisors of Mathematics worked together to develop a rigorous, fourth-year mathematics course to follow the Algebra I, geometry, and Algebra II sequence. Titled Advanced Mathematical Decision Making (AMDM), this course meets graduation requirements for any student seeking the distinguished level of achievement. It may also present an appealing option for students pursuing workforce training programs. The course emphasizes statistics and financial applications and prepares students to use algebra, geometry, trigonometry, and discrete mathematics to model a range of situations and solve problems (Charles A. Dana Center, 2019; Rennie Center for Education Research and Policy, 2009). There have been no studies on its effectiveness to date.

## **7.5 Washington**

In 2014, Washington State launched the Bridge to College (BTC) transition course to help non-STEM students prepare for success in college-level mathematics. With the participation of high school and college mathematics educators, the BTC project aims to identify the mathematics skills and knowledge that non-STEM high school graduates need to meet college admissions requirements and avoid developmental education upon college enrollment (Washington State Board for Community & Technical Colleges, 2015).

The state uses the Smarter Balanced Assessment to evaluate 11<sup>th</sup> and 12<sup>th</sup> graders' mathematics skills and determine whether or not they are college-ready. Students who score below college readiness are able to enroll in the BTC transition course, which emphasizes conceptual learning and real-world applications. Those who earn a grade of B or above in the BTC course are eligible to enroll in non-STEM college-level math

courses at any of the participating Washington higher education institutions (Washington State Board for Community & Technical Colleges, 2019).

One study of the effectiveness of the BTC course found that students who participate are more likely to begin college taking college-level mathematics than their peers in a comparison group, those who were not college-ready according to the Smarter Balanced Assessment but did not enroll in BTC (Baker, Mehlberg, & Macneille, 2018). Researchers found that about 70% of students who enrolled in a BTC course earned a grade of C or better in their first college-level mathematics course, a rate that was similar to peers who were deemed to not need such a course. Students who took BTC courses responded positively when asked about the support and instruction offered in these courses, with many reporting that the BTC course helped them develop a growth mindset and become more efficacious students (Baker, Mehlberg, & Macneille, 2018).

### **8. Facilitating a Paradigm Shift: Launch Years**

Informed by prior recent math reforms, the Launch Years initiative, created by the Charles A. Dana Center, aims to catalyze a paradigm shift in secondary math course offerings and instructional practices. The goal of the Launch Years initiative is to create a mathematics pathway starting in high school that leads seamlessly to students' next steps post-graduation and is comprehensive in its content, relevant to students' postsecondary and workforce goals, and equitable in terms of student access and outcomes. The Dana Center released a report in March 2020 that made the case for this new math paradigm and outlined several recommendations to help states increase equitable educational opportunities for students who face systemic barriers to advancing in mathematics (Charles A. Dana Center, 2020). The Launch Years initiative is also actively mobilizing other key education, workforce, and equity organizations to help refine, support, and disseminate key principles associated with the model.

The Launch Years initiative includes the design and implementation of two new high school math courses. The first is a transition course offered in high school to help students enter college well-prepared for college-level math courses. The second is a “modernized” Algebra II course with a revised curriculum that includes other

mathematical content, such as statistics and data science, in order to better align with students' postsecondary goals. In addition, these two courses include a Social, Emotional, and Academic Development (SEAD) component that aims to help students learn how to work collaboratively, react productively to mistakes, engage in positive academic behaviors, self-advocate, and maintain motivation.

The Launch Years initiative began in 2018 and has engaged with three states—Texas, Georgia, and Washington—to start implementing the initiative's recommendations. State and local legislatures, along with leaders, experts, and advocates from K-12, higher education, and business and industry, are working together to implement Launch Years courses while building a policy environment that will support them widely.

The Launch Years initiative learns from and builds upon previous reforms in math. It seeks to introduce new requirements, norms, and practices that are responsive to students' needs and the requirements of the economy and workplace. And it strives for the creation of equitable opportunities for success in math, higher education, and careers. Importantly, it contributes to the increasing trend toward the development of math pathways that may both eschew a strong focus on algebra and span the divide between K-12 and postsecondary education—it aims to improve students' progression through all their educational experiences and into the world of work. It will be important to watch the development of this initiative, to understand the challenges in its implementation, the extent to which states and institutions find resonance in its goals and structure, and what implications it holds for students.

## References

- Achieve. (2020). *The Algebra II variable: State policies for graduation requirements, assessments, and alignment to postsecondary expectations*. Washington, DC: Author.
- ACT. (2017). *STEM education in the U.S.: Where we are and what we can do*. Iowa City, IA: Author.
- Allensworth, E., Nomi, T., Montgomery, N., & Lee, V. E. (2009). College preparatory curriculum for all: Academic consequences of requiring Algebra and English I for ninth graders in Chicago. *Educational Evaluation and Policy Analysis*, 31(4), 367–391. Retrieved from [www.jstor.org/stable/25621591](http://www.jstor.org/stable/25621591)
- American Mathematical Association of Two-Year Colleges. (2014). *Position on the appropriate use of intermediate algebra as a prerequisite course*. Memphis, TN: Author. Retrieved from <https://amatyc.site-ym.com/page/PositionInterAlg>
- Baker, D., Mehlberg, S., and MacNeille, B. (2018). *College readiness math initiative: Bridge to College impact evaluation*. Bothell, WA: The BERC Group.
- Banerjee, P. A. (2016). A systematic review of factors linked to poor academic performance of disadvantaged students in science and maths in schools. *Cogent Education*, 3(1). doi:10.1080/2331186X.2016.1178441
- Barnett, E., Chavarín, O., & Griffin, S. (2018). *Math transition courses in context: Preparing students for college success*. New York, NY: Columbia University, Teachers College, Community College Research Center.
- Barnett, E., & Fay, M. P. (2013). *The Common Core State Standards: Implications for community colleges and student preparedness for college*. New York, NY: The National Center for Postsecondary Research.
- Berry, R. Q. (2003). Mathematics standards, cultural styles, and learning preferences: The plight and the promise of African American students. *The Clearing House*, 76(5): 244–249.
- Berry, R. Q., & Larson, M. R. (2019). The need to catalyze change in high school mathematics. *Phi Delta Kappan*, 100(6), 39–44.
- Boaler, J., Schoenfeld, A., Daro, P., Asturias, H., Callahan, P., & Foster, D. (2018, October 9). Opinion: How one city got math right. *The Hechinger Report*. Retrieved from <https://hechingerreport.org/>

- Bickerstaff, S., & Moussa, A. (2020). *A top-down/bottom-up approach to statewide change: Mathematics Pathways to Completion*. New York, NY: Columbia University, Teachers College, Community College Research Center.
- Burdman, P. (2015). *Degrees of freedom: Diversifying math requirements for college readiness and graduation* (Report 1 of 3). Oakland, CA: LearningWorks and Policy Analysis for California Education.
- Burdman, P. (2018). *The mathematics of opportunity: Rethinking the role of math in educational equity*. Berkeley, CA: Just Equations.
- Burdman, P. (2019). Re-thinking the role of Algebra 2 in college readiness. Retrieved from <https://theopportunityinstitute.org/blog/2019/re-thinking-the-role-of-algebra-2-in-college-readiness>
- California State University. (2019). CSU student success: Committed to student success from high school preparation to college graduation. Retrieved from <http://csustudentsuccess.org/>
- Cawelti, G. (2006). The side effects of NCLB. *Educational Leadership*, 64(3), 64–68.
- Charles A. Dana Center. (2019). Advanced mathematical decision making. Retrieved from <https://www.utdanacenter.org/our-work/k-12-education/k-12-education-curricular-resources/course-materials/advanced-mathematical-decision-making>
- Charles A. Dana Center. (2020). *Launch Years: A new vision for the transition from high school to postsecondary mathematics*. Austin, TX: Author.
- Chen, X., & Simone, S. (2016). *Remedial coursetaking at U.S. public 2- and 4-year institutions: Scope, experiences, and outcomes. Statistical analysis report* (NCES 2016-405). Washington, DC: National Center for Education Statistics.
- Conley, D. T. (2014). *The Common Core State Standards: Insight into their development and purpose*. Washington, DC: Council of Chief State School Officers.
- Cortes, K., Goodman, J., & Nomi, T. (2013). A double dose of algebra. *EducationNext*, 13(1).
- Crisp, G., & Nuñez, A. M. (2014). Understanding the racial transfer gap: Modeling underrepresented minority and nonminority students' pathways from two- to four-year institutions. *The Review of Higher Education*, 37(3), 291–320.
- Cullinan, D., Barnett, E. A., Ratledge, A., Welbeck, R., Belfield, C., & Lopez, A. (2018). *Toward better college course placement: A guide to launching a multiple measures assessment system*. New York, NY: Columbia University, Teachers College, Community College Research Center.

- CUNY Task Force on Developmental Education. (2016). *Report of the CUNY Task Force on Developmental Education*. Retrieved from [http://www2.cuny.edu/wp-content/uploads/sites/4/page-assets/about/administration/offices/undergraduate-studies/developmental-education/Proposed-Recommendations-of-RTF-06.17.16.final\\_.pdf](http://www2.cuny.edu/wp-content/uploads/sites/4/page-assets/about/administration/offices/undergraduate-studies/developmental-education/Proposed-Recommendations-of-RTF-06.17.16.final_.pdf)
- Daro, P., & Asturias, H. (2019). *Branching out: Designing high school math pathways for equity*. Berkeley, CA: Just Equations.
- Domina, T., & Saldana, J. (2012). Does raising the bar level the playing field? Mathematics curricular intensification and inequality in American high schools, 1982–2004. *American Educational Research Journal*, 49(4), 685–708.
- Dossey, J. A., McCrone, S. S., & Halvorsen, K. T. (2016). *Mathematics education in the United States 2016: A capsule summary fact book*. Reston, VA: National Council of Teachers of Mathematics.
- Douglas, D. & Attewell, P. (2017). School mathematics as gatekeeper. *The Sociological Quarterly*, 58(4), 648–669
- Dounay, J. (2006). *Alignment of high school graduation requirements and state-set college admissions requirements*. Denver, CO: Education Commission of the States.
- Durwood, C., Krone, E., & Mazzeo, C. (2010). *Are two algebra classes better than one? The effects of double-dose instruction in Chicago*. Chicago, IL: Consortium On Chicago School Research, University of Chicago Urban Education Institute.
- English, F. W., & Steffy, B. E. (2001). *Deep curriculum alignment: Creating a level playing field for all children on high-stakes tests of accountability*. Lanham, MD: Rowman & Littlefield Education.
- Fong, T., Perry, R., Reade, F., Klarin, B., & Jacquet, K. (2016). *Many pathways to student success in mathematics: Middle and high school math course sequences and placement decisions in the Math in Common districts*. San Francisco, CA: WestEd.
- Gamoran, A. (2010). Is ability grouping equitable? In R. Arum, I. R. Beattie, K. Ford (Eds.), *The structure of schooling: Readings in the sociology of education* (2<sup>nd</sup> ed., pp. 193–198). Sage Publications.
- H.B. 5. 83<sup>rd</sup> Texas Legislature, Reg. Sess. (2013). Retrieved from <https://capitol.texas.gov/tlodocs/83R/billtext/pdf/HB00005F.pdf>
- Hodara, M. (2019, March). *Understanding the developmental mathematics student population: Findings from a nationally representative sample of first-time college entrants*. Paper prepared for the Workshop on Increasing Student Success in Developmental Mathematics, Washington, DC.

- Howell, J. S., Kurlaender, M., & Grodsky, E. (2010). Postsecondary preparation and remediation: Examining the effect of the early assessment program at California State University. *Journal of Policy Analysis and Management*, 29(4), 726–748. doi:10.1002/pam.20526
- Kim, J., Kim, J., DesJardins, S. L., & McCall, B. P. (2015). Completing Algebra 2 in high school: Does it increase college access and success? *The Journal of Higher Education*, 86(4), 628–662.
- Jimenez, L., & Sargrad, S. (2018). *Are high school diplomas really a ticket to college and work? An audit of state high school graduation requirements*. Washington, DC: Center for American Progress.
- Jones, C. (2018, February 19). ‘Big data’ classes a big hit in California high schools. *Edsource*. Retrieved from <https://edsource.org/2018/big-data-classes-a-big-hit-in-california-high-schools/593838>
- Klein, D. (2003). A brief history of American K-12 mathematics education in the 20<sup>th</sup> century. In J. Royer (Ed.), *Mathematical cognition*. Retrieved from <http://www.csun.edu/~vcmth00m/AHistory.html>
- Ladd, H. F. (2017). No Child Left Behind: A deeply flawed federal policy. *Journal of Policy Analysis and Management*, 36(2), 461–469.
- Lubienski, S. T., & Shelley, M. C. (2003, April). *A closer look at U.S. mathematics instruction and achievement: Examinations of race and SES in a decade of NAEP data*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.
- Macdonald, H., Zinth, J. D., & Pompelia, S. (2019). *High school graduation requirements: What are the state’s course requirements for high school graduation?* Denver, CO: Education Commission of the States. Retrieved from <https://www.ecs.org/high-school-graduation-requirements/>
- Melguizo, T., & Ngo, F. (2020). Mis/alignment between high school and community college standards. *Educational Researcher*, 49(2), 130–133.
- Menken, K. (2006). Teaching to the test: How No Child Left Behind impacts language policy, curriculum, and instruction for English language learners. *Bilingual Research Journal*, 30(2), 521–546. doi:10.1080/15235882.2006.10162888
- National Council of Teachers of Mathematics. (2018). *Catalyzing change in high school mathematics. Initiating critical conversations*. Reston, VA: Author.
- Nomi, T. (2012). The unintended consequences of an algebra-for-all policy on high-skill students: Effects on instructional organization and students' academic outcomes. *Educational Evaluation and Policy Analysis*, 34(4), 489–505.

- Nomi, T., & Allensworth, E. M. (2013). Sorting and supporting: Why double-dose algebra led to better test scores but more course failures. *American Educational Research Journal*, 50(4), 756–788.
- Nomi, T., & Raudenbush, S. W. (2016). Making a success of "Algebra for All": The impact of extended instructional time and classroom peer skill in Chicago. *Educational Evaluation and Policy Analysis*, 38(2), 431–451. Retrieved from [www.jstor.org/stable/44984546](http://www.jstor.org/stable/44984546)
- Ngo, F. J., & Velasquez, D. (2020). Inside the math trap: Chronic math tracking from high school to community college. *Urban Education*, 1–29.
- Ohio Department of Education. (2016). *Career-technical education pathway guidelines for Algebra 2/Mathematics III replacement*. Retrieved from <https://education.ohio.gov/getattachment/Topics/Ohios-Learning-Standards/Mathematics/Math-Graduation-Requirements/Career-Technical-Pathway-Algebra-II-Replacement-Guidelines.pdf.aspx>
- Ohio Department of Education. (2019). Mathematics graduation requirements. Retrieved from <http://education.ohio.gov/Topics/Learning-in-Ohio/Mathematics/Resources-for-Mathematics/Math-Graduation-Requirements>.
- Oregon Department of Education. (2018). *Oregon Mathways Initiative: Logic model*. Retrieved from <https://www.oregon.gov/ode/educator-resources/standards/mathematics/Documents/Logic%20Model.docx>
- Orihuela, Y. R. (2006). *Algebra I and other predictors of high school dropout* (Doctoral dissertation). Retrieved from ProQuest Dissertations Publishing.
- Phelps, R. P. (2011). Teach to the test? *The Wilson Quarterly*, 35(4), 38–42. Retrieved from [www.jstor.org/stable/41484371](http://www.jstor.org/stable/41484371)
- Rennie Center for Education Research and Policy. (2009). *Alternative high school math pathways in Massachusetts: Developing an on-ramp to minimize college remediation in mathematics*. Boston, MA: Author. Retrieved from [https://www.renniecenter.org/sites/default/files/2017-01/Alternative High School Math Pathways in Massachusetts.pdf](https://www.renniecenter.org/sites/default/files/2017-01/Alternative%20High%20School%20Math%20Pathways%20in%20Massachusetts.pdf)
- Resnick, L. B., Rothman, R., Slattery, J. B., & Vranek, J. L. (2004). Benchmarking and alignment of standards and testing. *Educational Assessment*, 9(1–2), 1–27.
- Rothman, R. (2011). *Something in common: The Common Core Standards and the next chapter in American education*. Cambridge, MA: Harvard Education Press.
- Rutschow, E. Z., Cormier, M. S., Dukes, D., & Cruz Zamora, D. E. (2019). *The changing landscape of developmental education practices: Findings from a national survey and interviews with postsecondary institutions*. New York, NY: Center for the Analysis of Postsecondary Readiness.

- Rutschow, E. Z., Sepanik, S., Deitch, V., Raufman, J., Dukes, D., & Moussa, A. (2019). *Gaining ground: Findings from the Dana Center Mathematics Pathways impact study*. New York, NY: Center for the Analysis of Postsecondary Readiness.
- Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. Knoxville, TN: University of Tennessee Value-Added Research and Assessment Center.
- Schmidt, W. H., & Houang, R. T. (2012). Curricular coherence and the Common Core State Standards for mathematics. *Educational Researcher*, 41(8), 294–308. doi:10.3102/0013189x12464517
- Schoen, L., & Fusarelli, L. D. (2008). Innovation, NCLB, and the fear factor: The challenge of leading 21st-century schools in an era of accountability. *Educational Policy*, 22(1), 181–203. doi:10.1177/0895904807311291
- Schudde, L., & Meiselman, A. Y. (2019). *Early outcomes of Texas community college students enrolled in Dana Center Mathematics Pathways prerequisite developmental courses*. New York, NY: Center for the Analysis of Postsecondary Readiness. Retrieved from <https://postsecondaryreadiness.org/early-outcomes-texas-dcmp-prerequisite-courses/>
- Scogin, S. C., Kruger, C. J., Jekkals, R. E., & Steinfeldt, C. (2017). Learning by experience in a standardized testing culture: Investigation of a middle school experiential learning program. *Journal of Experiential Education*, 40(1), 39–57. doi:10.1177/1053825916685737
- Siegle, D., McCoach, D. B., Gubbins, E. J., Callahan, C. M., & Knupp, T. (2015). *Promising practices in gifted education for underserved populations*. Paper presented at the 62nd Annual Convention of the National Association for Gifted Children, Phoenix, AZ.
- Smith, J. M., & Kovacs, P. E. (2011). The impact of standards-based reform on teachers: The case of ‘No Child Left Behind.’ *Teachers and Teaching: Theory and Practice*, 17(2), 201–225.
- Smyth, T. S. (2008). Who is No Child Left Behind leaving behind? *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 81(3), 133–137. doi:10.3200/tchs.81.3.133-137
- Solórzano, D., & Ornelas, A. (2002). A critical race analysis of Advanced Placement classes: A case of educational inequality. *Journal of Latinos and Education*, 1(4), 215–229. doi:10.1207/S1532771XJLE0104\_2
- State of New Jersey, Office of Governor Phil Murphy. (2019, January 30). *Governor Murphy announces grants to advance “Computer Science for All” initiative* [Press release]. Retrieved from <https://nj.gov/governor/news/news/562019/approved/20190130a.shtml>

- Texas Education Agency. (2016). *House Bill 5: Foundation high school program*. Austin, TX: Author.
- Transforming Post-Secondary Education in Mathematics. (n.d.). TPSEMath. Retrieved from <https://www.tpsemath.org/>
- Volante, L. (2004). Teaching to the Test: What Every Educator and Policy-Maker Should Know. *Canadian Journal of Educational Administration and Policy*, (35).
- Washington State Board for Community & Technical Colleges. (2015). *Bridge to College courses in Washington: Project overview*. Retrieved from <https://app.leg.wa.gov/committeeschedules/Home/Document/173875>
- Washington State Board for Community & Technical Colleges. (2019). *Bridge to College transition courses: Questions and answers*. Retrieved from <https://www.sbctc.edu/resources/documents/about/agency/initiatives-projects/bridge-to-college-transition-courses-q-a-june2019.pdf>
- Zinth, J. (2018). *Education Commission of the States: Response to information request*. Retrieved from [https://www.ecs.org/wp-content/uploads/State-Information-Request\\_Math-Science-Computer-Science-in-Graduation-Requirements.pdf](https://www.ecs.org/wp-content/uploads/State-Information-Request_Math-Science-Computer-Science-in-Graduation-Requirements.pdf)