

Momentum for Improving Undergraduate Mathematics: Progress from State Mathematics Task Forces

Introduction

Mathematics professional associations recently identified a common vision for improving college student success through the use of multiple math pathways. Entry-level college math courses—often referred to as gateway courses—and developmental math courses are considered to be the biggest barriers to college completion, not only among policymakers and institutional leaders, but also among the leadership of the American Mathematical Association of Two-Year Colleges (AMATYC), the American Mathematical Society (AMS), the American Statistical Association (ASA), the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM).

Mathematics leaders point out that, historically, students have taken a one-size-fits-all sequence of mathematics courses designed to prepare them for calculus. Today, there is a growing consensus that students need different mathematics skills depending on their career interests and fields of study. Redesign of gateway and developmental mathematics courses to form mathematics pathways is increasingly common among individual institutions, as math faculty or partner discipline faculty review courses and identify student populations that are not well served by the traditional, algebra-based calculus sequence. Math pathways are characterized by rigorous mathematical content aligned to students' academic and career goals, and acceleration that allows students to complete developmental and college-level mathematics courses in as little time as

possible, often one year or less. Despite this progress, efforts to implement mathematics pathways at the state level have been slowed by inconsistencies in transferability and learning outcomes of new courses as well as by policy and institutional barriers to modify traditional developmental education practices.

Since 2013, at least nine states have undertaken efforts to reform undergraduate mathematics in a more systemic way, specifically through the creation of statewide mathematics task forces that bring together faculty leaders and state agencies to create a common vision for math pathways. A state-based approach is critical to ensure that math pathways are rigorous and are developed coherently across institutions so that mobile students can benefit from improved math pathways. Through these task forces, states can attend to systemic issues such as transfer, developmental education, placement and advising, and data collection and evaluation.

In 2013, the [Charles A. Dana Center at The University of Texas at Austin](#) supported statewide mathematics task forces in Georgia and Ohio. Beginning in 2014, the Dana Center, in partnership with Complete College America, supported additional task forces in Colorado, Indiana, Missouri, Montana, Nevada, and the Houston region of Texas. The state of Washington independently mobilized similar faculty and state agency groups. In each of these states, task force members developed recommendations for implementing and monitoring the success of math pathways.

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This brief provides a summary of state math task force recommendations (see Table 1 on p. 4 for a visual summary). The brief is intended to inform policymakers, senior and mid-level administrators, faculty, and state

agencies about the growing consensus for change in the field and to identify the domains for coordinated action associated with implementation of multiple math pathways.

Analysis of State-Based Task Force Recommendations

A Common Vision for Redesign and Increasing System Coherence

A central theme of each of the nine mathematics task force reports reviewed here is the creation of alternative options to the traditional mathematics pathway that begins with college algebra. The most common alternatives are quantitative reasoning and statistics, with most states emphasizing an important role for quantitative reasoning courses that prepare students whose programs do not require calculus. Some states identify pathways for students in particular programs, such as education. At the same time, several task forces highlight the need to improve the traditional math pathway for students in STEM and other math-intensive fields who need to succeed in pre-calculus and calculus, not only in college algebra.

Some states specifically link proposed pathways to meta-majors. Indiana's pathways framework, for example, includes a Quantitative Reasoning pathway (the default pathway), which is designed for arts and humanities, social and behavioral sciences, nursing, and public health majors, and a Calculus pathway that is geared toward STEM, allied health, and some business and economics majors. Additionally, Indiana plans to have a Finite Math pathway for other business and economics majors, a Math for Elementary Educators pathway for elementary and

special education majors, and a Technical, Industry-Specific pathway for technical and trade programs. Each pathway begins with a different gateway course, and no pathway requires college algebra as the default gateway course.

States' recommendations at the developmental level focus on alignment of content and structures for acceleration. Another common issue is ensuring that state and institutional definitions of college readiness do not depend on the completion of intermediate algebra. Five of the nine states recommend implementing a co-requisite approach. There is an intentional focus on a seamless sequence of courses and reducing the time to complete developmental and gateway course requirements. Georgia's task force not only emphasizes the importance of integrating a one-semester, co-requisite model, which might be more advantageous for students who are at least moderately prepared, but it also recommends a year-long model designed for students to complete gateway requirements with back-to-back mathematics coursework for both STEM and non-STEM pathways. The task force in Ohio intends to "develop and disseminate co-requisite curricular materials to provide just-in-time support to students and resources for advisors placing students in co-requisites.

College algebra, pre-calculus, quantitative reasoning, elementary statistics and modeling should be the focus of co-requisite materials development. The [task force] should provide information about the number and type of credits offered, staffing, target student populations, pedagogical strategies, faculty professional development and financing.”*

Almost all of the task forces highlight the importance of aligning math pathways across two- and four-year institutions. The majority cites the need to revisit statewide transfer policies to include articulation for mathematics pathways and, if applicable, the meta-majors that emerge from a pathway-based model.

Preserving math credits when students transfer from one institution to another is a key concern. A related issue is whether those math credits count toward students’ degrees. To address these concerns, states recommend strategies such as developing common learning outcomes, identifying common course numbers, adding multiple gateway math courses to general education/core curriculum, and identifying the majors (or creating meta-majors) that align to different

Other Policy and Capacity Considerations

While there are common recommendations across states regarding pathways, transfer, and advising, other recommendations vary based on a particular state’s interests and needs. Some task forces propose establishing multiple measures or modifying placement to support multiple math pathways. Other task forces seek to end the use of cut-off scores as a means for a placement or exit requirement, or to transition to placement

math pathways. Missouri’s task force notes that articulation agreements should not be limited to a default College Algebra pathway but that they should also be inclusive of mathematics courses in alternative pathways. The task force states that “[o]ne reason that community college students or university students who believe that they might transfer to another university take College Algebra is because they are confident that College Algebra will transfer to other Missouri colleges and universities for all majors. Registration advisors often advise students to take College Algebra for this reason.”

Like Missouri’s, recommendations from the other task forces stress the importance of advising in some manner, and eight of the nine task forces explicitly point to the need for training advisors on new and emerging mathematics pathways. Many of these recommendations place an emphasis on decreasing or eliminating instances in which students are advised into college algebra as a default pathway. Washington’s task force underscores the importance of well-informed advisors who pair mathematics pathways with major- and degree-specific goals and students’ educational needs.

based on cut-off ranges rather than cut-off scores. Nevada’s work on multiple measures includes policy changes such as using a combination of “placement exams; high school GPA; course selection and performance in the senior year of high school; and intended postsecondary program of study to determine appropriate placement,” while still honoring the state’s commitment to use ACT scores.

Table 1: Summary of Major and Minor Recommendations of State Mathematics Task Forces

Current and Proposed Mathematics Pathways	Developmental Education	Statewide Transfer and Articulation	Applicability of Math Pathways to Programs of Study	Course Development	Advising	Placement	Partnering with the K-12 Education Sector	Faculty Professional Development	Data & Evaluation
Colorado 1. Calculus Path 2. Statistics Path 3. Quantitative Thinking Path	Major	Major	Major	Major	Major	Major	Minor	Major	Major
Houston 1. College Algebra 2. Math for Liberal Arts 3. Statistics	Minor	Major	Minor	Major	Major	Minor	Minor	Minor	Major
Indiana 1. College Algebra 2. Quantitative Reasoning (new default) 3. Calculus 4. Finite Math 5. Math for Elementary Educators 6. Technical/ Industry-specific	Minor	Major	Minor	Major	Major	Minor	Minor	Minor	Major
Missouri 1. College Algebra 2. Quantitative Reasoning 3. Statistical Reasoning	Major	Major	Major	Major	Major	Major	Major	Major	Major
Montana 1. College Algebra 2. Additional pathways throughout the state	Major	Major	Major	Major	Major	Major	Major	Minor	Major
Nevada 1. STEM Pathway 2. Math Literacy Pathway	Major	Minor	Major	Minor	Major	Major	Major	Minor	Major
Ohio 1. College Algebra 2. Statistics 3. Quantitative Reasoning	Major	Major	Major	Major	Major	Major	Major	Major	Major
Georgia 1. College Algebra 2. Quantitative Skills & Reasoning 3. Introduction to Mathematical Modeling	Major	Major	Major	Major	Major	Major	Major	Major	Major
Washington 1. College Algebra 2. Additional pathways throughout the state	Major	Minor	Major	Minor	Major	Major	Major	Major	Major

Key to Symbols:

-  Major recommendation (explicitly stated as a primary focus of a report, listed in a major heading, is of considerable length, and/or includes detailed action steps)
-  Minor recommendation (explicitly stated as a sub-focus, listed in a sub-heading, is mentioned briefly, and/or includes vague or no details for implementation)

Six states note the implications of math pathways for K–12 education. Recommendations regarding K–12 alignment identify a need for increased consideration of state-based or Common Core standards and dual enrollment as a starting point for such work.

A few task forces offer recommendations for providing professional development to faculty members about pathways. They highlight increasing professional development opportunities, strengthening communication with faculty, pairing faculty members with a master instructor, and ensuring financial support. Colorado’s task force mentions challenges in terms of resources and qualified, full-time instructors for pathways courses. It suggests a state- and institution-level focus on strengthening faculty development and involvement (e.g., pairing new instructors with a master instructor; providing instructors with course syllabi, materials, and a course repository) and increasing the frequency of professional development opportunities so that faculty can have additional opportunities for discussion.

Several states describe the importance of building a central capacity to support data

collection and evaluation. Task forces articulate the need for systematic, iterative methods of communication and reporting between the state and institution levels. Most task forces recommend the examination of enrollment data, course completion rates, and student-level characteristics such as age or selected major. One task force plans to implement a survey of the skills that faculty deem integral to a quantitative reasoning course. Another task force proposes analyzing data to evaluate and enhance placement policies. Ohio’s task force describes a collection of state-level data points as well as a plan for disseminating and analyzing such data at the campus level. The task force describes the importance of creating “a common protocol for collecting, analyzing and reporting data relating to student success and program effectiveness.” It recommends that this protocol include students’ course grades; students’ success in subsequent mathematics courses; degree or certificate completion; and comprehensive final exams and student work samples. Ohio’s task force also suggests a thorough analysis of the data and strategies for communicating such findings with mathematics chairpersons throughout the state to highlight future steps.

Progressing from Vision to Action

Multiple math pathways are an increasingly popular approach to improving student success that requires coordinated institutional and state activity. While institutional-level redesign work provides valuable evidence for change and advice for implementation, state-level work is essential for scale by aligning policies and practices to support multiple math pathways.

In the nine states and regions reviewed here, leaders came together to commit to a vision for improving success in undergraduate mathematics in a way that is rigorous and coherent statewide. Our analysis finds a growing consensus for mathematics pathways based on students’ program, career, and life needs. Common areas of agreement among mathematics faculty

leaders include implementation of math pathways in college-level and developmental courses and ensuring their transferability and appropriate advising. To a lesser extent, task forces also grappled with issues of placement, faculty capacity, K–12 alignment, and use of data for improvement.

For policymakers, institutional leaders, and faculty in Georgia, Ohio, Montana, Missouri, Colorado, Washington, Nevada, Indiana, and the Houston region of Texas, we encourage you to engage directly in the work by

participating in or leveraging the state policy and capacity building efforts that will enable institutional work. For those in other states, we hope this brief encourages and guides similar work in your system and builds upon the lessons learned from these task forces about common issues, themes, and strategies that are important in the planning phases of this work.

These task forces will now move into an implementation phase that promises additional lessons for the future.

* Math task force reports from Missouri, Nevada, Ohio, Georgia and the Houston region of Texas are available on the Dana Center website: <http://www.utdanacenter.org/higher-education/higher-education-resources/policy-resources/scaling-modern-undergraduate-mathematics/>. Task force reports from Colorado, Indiana, and Montana are still under development and will be added upon publication. The Washington task force report is available at: http://www.sbctc.ctc.edu/college/education/math_tf_summary_handout_feb2015.pdf

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About the New Mathways Project

The New Mathways Project (NMP) is a systemic approach to dramatically increasing the number of students who complete math coursework aligned with their chosen program of study and who successfully achieve their postsecondary goals. The Dana Center launched the New Mathways Project in 2012 through a joint enterprise with the Texas Association of Community Colleges. For more information about:

- the New Mathways Project, see www.utdanacenter.org/mathways
- the Texas Association of Community Colleges, see www.tacc.org

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