Mathematics At The Transition

Opportunities to align high school and college mathematics in Texas

Texas leaders and educators continue to be concerned about the readiness of students who complete high school and matriculate to higher education. It is an important time to ensure that Texas students have the skills they need for tomorrow's economy. The Texas Education Agency reports that only 67% of graduating high school seniors are prepared for college mathematics.[i] This contributes to large numbers of students needing to take developmental (remedial) courses in college. Complete College America found that 51% of two-year and 12% of four-year students in Texas require remediation upon entry to college.[ii] Of two-year college students who begin taking developmental classes, only 5.8% of them earn a degree in three years.[iii] Given these factors, the state is at risk of not meeting the needs of the workforce. By 2018, 56% of jobs in Texas will require a postsecondary technical, two-year, or four-year degree. Currently only one-third of Texans meet one of these educational bars.[iv]

Teachers, administrators, and policymakers are grappling with questions about the kind of mathematics, and how much mathematics, high school students need to take in order to be ready for postsecondary opportunities. Recent K–12 legislation provides districts with the flexibility to allow students to choose mathematics courses that best prepare them for their college major and career. House Bill 5 revised high school graduation requirements to include endorsements. Endorsements are similar to a college major and allow students to build their mathematics sequence around their targeted areas of study. "Areas," "fields," or "programs of study" are similar to a specific group of courses needed for an industry certificate, associate's degree, or four-year college major.

At the same time, the mathematics community in higher education is working towards better alignment of mathematics to students' career pathways. Responding to industry needs, many institutions of higher education require different mathematics courses like Statistics or Quantitative Reasoning (also called Contemporary Mathematics) based on students' programs of study. Historically, all postsecondary students took College Algebra whether or not it would be useful for their career.

This brief synthesizes policies and offers recommendations for a more coherent approach to mathematics preparation at the high school to postsecondary transition.

Relevant Texas Policy Considerations and Initiatives

- House Bill 5 graduation requirements with endorsements and the College Prep course
- The Texas Success Initiative and measuring college mathematics readiness
- Improving developmental education through the New Mathways Project
- The Texas Higher Education Coordinating Board rule change regarding differentiated college mathematics readiness

Recommendations for a Seamless Transition

- Mathematics course sequences should align with programs of study.
- All students need third-year mathematics courses that deepen their understanding and facility with core concepts of algebra.
- All students should take mathematics every year in high school.
- Students should take fourth-year high school mathematics courses that prepare them for college-level mathematics.
- The state should expand efforts to accelerate student time in developmental education courses and align them to college and career pathways.

Relevant Texas Policy Considerations and Initiatives

House Bill 5 graduation requirements with endorsements and the College Prep course

Texas policymakers have attempted to address the challenge of the vertical alignment of mathematics courses from high school to higher education in several ways. House Bill 5 called for the revision of graduation requirements, enabling students to explore careers through endorsements beginning in ninth grade. Endorsements are coherent course sequences related to career fields. Built on a foundation of a core curriculum, endorsements add specific knowledge for college and careers. In their third and fourth years of mathematics, students have the opportunity to choose courses that emphasize the mathematics needed for their endorsements and programs of study for postsecondary technical certificates and degrees.

Under new graduation requirements in Texas, students on the foundation graduation plan must take Algebra I, Geometry, and one other advanced mathematics course. Although students can earn a high school diploma on the foundation plan, districts start all students on the graduation plans that include adding an endorsement, or an endorsement and distinguished level of achievement. Pursuing an endorsement or the distinguished achievement graduation designation requires that students take four years of mathematics that may or may not include Algebra II.

Additionally, the legislation requires that districts partner with institutions of higher education to develop and offer a College Prep Mathematics course for entering twelfth graders who are not yet ready for college-level mathematics. Developing this course has spurred conversations between school districts and institutions of higher education across the state about what students need to learn to be prepared for a variety of entry-level college courses. The Texas Success Center convened high school and college educators to develop a framework of student learning outcomes for the College Prep course. The Texas Success Center's mission is to build the capacity of the Texas Association of Community College's (TACC) ability to support and scale college student success efforts.

The Texas Success Initiative and measuring college mathematics readiness

Districts and institutions of higher education continue to grapple with the issue of how best to provide consistent accountability for college readiness across the state while taking into consideration that not all pathways require the same mathematics skills. Historically, College Algebra was the only entry-level college course whereas now, colleges offer three to four. It is important to modernize the Texas Success Initiative (TSI) assessment so that it evaluates students' preparedness for the variety of pathways that exist.

The TSI assessment is available statewide and used for college course placement. A challenge with the TSI assessment is that the mathematics section is geared to test for readiness in only algebraically intensive content needed for only some majors. An aspiring nurse or communications major, for example, could have the mathematical content needed to be successful in Statistics, Contemporary Mathematics, and other courses required to complete his or her degree, yet not pass the TSI assessment. The test's single mathematics pathway measure of college readiness will slow down, and possibly derail, a student's plans of earning a degree. A careful look at how the TSI assessment can be improved to differentiate readiness for all entry-level mathematics courses will be an important part of setting up metrics to reflect the diversity of pathways into high paying jobs.

Improving developmental education through the New Mathways Project

For the foreseeable future, there will be students immediately enrolling in college or returning to community college from the workforce who need to enroll in developmental mathematics courses. Of students who begin two-year colleges in developmental education courses, only 5.8% graduate within three years.[v] To help address this issue, TACC entered into an innovative collaboration with the Charles A. Dana Center to develop and implement a statewide initiative called The New Mathways Project (NMP). NMP is a systemic approach to improving student success and completion through implementation of processes, strategies, and structures built around three mathematics pathways—Statistics, Quantitative Reasoning, and STEM—that support students' career goals and aspirations. Each mathematics pathway includes rigorous, transferrable, college-level content that meets the requirements of specific academic programs and careers. The goal of NMP is to ensure that more students are successful in developmental education courses and that they can more quickly enroll in college-level mathematics courses for their intended programs of study.

Texas Higher Education Coordinating Board rule change regarding differentiated college mathematics readiness

In an effort to improve completion rates and align with the direction of differentiated mathematics requirements, the Texas Higher Education Coordinating Board made a rule change regarding multiple mathematics college readiness designations. Rules 4.54 and 4.59 in the education code were modified to allow (but not require) institutions to specify two levels of college readiness in mathematics: one level for any freshman level mathematics course (Math 1314/1414, 1324, 1342/1442, and 1332); and another level for students who are college ready for non-algebraically intensive mathematics courses, specifically Statistics (Math 1342/1442) and Contemporary Mathematics (Math 1332). If a student becomes college ready in Statistics or Contemporary Mathematics only, but later decides to pursue a major that requires College Algebra or Business Mathematics, he or she may be required to complete additional developmental work based on institutional discretion.

Course Recommendations for a Seamless Transition

The confluence of policy and practice changes in high school and college-level mathematics have raised many questions about how best to prepare students for postsecondary certificate and two- and four-year degree programs. House Bill 5 and change efforts in higher education have presented new opportunities to broaden the quantitative experiences of students and to ensure that those experiences are relevant to their pathways. The flexibility of the new mathematics graduation requirements makes it imperative that schools, counselors, parents, and students are armed with the necessary information to help students determine which math courses they need to take to prepare for their college and career plans.

The Dana Center offers the following professional recommendations based on 20 years of experience in mathematics education at the transition between K–12 and higher education. These recommendations aim to fulfill the best intentions of House Bill 5 and to capitalize on the momentum of change in higher education, while ensuring access to an excellent education for all students.

Recommendations for a seamless transition

(1) Mathematics course sequences should align with programs of study.

(2) All students need third-year mathematics courses that deepen their understanding and facility with core concepts of algebra.

(3) All students should take mathematics every year in high school.

(4) Students should take fourth-year high school mathematics courses that prepare them for college-level mathematics.

(5) The state should expand efforts to accelerate student time in developmental education courses and align them to college and career pathways.

1. Mathematics course sequences should align with programs of study.

Historically, students entering postsecondary certificate and degree programs took the same sequence of algebraically intensive mathematics courses with content intended to prepare them for Calculus. In 2004, the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics recommended that courses and programs be better aligned with students' needs for increased quantitative and logical reasoning abilities that are useful to a broader spectrum of disciplines.[vi] Courses that currently meet these needs have a variety of names such as Contemporary Mathematics, Quantitative Reasoning, Liberal Arts Mathematics, or Modeling.[vii] Only students pursuing the Business and Industry endorsement and STEM fields (e.g., finance; physical, biological, or computer sciences; technology; and engineering) need the intensive, college-level algebraic preparation in the traditional college math sequence.

The following chart is based on mathematics requirements for specific majors at a variety of four-year public universities in Texas. All of the third- and fourth-year content or courses recommended below are best aligned with the endorsement and postsecondary pathway listed. There is some variation in requirements for a given major. Content specified below represents requirements for most majors within each endorsement category. The third year refers to the year after students have completed Algebra I and Geometry, which would be before eleventh grade for students who completed Algebra I prior to ninth grade. Students who earn dual credit through Advanced Placement (AP) or other programs during their fourth year of high school will not need to repeat that entry-level college course when they matriculate.

Although applied algebra and statistics content found in various third-year high school courses prepares students for subsequent courses aligned with postsecondary expectations, four-year colleges and universities require successful completion of Algebra II for admission. As long as this policy is in place, all students planning on attending a four-year college or university must take Algebra II even if another third-year course may better fit the mathematical content needed for their future careers.

Endorsement	3rd Year *Content* or Courses	4th Year *Content* or Courses	Entry-Level College *Content* or Courses	Sample College Majors
Business and Industry	Algebra II	Precalculus	College Algebra or higher level course	Accounting, Finance
Public Service	Algebra II (*statistics* or *applied algebra*)	AP Statistics or *quantitative reasoning*	*statistics* or *quantitative reasoning*	Nursing, Government, Criminal Justice
Arts and Humanities	Algebra II (*statistics* or *applied algebra*)	AP Statistics or *quantitative reasoning*	*statistics* or *quantitative reasoning*	Communications, English, Art History
Multidisciplinary	Based on intended college major	Based on intended college major	Based on intended college major	Varied
STEM	Algebra II	Precalculus	College Algebra or higher level course	Engineering, Computer Science, Chemistry

2. *All students need third-year mathematics courses that deepen their understanding and facility with core concepts of algebra.*[viii]

Broadening mathematics pathways to better prepare students with the knowledge for their chosen field begins in the third year of high school mathematics after Algebra I and Geometry. Students need some, but not necessarily all, content in Algebra II. Courses that include applied algebra and statistics content cover a broader range of skills and critical thought processes. For example, when encountering data and statistics, these courses teach students how to evaluate the validity of the information, draw conclusions, and strategically problem solve. As stated above, however, Algebra II is still required for admission to most four-year universities; thus, all students intending to matriculate at four-year colleges should take Algebra II.

3. *All students should take mathematics every year in high school.*

All students need to take college-aligned mathematics every year in high school to increase their chances of entering college prepared for college-level courses. In a study of students who took the ACT in three states, 74% of those who had completed at least Algebra I, Geometry, and Algebra II moved directly into college-level, credit-bearing courses. The percentage increased to 83% for students who took an additional fourth year of rigorous math in high school.[ix] It is critical to ensure that students' third and fourth years of high school mathematics courses prepare them to move directly into college-level mathematics courses needed for their intended certificate or degree program.

4. *Students should take fourth-year high school mathematics courses that prepare them for college level mathematics.*

The fourth year of high school should mark the beginning of students' college mathematics sequences. By the fourth year, many students are prepared to take foundational college-level mathematics courses through AP and other dual credit options. Districts and local institutions of higher education should continue or begin working together when choosing or developing fourth-year mathematics course options to confirm alignment. Some students may not yet be deemed college ready and can instead complete a College Prep course. The College Prep Mathematics course is for twelfth grade students who still have gaps between high school and college-level mathematics that are significant enough to predict that they would be assigned to developmental education courses if they enroll at a postsecondary institution.

The following options provide the opportunity for all twelfth graders to either finish preparing for college-level mathematics or take the mathematics course that is aligned with their programs of study.

Programs of Study Requiring Algebraically Intensive Mathematics

The traditional Pre-Calculus and AP Calculus pathway is intended for individuals invested in the possibility of pursuing algebraically intensive majors in fields such as physical science, mathematics, biological science, computer science, engineering, business, or agriculture.[x] These majors typically require students to have conceptual understanding and high levels of computational facility with algebraic and trigonometric expressions and functions. In college, this content is covered in College Algebra and Pre-Calculus courses.

Programs of Study Requiring Non-Algebraically Intensive Mathematics

For students interested in fields that do not require extensive knowledge of algebraic computation, other fourth-year mathematics course options—many of which are offered for dual credit—provide more relevant quantitative preparation. Courses such as Statistics, Contemporary Math, and Quantitative Reasoning, taken after successful completion of an Algebra II-based course, are intended for the large population of students pursuing degrees in fields such as the allied health sciences, public safety, or academic programs in the liberal arts and social sciences.[11]

Final Preparation for College Mathematics

Finally, for students who need additional work on Algebra II-based reasoning skills and quantitative literacy, a transition course may be the best option. TACC's Texas Success Center convened a task force of mathematics content experts from K–12 and higher education to develop a framework of student learning outcomes for the College Prep Mathematics course, which has been made available to districts across the state as a resource. Successful completion of courses aligned to this framework would prepare students to successfully enroll in and complete any entry-level college mathematics course. The Texas Association of School Administrators, the Dana Center, and various colleges across the state have curricular resources to support the teaching of this College Prep course. The Texas Success Center will continue to convene the task force and gather feedback from teachers to help revise and improve the content framework and curricular resources.

Partnering K–12 and higher education institutions are responsible for determining the measure of successful completion of the College Prep course. If students are successful in the College Prep course, they are deemed TSI exempt and therefore college ready at the partnering institution.

5. ***The state should expand efforts to accelerate student time in developmental education courses and align them to college and career pathways.***

   Students who have taken four years of college-aligned mathematics should be able to make a seamless transition into entry-level college mathematics courses. For students who need additional preparation, it is imperative that they take accelerated developmental courses sequences aligned to the mathematics they need for their certificate or degree program.

   The New Mathways Project is an example of an effort to improve developmental education by accelerating students' transitions to college-level mathematics courses and aligning the courses with students' programs of study. Nine of the 50 two-year institutions of higher education are currently implementing NMP, with 26 additional colleges beginning to redesign their mathematics developmental education program in the next two years. Over the next four years, at least 47 of the 50 Texas community colleges will implement NMP with the goal of 25-50% of students enrolled in developmental education at each campus taking NMP courses. The state should continue to support efforts that accelerate student time in developmental education courses so they can more quickly move into college-level courses towards degree completion.

Texas Policy and Initiatives Can Set Students Up for Success

Texas is leading the national trends in mathematics education. The state has enacted policies outlining a comprehensive approach that aligns mathematics to higher education and careers. Beginning with the third year of high school, students can take mathematics courses that best fit their career interests and that are rigorous enough to prepare them for college mathematics courses. In the fourth year of high school, students will either finish their preparation for college-level mathematics in the College Prep course or begin college mathematics sequences that align with their intended career pathway. The final intervention that Texas has in place is the revision of the developmental education system through the NMP. NMP empowers postsecondary students who are unprepared for college-level mathematics with the tools to persevere and the skills to progress through their programs of study more quickly. The five recommendations in this brief are a guide for policy and education leaders to implement Texas policies and course offerings in a way that takes full advantage of the opportunity they afford to create a seamless transition from high school to postsecondary mathematics.

Endnotes

[i] Texas Education Agency. (2012). Academic Excellence Indicator System Report, http://ritter.tea.state.tx.us/perfreport/aeis/2012/state.html

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[ix] ACT, Inc. (2007). *Rigor at Risk: Reaffirming Quality in the High School Core Curriculum*. Retrieved March 18, 2014, from https://www.act.org/research/policymakers/pdf/rigor_summary.pdf.

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