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## High School to College Mathematics Pathways: Secondary Mathematics Teacher Preparation is Key

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### Abstract

This chapter addresses a critical problem in mathematics education in the United States: Too many students are not successfully completing the mathematics they need for their future success across Grades 11–14 (National Center for Educational Statistics [NCES], 2020). Moreover, this problem is more acute for some students on the basis of income, geography, race/ethnicity, and/or language (Aguirre et al., 2017). We begin by defining the problem, then discuss some of the current work being done in this arena, using the state of Alabama as an example, and wrap up with some ramifications for secondary mathematics teacher preparation.

### Defining the Problem

The lack of student success in mathematics from high school to postsecondary is particularly challenging due to its multidimensional nature. First, many students are not completing high school ready for credit-bearing, college-level coursework in mathematics. For example, 56% of those students entering two-year colleges and 31% of those entering four-year colleges (NCES, 2020, 2016) needed to take at least one remedial course in mathematics. This problem is particularly acute for students who have been historically underserved; for example, African American students are 60% more likely to be in remedial classes (Complete College America, 2016).

Second, students who enter postsecondary education unprepared to enroll in credit-bearing mathematics coursework are often required to complete a remedial program. Yet these programs all too frequently do not provide students the support they need to be able to complete an initial credit-bearing mathematics course. Remedial programs become an insurmountable barrier; only 20% of those entering a remedial course go on to earn a credit in an entry-level mathematics course (Complete College America, 2016).

Third, credit-bearing courses at the college level may not adequately address students' future mathematics needs. For example, College Algebra is the mathematics course required for many majors, yet the course largely duplicates the content students already had in second-year algebra in high school, likely decreasing its interest for many students. Moreover, the content has little to do with the mathematics students will actually use in their field. Many students would be better served by a course in statistics or other areas.

Finally, mathematical pathways between K–12 and higher education are not well-articulated, which further complicates students' progress in mathematics. There are a number of areas of misalignment. There may not be clear connections between the courses students take in high school and their initial postsecondary mathematics courses. In the example with College Algebra above, the content may be duplicated. In other cases, senior-level high school courses may be more focused on providing students with the credits they need to graduate than on ensuring they are ready for success after graduation. Another area of misalignment may occur in the amount of attention paid to developing mathematics processes and practices, a requirement in most state K–12 mathematics standards, as well as instructional methods based on the mathematics teaching practices

(National Council of Teachers of Mathematics, 2016), which emphasize problem-based or inquiry-based instruction. In contrast, introductory mathematics classes at the postsecondary level are often large lecture classes that emphasize learning facts and procedures—although a number of projects seek to address this issue (cf. Association of Public and Land-grant Universities, 2020).

### Addressing the Problem

To address the issues in ensuring clear pathways from high school to postsecondary mathematics, the Conference Board of Mathematical Sciences (CBMS), an umbrella organization consisting of 18 national professional societies related to the mathematical sciences, launched the Mathematics Pathways Initiative in 2019. This initiative seeks to assist states in forming task forces to coordinate efforts across Grades 11–14 that will lead states to create policies and practices for mathematics instruction that contribute to successful completion without reducing quality. Twenty-two states (including Alabama) were selected to participate in the initiative.

CBMS set forth a two-year process to engage the states, as summarized in the following timeline:

- Spring/Summer 2019: Assessment of background data
- September 2019: Three-day forum of all 22 state teams.
- September 2019–September 2020: Quarterly meetings across teams.
- October 2020: Second forum of state teams to be held virtually
- October 2020: State team’s final set of recommendations to be completed.
- Following October 2020: Advocate for the recommendations.

Alabama dubbed its task force the Strategic Task Force to Accelerate Mathematics Pathways or STAMP (STAMP, 2020). The task force was launched by a leadership team consisting of two K–12 representatives, two community college mathematics instructors, two four-year/university mathematics instructors, and two mathematics teacher educators. This leadership team meets biweekly to facilitate the activities. The taskforce itself includes 14 additional people representing a broader slice of entities, including state initiatives and commissions, mathematics-related organizations, workforce groups, K–12 and higher education administrators, and K–12 counselors. This taskforce meets quarterly, although the May 2020 meeting was delayed due to COVID-19. In addition, a convening of about 50 persons representing a broader set of stakeholders met in November 2019 to provide additional input.

STAMP identified four initial areas of work to address issues related to mathematics pathways in Alabama, as outlined in the following:

- **Resources**
  - Increase the number of certified teachers in mathematics and special education (focused on mathematics)
  - Increase focus on academic counseling
  - Increase access to professional learning and technology to support student success
- **Beliefs and values**
  - Build mindsets that understand the value of mathematics cradle to grave across all stakeholders including communities and families
  - Dispel stereotypes and beliefs that hinder the success of all students
- **Vision**
  - Establish a coherent vision for what counts as mathematics and what experiences student should be having

- **Alignment**

- Align pathways from K–12 with both college and careers, ensuring they are flexible to meet changing needs.

The task force subsequently drafted a set of five more specific recommendations as follows: (1) create a statewide organization to extend the work of STAMP; (2) improve teachers’ mathematical content knowledge relevant to teaching (pre-service and in-service); (3) promote understanding of and communication about the impact of cut scores and placement practices in entry-level postsecondary mathematics courses; (4) aggregate resources to improve mindsets about learning mathematics across multiple stakeholder groups, and (5) develop and disseminate information about curriculum pathways from K–12 through higher education. Each recommendation follows a common template. An example recommendation is shown in the Figure 1.

<b>Recommendation #2:</b> Facilitators: (omitted)	Improve teachers’ mathematics content knowledge relevant to teaching	
<ul style="list-style-type: none"> <li>• Provide a baseline of teachers’ content and pedagogical knowledge based on the AMTE Standards.</li> <li>• Assess what content and pedagogical needs are and plan mechanisms to meet them.</li> </ul>		
<b>Why does this recommendation need to be implemented?</b>		
<ul style="list-style-type: none"> <li>• Better-prepared teachers ensure that students are prepared to succeed in mathematics. Developing a better understanding of this issue will help us to determine how to improve teacher preparation and in-service education to positively affect K–12 instruction.</li> </ul>		
<b>Who needs to do what?</b>		
<ul style="list-style-type: none"> <li>• Collect background data: preservice students, program requirements, distribution of underprepared teachers</li> <li>• Form a subgroup to analyze the data and determine next steps</li> </ul>		
<b>Deadline for Completion:</b>	Ongoing, partial completion by August 2020	
<b>Assignments</b>		
<i>What</i>	<i>Who</i>	<i>When</i>
(omitted)		

Figure 1. Recommended template from the Strategic Task Force to Accelerate Mathematics Pathways (STAMP).

In June 2020, STAMP formed working groups to refine the plans for each of the recommendations and begin initial work. The full task force will convene virtually in late August 2020 to provide further feedback on the set of recommendations as a whole, and a draft report will be presented to CBMS at the virtual conference in October 2020. The task force also will develop a plan for disseminating the recommendations and connecting with related organizations.

## The Role of Mathematics Teacher Preparation

Mathematics teacher preparation plays a critical role in improving the high school to postsecondary mathematics pipeline. The importance of having an adequate number of *well-prepared* mathematics teachers is threaded throughout STAMP’s recommendations. In fact, mathematics teacher preparation is an important part not only of the STAMP agenda but of almost every state team with whom we have interacted. Moreover, mathematics teacher educators can play a critical role in these discussions, since they are engaged in both K–12 and higher education.

We propose the following questions for Program NICs and MTE-Partnership Teams to consider as they plan their activities:

- How can MTE-Partnership Teams and Program NICs more effectively engage in and leverage the work that is being done on mathematics pathways? In particular,
  - How can we promote a positive mindset toward learning mathematics across not just teachers and students but also families and the community?
  - How can we inspire a broader view of mathematics as more than a tool for the sciences?
  - How can mathematics teacher educators effectively contribute to discussions around pathways?
  - How can K–12 and postsecondary mathematics educators collaborate to create more coherent pathways?

In closing, we encourage MTE-Partnership participants to learn more about the work around mathematics pathways, including the CBMS Pathways Initiative. And, if there is a task force in your state, explore how you might engage with it.

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