National Strategy
for
Advancing Mathematics Pathways
for Student Success

DRAFT document
for review by the Summit on Mathematics Pathways
Indianapolis, Indiana
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By the partners of Advancing Mathematics Pathways for Student Success (AMPSS):

[Logos of the partners]
Vision statement

All students desiring public postsecondary education will have options to receive the rigorous mathematics instruction that is most relevant to their chosen programs of study, whether begun at a community college or 4-year institution and regardless of their level of preparation; there will be seamless transfer of mathematics credits from 2-year to 4-year institutions contributing to greater student course and degree completion.

Summary

Gateway and developmental mathematics courses pose the most significant academic barrier to postsecondary attainment for millions of students each year, especially those from underrepresented or nontraditional groups of college students. Only 37% of students complete their gateway math course within one year and only 46% complete one within the first two years.

Modernizing the beginning sequence of mathematics courses –“mathematics pathways”– to streamline students’ routes into and through their chosen programs of study can significantly increase success rates in 2- and 4-year colleges and universities. Early data from new math pathways efforts show remarkable increases in student success – increasing first-year math credit completion by community college remedial students by 4-8 times and transfer rates from 2- to 4-year institutions by about 40%.

Ideally, math pathways should be designed so that students are appropriately placed and enrolled in the rigorous math courses that are needed for their chosen program of study, rather than in math courses such as College Algebra that they may not need. These pathways should be transferrable and applicable to specific programs of study at all institutions in a state, and students should be able to progress through an appropriate college-level mathematics course within one year of matriculation.

Key organizations have formed a unique national coalition to help students surmount this mathematics hurdle to their postsecondary success. Advancing Mathematics Pathways for Student Success (AMPSS) proposes this draft national strategy for implementing math pathways in at least 40 states to make significant impacts on student success. The coalition
comprises mathematics professional societies, higher education leadership associations, and national education nonprofits that work directly with institutions and states. Together, the AMPSS partners have both broad reach and important expertise for implementing the national strategy.

The AMPSS proposed national strategy reflects our strong belief that successful change will need to be a collective process that is faculty led, administratively supported, policy enabled, and culturally reinforced. For true scalability, efforts must be undertaken across a state or region, to ensure that transfer students are not unduly hindered. The AMPSS theory of change, which is based on our collective experience, incorporates four general phases in order for leaders in a state to design, implement, and sustain appropriate math pathways at scale. State- and institution-level processes must mutually support aligned efforts to reform remediation, transfer, guided pathways, advising and placement, faculty development, and other key initiatives to enhance student success. Many groups at the local and national levels have taken significant steps to enact some of these changes, but efforts remain sporadic and often incomplete. A systemic effort at every level is required for scaled and sustained success.

To implement this comprehensive strategy, AMPSS proposes a corresponding action plan to galvanize interest and engagement across higher education and mathematics, support state teams in developing enabling conditions to redesign and implement math pathways, and evaluate the impact of redesigned math pathways on students of all types across the nation. The plan includes comprehensive engagement and communications, a strategy for training and deploying expert consultants to state teams, and monitoring and evaluating progress as states make their way through the four phases.

By supporting approximately 40 states over a five-year period in significant math pathways redesign, the AMPSS national strategy has the potential to make a profound positive impact in the success of millions of students.
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1. National Context

Postsecondary attainment is an urgent national issue, and mathematics is the most significant academic barrier to completion

The need is urgent. The U.S. no longer leads the world in the portion of the young adult population with a college degree or credential, and young adults can no longer expect to be as well off as those of their parents’ generation. As the better paying jobs migrate to those appropriately educated elsewhere in the global economy,\(^1\) U.S. workers are finding the American Dream increasingly out of reach. To strengthen social equity and bolster Americans’ economic security, we must prepare more college graduates who are engaged citizens and have the knowledge, skills, and integrity to effectively lead people and organizations in a highly competitive, global environment.

*Gateway and developmental mathematics courses pose a significant barrier to postsecondary attainment for millions of students, especially for those from underrepresented or nontraditional groups.* Research shows that completion of math coursework early in a student’s academic career is strongly correlated with postsecondary success.\(^2\)

Unfortunately, far too many students fail to learn suitable mathematics skills and pass appropriate mathematics courses in their first or even second year of college: only 37% of students complete their gateway math course within one year and only 46% complete one within the first two years. The data for community colleges is particularly troublesome with only 28% of students completing a math gateway course after two years. At 4-year, non-flagship institutions, only 55% of students complete a math gateway course in their first year and only 66% complete one in 2 years.\(^3\)

About a million students each year take College Algebra to fulfill their math requirement, yet nearly half of them withdraw, fail, or earn a D grade. Many more students never even get as far as College Algebra or other college-level “gateway” math, and are stuck in non-credit-bearing remedial (or “developmental”) math courses for semesters or years.\(^4\)

This stagnation is most pronounced among underrepresented minority students and those from low income backgrounds. Figure 1 breaks these data out by race/ethnicity and Pell eligibility and illustrates clear gaps for underrepresented minority and low-income students.

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\(^1\) Georgetown University Center for Education & the Workforce (2016), *America’s Divided Recovery: College Haves and Have-Nots.*


\(^3\) Data submitted to CCA by 30 participating states during the 2016 data collection for the Fall 2012 first-time full-time and part-time entering cohorts. National estimates are calculated by using a mean of data submitted by participating states.

\(^4\) 70% of students in remediation fail to enroll in a gateway math course within two academic years, according to the U.S. Department of Education (2009).
Data for students with remedial need shows a similar trend (see Figure 2). Among community college students, only 21% of those in remedial math go on to complete a gateway course within two years of entry. At 4-year institutions, 23% of students enroll in remedial coursework in their first year and only 36% of those students complete gateway courses within two years, a considerably lower rate than for all students.

Students unable to earn college math credit are excluded from transfer to 4-year degree programs and from a broad range of educational and vocational options; most importantly, they are excluded from earning a college degree altogether.

This status quo is clearly not acceptable. A major portion of all students – including first generation and students of color – could surmount this mathematics hurdle if they had broader options to attain appropriate math competencies and support for choosing the right option for their preferred academic path.

Redesigned math pathways can solve this problem

Carefully designed sequences of math courses – “math pathways” – can significantly increase student success by shortening course sequences and eliminating the common mismatch between entry-level math content and a student’s program of study. There are growing evidence-based efforts in over 100 2- and 4-year institutions across at least 15 states to revise these pathways, yielding significant increases in student learning and course success.
Professional mathematics associations strongly state that **not all students need or benefit from the College Algebra-to-Calculus pathway,** which has been the default math requirement in most places. Many students would benefit from pathways built on rigorous courses in statistics, probability, math modeling, or quantitative reasoning, that are more appropriately targeted to different academic programs and intended careers. What’s more, by directing all students into College Algebra, the current system also fails to serve those who actually need rigorous Algebra skills to achieve subsequent success in Calculus and beyond. More appropriate and effective math pathways are strongly supported by the umbrella organization for all 17 math professional societies, the Conference Board of Mathematical Sciences (CBMS).

Many current reformers are adopting accelerated pathways in statistics for students in the social sciences, or quantitative reasoning courses for students in humanities or the fine arts, and many also seek to accelerate and improve student success in the sequence that prepares STEM students for Calculus (see Figure 3). In addition, new co-requisite models are resulting in dramatic improvements in student success in math gateway courses in far shorter times than with traditional remedial education.

Some efforts, however, are not always coherent or sustained across departments, institutions, and states, largely because such reforms touch so many parts of the system and therefore require a systemic approach. Drawing these efforts into such a systemic process, and bringing in others who may not yet be aware of the value of these reforms, holds great promise for mitigating the math barrier to student success.

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6 E.g., through initiatives such as Carnegie’s Statway/Quantway, the Dana Center’s New Mathways Project, the California Acceleration Project, and other locally-inspired projects.
7 A. Logue, M. Watanabe-Rose, & D. Douglas (2016). *Should Students Assessed as Needing Remedial Mathematics Take College-Level Quantitative Courses Instead? A Randomized Controlled Trial.*
**More on what we mean by math pathways**

A mathematics pathway is a mathematics course or sequence of courses that students take to meet the math requirements of their program of study. The concept of math pathways applies to pathways for both college-ready and underprepared students (because remediation is often the first part of a math pathway). Most important are the need for a small number of pathways with relevant and challenging mathematics content aligned to broad fields of study and acceleration that allows students to complete a college-level math course and enter a program of study in their first academic year. Full, national implementation of appropriate math pathways would require a network of state and institutional efforts to modernize math pathways at scale. Our view of what the “new normal” should look like is that in each state:

1) students have the opportunity to enroll in a set of rigorous, entry-level, credit-bearing mathematics courses that are transferable and applicable to specific programs of study across 2- and 4-year institutions in the state.

2) all students are enrolled in the appropriate math pathway.

3) all students who need it are provided with accelerated or co-requisite remediation so that they can succeed in the appropriate college-level, credit-bearing math course within one year of matriculation.

As described later, successful efforts to increase degree completion by expanding math pathways must address several related issues simultaneously – spanning state and institutional policy, course development, remediation, transfer, faculty engagement, student advising, and K-12 alignment. More detail on what math pathways should look like, and how they interact and overlap with other student-success issues, is provided in our “Goal” section below.

**Current efforts to redesign math pathways**

Over the past several years, major initiatives related to math pathways have emerged from national higher education organizations focused on student success. The most extensive of these are the work of the Carnegie Foundation for the Advancement of Teaching, Complete College America, and The Charles A. Dana Center at The University of Texas at Austin. A summary of these endeavors, along with six related efforts by other groups, is provided in Appendix A.

Based on the collective engagement of the AMPSS partners in math pathways efforts across the country, we have assembled an inventory of relevant characteristics of each state in this regard. In short, we found ten states with state-level task forces, math pathways for meta-majors in place or in progress, and co-requisite or accelerated developmental programs. Policies supporting transfer and collaboration between the two- and four-year institutions are still concerns in most cases. In some of these states, pathways had been designed but not fully implemented.

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9 Some of the initiatives underway in 2013 are described in P. Burdman (2013), Changing Equations: How community colleges are re-thinking college readiness in math, LearningWorks. *(PDF)*
The AMPSS inventory also identified twenty-two states with little coordinated activity thus far. The remaining 18 states have demonstrated some level of interest or activity in math pathways, at multiple institutions or at the system level, but do not appear to have the same degree of statewide coordination as the ten states identified above. These states are ripe for deeper development, and could benefit from significant support from those who have already worked in this area.

Most of the activity captured in this inventory has happened in the states and institutions depicted in Figure 4. More detail about the entire inventory is provided in Appendix A.

Ohio is a good example of a state making strong progress in moving math pathways forward for all students in public institutions. In 2013, Ohio’s institutional and state higher education policy leaders began formal discussions of postsecondary math education, and soon created a Math Pathways Steering Committee. With the direct support of CCA and the Dana Center, the Steering Committee studied the issue and produced a set of concrete recommendations in 2014.  

Since publishing the recommendations, Ohio has changed its policy to no longer require Intermediate Algebra as the metric for college readiness, developed a new definition of college-level content, and established a new Quantitative Reasoning course in its Transfer Module. In April 2016, the state began its move towards institutional implementation when representatives of all 37 public universities and colleges attended a two-day workshop on Designing Math Pathways presented by the Dana Center. The institutional teams drafted goals for scaling pathways at their institutions and created action plans for implementation, which are currently underway.

\[\text{Ohio Mathematics Initiative, Rethinking Postsecondary Mathematics. (PDF)}\]
Early success of redesign efforts

Several of the states that are farther along in implementing redesigned pathways have had success in improving seamless transfer of math credits, requiring students to take gateway math in their first year of college, aligning pathways with courses of study, and other aspects of statewide transformation. Likewise, many individual institutions have succeeded in some of the same areas.

To date, most of the success in redesigning math pathways that has been measured comes from efforts to streamline remedial (developmental) mathematics. In these efforts, several states have realized that they must address the relevance of developmental math and the processes for placing students into developmental math courses. Current placement structures often require students to show that they are ready for College Algebra before they can enroll in any math gateway course, regardless of whether algebra and precalculus skills are relevant to the degree or certificate they seek. At Ivy Technical College in Indiana, they were able to reduce the need for remediation by as much as 40 percent by placing students in a degree/certificate-relevant technical math course with corequisite supports rather than require students to complete a developmental algebra course.11

After five years, the Carnegie Foundation’s Math Pathways initial results show dramatic increases in student success. Award of college credit for mathematics within one year by community college students increased from about 6% to a remarkable 48% with the

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11 Data shared by Ivy Technical College with Complete College America, 2017.
introduction of the Statway statistics pathway. Early results for 2-year degree completion and transfer to 4-year institutions are also impressive. Students taking Quantway courses attained 2-year credentials at over 40% greater rates than all students from the same colleges (26% vs. 18%). Similarly, Statway and Quantway students transfer to 4-year colleges at about a 40% higher rate than do all students from the same colleges, according to National Student Clearinghouse records (about 43-45% transfers vs. 32% for other students from the same colleges).12 (Statway/Quantway improved transfer rates may increase, as the initial cohorts tracked students after 4 or 5 years, compared with the normal 6 years of the NSC records.)

Tennessee has also seen dramatic improvements in gateway math success by implementing co-requisite remediation in math. After full implementation of the model by 13 community colleges, students in the co-requisite implementation passed the credit-bearing math course at a rate more than 4 times higher than those in the prior pre-requisite model. For minority students, the success rate in math rose more than six-fold (to 43%).13

Individual institutions implementing alternative math pathways have sometimes met with success as well. In California, Los Medanos Community College created a statistics pathway that allows students who place into elementary or intermediate algebra to enroll in an accelerated statistics pathway. Eighty-two percent of students who place into intermediate algebra that chose this pathway completed a college level statistics course within one year compared to 33 percent for those in the traditional pathway. For students who place into elementary algebra, 78% that chose this pathway completed a college level statistics course within one year compared to 17 percent for those in the traditional pathway.14

On average, only about 20% of students placed in remedial math eventually pass a gateway math course. In states where significant redesign of remedial math pathways has been implemented, the pass rate is consistently three times higher (about 60%) for remedial students.15

The time is right for the AMPSS coalition
The time is right to leverage redesigned math pathways to achieve a significant increase in student success across the nation. Advancing Mathematics Pathways for Student Success (AMPSS) is a coalition of leading organizations working in math pathways and degree completion that has been formed over the last year. It incorporates the leadership of mathematics societies, higher education associations, and organizations doing groundbreaking work in math pathways.

13 Tennessee Board of Regents (2015). Co-Requisite Remediation Pilot Study (Fall 2014 and Spring 2015) and Full Implementation (Fall 2015). (PDF)
15 Data from the Carnegie Foundation, CCA, and the Dana Center.
The goal of AMPSS is to address the math portion of existing and new degree-completion and student-success initiatives, by integrating support for math pathways redesign into these initiatives at national scale.

*The AMPSS partnership*

Advancing Mathematics Pathways for Student Success (AMPSS) intends to advance the following vision:

*All students desiring public postsecondary education will have options to receive the rigorous mathematics instruction that is most relevant to their chosen programs of study, whether begun at a community college or 4-year institution and regardless of their level of preparation; there will be seamless transfer of mathematics credits from 2-year to 4-year institutions contributing to greater student course and degree completion.*

The coalition incorporates the mathematics leadership of Transforming Postsecondary Education in Mathematics (TPSE Math, or TPSE); builds on the groundbreaking work of The Charles A. Dana Center at The University of Texas at Austin, Complete College America (CCA), and the Carnegie Foundation for the Advancement of Teaching, and leverages the leadership of three major public university associations: the Association of Public and Land-grant Universities (APLU), the American Association of State Colleges and Universities (AASCU), and the National Association of System Heads (NASH). A core mission of all AMPSS partners is to provide access to a quality higher education to students from all different backgrounds.

In 2016, AMPSS embarked on a planning period to build a collaborative partnership and craft a consolidated strategy, based on our combined expertise, to bring math pathways redesign to scale for as many states as possible. This national strategy document is the result of this planning period.

*A part of existing initiatives*

Because redesigning mathematics pathways involves addressing many other issues - transfer, remediation, placement, the broader math curriculum, etc. - it is best to conceive of math pathways not as a new initiative, but rather as an aspect or component of existing initiatives to increase student success. Indeed, that is how it is conceived within each of our partner organizations, which have broader missions than just math pathways. Any realistic strategy for modernizing math pathways must incorporate and feed into efforts to reform these relevant policies and procedures, whether the efforts are already underway or not.

This AMPSS strategy comprises a coordinated way to advance existing initiatives (of institutions, states, or national organizations) by supplying or feeding them with support for math pathways reform, as a way to help address these related issues.

*The potential impact of a national effort*

The substantial data on the barrier posed by remedial and gateway mathematics, particularly for underrepresented groups, reveals a problem of enormous scale and
outlines its key features. While evidence of successful reforms is early, much of it points to a likely solution, but only if widespread systemic change is achieved. For promising interventions to fully impact the field, they must be coordinated across higher education systems to ensure that redesign of pathways through remedial and gateway math are embedded in transfer and articulation agreements, redesign of placement and advising strategies, and other essential components of student success. They must also be implemented at scale so that millions more students have access to what is a key first indicator in long-term college success, the completion of a gateway math course in their first one or two years in college.

Some research has suggested that each year, approximately 500,000 community college students drop out largely because they cannot pass a mathematics course. The number of 4-year college students who drop out for similar reasons is probably not as large, but could still be sizeable. Leading efforts of math pathways redesign supported by AMPSS partners and others show that success rates in gateway math can be roughly tripled. If these efforts were improved and scaled nationally over several years, we could expect millions more students to attain degrees or credentials who otherwise would not have.

The impact on students from underrepresented groups could be disproportionately positive. Students assessed as needing remediation are more likely to be members of underrepresented groups. Therefore, raising mathematics remediation pass rates in general can contribute to higher college attainment rates of members of underrepresented groups. Systemic reforms, if done properly, can therefore make a significant impact on reducing the attainment gap for underrepresented students.

2. The goal of a long-term strategy

Our long-term goal is to build a network of state efforts around the country to modernize math pathways at national scale. We believe we can help at least 40 states make significant changes to undergraduate mathematics in five years, changes that will have significant impacts on student success.

Core elements of the desired outcome:
In each state, we expect that successful implementation of this strategy to achieve three core outcomes:

1) students have the opportunity to enroll in a set of rigorous, entry-level, credit-bearing mathematics courses that are transferable and applicable to specific programs of study across 2- and 4-year institutions in the state.
2) all students are enrolled in the appropriate math pathway.
3) all students who need it are provided with accelerated or co-requisite remediation so that they can succeed in the appropriate college-level, credit-bearing math course within one year of matriculation.

Note that “statewide” and “in each state” refer to the entire public higher education arena, including all public 2-year and 4-year institutions. (Private institutions’ related activity would of course be welcomed, and if possible, coordinated with the efforts of the public institutions.) It also may refer to regions within very large states, or to groups of two or more small states.

More detail:
To be successful, efforts to increase degree completion by expanding math pathways must tackle several issues simultaneously, spanning state and institutional policy, course development, remediation, transfer, faculty engagement, student advising, K-12 alignment, and other issues. Below we describe what we believe are important outcomes in these areas, related to math pathways.

**Meta-majors**
We expect that the most efficient way to align math pathways with programs of study is to identify groups of programs with similar math needs and link a single math pathway to that “meta-major,” such as humanities, the social sciences, or STEM fields. This term is often used by other student success initiatives. Aligning math pathways with meta-majors will provide additional benefit to students who change majors within a meta-major. Pathways should be implemented in a way that ensures mobility so that the small number of students who may later decide to switch into algebra- and calculus-intensive majors to change pathways without undue burden. These should be pathways, not prisons.

**Transfer and applicability**
Transferability of credits to other institutions, and their applicability to a student’s chosen program of study, are significant factors in a student’s chance of success. Though many states have worked hard to create transfer pathways, those pathways do not always ensure program applicability of the transferred courses. Because so many students transfer among institutions, courses must also transfer seamlessly and apply to the degree or credential a student is pursuing. Math pathways provides an opportunity to address applicability when done well.

**Placement and Advising**
To ensure that students enroll in the math pathway that aligns with their chosen program of study, institutions must redesign how they guide students into the correct math courses. In particular, they should move to more robust approaches to placement. This would include clear articulation of the stakes associated with placement testing, opportunities for students to refresh skills before testing, and optional retesting with non-optional practice
support before the retest. Multiple measures to improve placement accuracy should be used, including transcript data for younger students and self-guided placement review for older students (based on surveys and formative assessments). More generally, placement should be part of a coordinated strategy that would include academic advising, career guidance and exploration for different meta-majors, and any Guided Pathways initiatives or other student support mechanisms. Professional development for advisors, who will need to help remedial, transfer, and other students into and along the right pathway, is also an important component.

Data/measurement capacity
To help determine what specific changes might be priorities, and to track progress and ensure success, it is important for states implementing math pathways to understand their current student behaviors and be able to measure any changes. At a minimum, this requires examining enrollments and success rates in relevant courses for different groups of students (e.g., underrepresented minorities, Pell-eligible students, transfers, underprepared students). Additional measures of student progress/success and quality of reforms would further enable continuous improvement and accountability within the state. This will help ensure that the pathways as implemented achieve the desired characteristics mentioned above (e.g. rigor, transferability, applicability, readiness, alignment), and that they are having the desired impacts (completion, equity). In addition to informing the state’s efforts, these data will allow AMPSS and others to evaluate the collective impact of this national work and make it transparent.

Alignment with K-12
Student success, including acceleration and placement, is of course aided by adequate preparation in high school and alignment of K-12 mathematics with postsecondary coursework. Therefore, success would be aided greatly by coordination with the K-12 sector. Knowing where students are coming from and better linking with high school algebra and other mathematics courses will be of increasing importance.

3. The deeper context: ongoing efforts to improve student success
Fortunately, there are many existing efforts to address several of the broader and complementary issues related to math pathways. Math pathways redesign feeds into and interacts with these other efforts to ultimately increase degree completion and opportunities for students. And in the cases of math remediation and transfer, they are essentially different types of math pathways, or parts of math pathways.

Remediation (developmental education)
The barrier to student success posed by inadequate or poorly-planned developmental education has increasingly been targeted for study and reform. Notably, in 2015, six national organizations representing thousands of higher education institutions and millions of students released design principles to significantly increase the number of students completing college and close attainment gaps for historically underserved populations. Their report, *Core Principles for Transforming Remediation within a*
Comprehensive Student Success Strategy\textsuperscript{19} highlights practices such as placing the vast majority of students directly into credit-bearing work with effective support; refining mathematical and other academic content to align with each student’s choice of academic direction; and helping students stay on track to a college credential. The critical portions of math pathways are integrated into these principles, which call for an intake process that helps students select and enter into gateway courses that are aligned to their programs of study and are designed with appropriate academic and nonacademic supports to enable all students to succeed.

Transfer and applicability

In a system of scaled math pathways, a small set of gateway mathematics courses need to be guaranteed to transfer across institutions \textit{and} apply predictably to programs of study. This requires coordinated action across institutions and states and across disciplines. At the state level, high-quality learning outcomes should be established that will ensure that all institutions will accept the courses for transfer. Applicability may be addressed statewide or through inter-institutional agreements. Regional action to establish agreements on applicability are often an efficient way to coordinate this work.

While all states have some type of policy or organizational structure for addressing transfer (and sometimes applicability), the types of structure vary enormously by state. So too do strategies or initiatives for streamlining transfer and mitigating barriers to student success.

Advising and placement

The way in which students are placed in developmental or college-level math courses, and guided into paths aligned with their career goals, is another important factor in student success. There are numerous examples across the country from which one can learn important lessons. Long Beach City College published one of the earliest studies of the impact of a multiple methods approach to placement, testing various approaches to combining placement (and other) test scores with high school transcript data. They were able to successfully place a larger proportion of students directly into college-level mathematics. These methods are being tested by colleges and universities across the country. The California Community College System is engaged in a large scale pilot to evaluate this method of placement as they implement a new statewide placement assessment.

Just as we see substantial adjustments being made to placement processes, it has become increasingly clear that dramatic changes in advising are also being developed and tested. A pathways approach argues for a simplification of choices and a more coherent approach to career exploration that links to areas of study, such as the modern, evidenced-based approach taken by Georgia State University. SUNY Suffolk has substantially redesigned its new student orientation, with particular emphasis on mandatory training for adjunct advisors. Every student meets with an advisor who has received intensive training. This

\textsuperscript{19} Multiple organizations (2015). Core Principles for Transforming Remediation within a Comprehensive Student Success Strategy. (PDF)
systematic training has improved the overall quality and consistency of advising which, in turn, has resulted in better decision making by students.

Many institutions around the country have designed proactive, holistic, campus-wide advising systems, supported by the strategic use of technology and data analytics. Known generally as Integrated Planning and Advising for Student Success (iPASS), these systems enable monitoring of many aspects of students’ progress and allow faculty and staff to intervene as necessary to help them stay on track.

In January 2017, APLU launched A SMART Approach to Student Success: Strategic Management of Advising Reform and Technology, an online course to guide leaders in academic affairs and student affairs, advising managers, professional advisors and faculty in launching robust iPASS systems. Based on in-depth interviews with presidents, provosts, vice provosts for student success, vice presidents of information technology, and advising personnel from five leading institutions, the course explores the intersection of proactive advising, institutional policy and practice change, technology, data analytics, student success objectives and return on investments. The course is designed to guide participants through the entire process of transforming an advising system such that student success becomes a collaborative effort and strategic priority.

This year, APLU will share the course with 2 and 4 year postsecondary institutions by working with higher education associations and other national organizations that support postsecondary institutions in reforming policies and practices to increase student success. In the fall of 2017, APLU will convene representatives from institutions that have participated in A SMART Approach to Student Success to discuss their experience using the resource, to identify best practices for using the course materials with multiple campus constituencies, and to brainstorm opportunities for expanding course content to support the iPASS field as it continues to evolve.

**Guided Pathways**

An increasing number of 2-year and 4-year institutions have begun implementing a Guided Pathways approach to addressing student success. This model is an integrated, college-wide approach that creates a mapping system for students to navigate their way through their entire higher education experience to completion. This mapping system is designed to meet four key objectives:

1. Clarify the path
2. Help students choose and enter a pathway
3. Help students stay on the path
4. Ensure that students are learning

At the core of this system (created by faculty and advisors) are clear, educationally coherent program maps. They include easy-to-understand steps for the routes through programs, along with the learning outcomes of programs that are aligned with identified requirements for success when transferring and entering the workforce. The system helps identify the student’s starting position on the map, provides the support necessary to get the student into college-level pathways, and keeps the student on the pathways to
successful completion of the program. Modernizing mathematics pathways is an important part of helping students through their overall academic path.

Other degree completion efforts
For many years, higher education policy and practices have had a robust focus on student attainment of postsecondary degrees and credentials. This perspective on student success has led to a significant number of interventions at every scale to address degree completion, touching every institution in the country.

One example is Project Degree Completion, developed by APLU and AASCU, in which nearly 500 public colleges and universities have pledged to increase not just the number of Americans who go to college, but also the number who finish and earn a degree. The total number of college degrees granted by these institutions would rise an additional 3.8 million between 2012 and 2025 while maintaining affordability and quality.

The significant overlap among math pathways and these other areas can be utilized to accelerate positive change in each. Math pathways redesign can benefit from ongoing reforms in remediation, Guided Pathways, and so on; likewise, a robust effort to address math pathways will necessarily create pressure for addressing issues in these related areas.

4. Theory of Change

Given the context and goals outlined above, an appropriate and empirically-based theory of change is necessary for understanding how desired change might happen and how key players, such as the AMPSS partners, might implement a national strategy for effecting that change. The theory of change below comes from the combined expertise and experience of those working most directly on math pathways reform and related efforts, and serves as the foundation of the AMPSS strategy and action plan. The theory draws on a number of key principles that have been identified and published by AMPSS partners and others, and on additional collaborative work of the AMPSS partners during the development of this national strategy.

Change is a collective action process
Efforts to build math pathways must start with math faculty leaders who can articulate a clear vision and set of recommendations for how to ensure undergraduates acquire the necessary quantitative skills to succeed in their chosen program. However, to fully implement the pathways, efforts must include state leadership, institutional leadership, and the full engagement of client (or partner) disciplines and student support services to ensure the necessary policies are in place and the appropriate systems are established to guide students into and through the math pathways that are aligned to their program of study. Additional broader engagement by national groups, including professional societies and higher education leadership associations, is essential for aligning both the policy

The Dana Center Mathematics Pathways Model.
environment and academic culture with the needs of any redesign effort. AMPSS borrows this important idea, that moving to scale requires the strategic coordination of institutional and disciplinary leaders, from the Core Principles for Remediation group (whose partners include three AMPSS partners). In summary, successful change efforts must be:

1. faculty led,
2. administratively supported,
3. policy enabled, and
4. culturally reinforced.

**Change must be coordinated across each state or region**

For institutions, systems, and states to make and sustain the changes described above, a systemic effort involving partnerships across the entire public education sector in each state is required. The reasons are threefold: (1) many students transfer among different institutions, usually in the same state or region, (2) institutions need not “go it alone” if others nearby are working on similar challenges, and (3) in order to achieve significant improvements in student success, the work must be done at sufficient scale to impact many students.

**Four phases of state activity**

In each state or region, we see this process comprising **four general phases of activity**:

1) Building awareness of the value of math pathways redesign for student success
2) Mobilizing and organizing key stakeholders in the state and setting a concrete vision
3) Creating enabling conditions for implementing math pathways, including designing the pathways themselves
4) Implementing redesigned math pathways in institutions and enrolling students in them

As each state moves through these phases, it would benefit from being part of a national network that enables it to draw on the experiences of other states and systems that are making these changes and the resources and support that AMPSS partners and others can provide.

The activities and outcomes of each phase are listed in Table 1 and described in greater detail below. In the subsequent section, we describe how AMPSS would play constructive roles in helping states navigate their way through each phase.
Table 1: Phases of activity for each state or region, from the AMPSS Theory of Change.

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<tr>
<td>Activities</td>
<td>Building awareness of math pathways work and its value among key stakeholders, deciding to act</td>
<td>Visioning, identifying goals and barriers, organizing, and planning</td>
<td>Designing pathways, building policy and conceptual infrastructure, minimizing barriers</td>
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<tr>
<td>Outcomes</td>
<td>Formation of a state math pathways task force</td>
<td>• Published, detailed recommendations from state math pathways task force. • State- or region-wide math pathways task force officially empowered to take action.</td>
<td>• Math pathways and corresponding learning outcomes are determined • Plans made for engaging additional stakeholders, scaling across institutions, evaluating process and impact, and addressing major barriers • Institutions commit to implementation</td>
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**Phase 1: Building awareness**

This initial phase is characterized by the development of a variety of connections among people in many roles, in institutions and states and from national organizations, as they learn from each other about the value of math pathways redesign for increasing postsecondary attainment and how it might interact with other student success strategies. Organizations from outside of the state, particularly AMPSS partners, have begun informing mathematics, institution, and state education leaders of the opportunities and potential for advancing math pathways in every state, using the work in the dozen states with existing efforts as models. AMPSS would instigate a structured effort to create a sense of urgency among various stakeholders inside the state that there is a critical but addressable problem in math curriculum, to inform and educate them about math pathways, convene the appropriate leaders, and begin to form a state math pathways task force.
The state, institutional, and math departmental leaders within a state would then continue to discuss math pathways, establish a plan for communications and engagement of a broad group of stakeholders (in subsequent phases), and formalize their creation of a state task force or leadership team focused on math pathways redesign. In particular, the state task force must include or engage with those in the state responsible for addressing issues of remediation, transfer, and other key aspects of the higher education landscape, and maintain that engagement throughout the four-phase process.

The key outcome of this phase is the formation of a state math pathways task force, led by math faculty with a few institutional administrators and state-level officials, with sufficient buy-in and commitment from key stakeholders to make success probable. As described below, AMPSS will help build awareness broadly, connect key leaders within states, and help them to form task forces. As more states and institutions across the country engage in these efforts and as a nationwide network forms, we anticipate the resulting momentum would make the work of building awareness in even more states to become significantly easier.

**Phase 2: Mobilizing**

Once a group has formed and decided to act, the initial planning must begin, based on an agreed-upon vision and goal.

First and foremost, the state task force or other leadership body must be organized to ensure the collective action and coordination across stakeholders and sectors. A well-designed structure and faculty-driven process will result in the development of a leadership structure, perhaps involving a respected “champion,” that can begin the work in earnest.

The task force brings together representatives from institutions across the state, identifies the problem’s parameters at those institutions and statewide, defines the leadership and roles of particular individuals, institutions, and sectors, and begins building legitimacy among key stakeholders who are not yet involved (by engaging them using the communications plan designed in Phase 1). The task force should also solicit the aid of institutional researchers and state officials in carefully assessing the outcomes of existing math pathways for different groups of students.

A key outcome of the mobilizing phase is a published report from the state math pathways task force, outlining recommendations or other documentation that lays out a clear vision for math pathways in the state and that recognizes that institutions must work together. At this point, the task force or a related group should also be formally empowered (by an appropriate state body or, where none exists, by a consensus of institutional leaders) to take action on their recommendations for math pathways.

**Phase 3: Creating enabling conditions**

Addressing policy and procedural barriers, as well as designing and aligning the math pathways themselves, are the core activities of Phase 3. In particular, the state task force in this phase should:
• Identify meta-majors and corresponding math learning outcomes for each (in common across all state institutions),
• Design or redesign math pathways for specific programs of study (grouped by meta-major to the extent possible) and determine common gateway course learning outcomes for the state,
• Continue building legitimacy among key stakeholders,
• Review and revise policies and procedures (state and institutional) that might be barriers, working with other key personnel on issues such as transfer,
• Design a plan for strategically scaling implementation of redesigned math pathways across institutions in Phase 4.

Phase 3 involves a significant amount of work on policies and procedures, including addressing or even eliminating any legal requirements for graduates to pass College Algebra (which still exist in many states), transfer protocols and alignment of 2-year and 4-year institutional policy, and common procedures for student placement. It also involves significant effort to get the pathways right, by working with partner or client disciplines to determine what math is actually needed for what programs.

The outcomes of Phase 3 are many:
• Math pathways and corresponding learning outcomes are determined.
• Major state/regional barriers identified and plans are made to address each of them.
• Plan for scaling across and within institutions is established.
• Plan for communications and engagement of broad stakeholders in Phase 4 is established.
• Evaluation plan is established.
• Some subset or all institutions make a formal commitment to implementation as defined by the state task force.

Phase 4: Institutional implementation

In the final phase, institutions develop and enact local implementation of redesigned math pathways, including offering new courses, enrolling the right students in each of them, and implementing new advising and placement practices. Implementation is not merely a course mapping activity, but is a systemic change that addresses how math education operates at the institutional and cross-institutional levels, and touches on pedagogy, support systems, advising, and professional development.

Crucially, institutions and the state task force (or whatever new structures might be formed) must take action to create the conditions for sustaining full-scale implementation. In this sense, Phase 4 is never complete, as changing conditions will always require additional action to ensure success is sustained. These sustaining conditions include appropriate transfer policies and agreements, multiple sources of funding, monitoring of program effectiveness and student success, and provision of ongoing technical assistance to departments, advisors, registrar, etc. as needed.

When successful, work in Phase 4 results in these outcomes:
• Institutions meet common criteria for implementation.
An evaluation plan is used to collect and use data for continuous improvement.
All barriers identified in Phase 3 continue to be addressed in some way.
Students are actively advised, placed, and enrolled in high-quality, aligned, accelerated math pathways as normative practice.

Two states that may have reached Phase 4 are Ohio and Indiana. Because each has developed common learning outcomes for the key math pathways in their state, they are able to design and provide professional development for faculty from across the state related to the teaching of specific courses. New York has implemented elements of Phase 4 by adopting Carnegie’s Quantway and Statway in its SUNY system, even as it continues to work on key tasks of Phase 3.

As more states move into later phases and show progress and results, we expect that the states that are not as far along will feel more pressure to make changes, lest they be seen as hindering the success of certain students with outdated math pathways.

5. The AMPSS Action Plan for advancing math pathways nationally

Our goal over the next 5 years is to galvanize 40 states to redesign their math pathways. We begin by supporting the 10-12 states already implementing significant math pathways redesign, then engage thirty “new” states, adding them to an emerging national network of states committed to math pathways. We would provide significant support for moving states through the phases to successful and sustainable implementation.

Drawing on the resources and expertise of its partner organizations and others, AMPSS would contribute to each state’s efforts in each phase of activity and help knit together a national network. In particular, AMPSS would:

1. Provide substantial technical and policy support and guidance for implementing math pathways
2. Engage mathematicians and math departments
3. Engage institutional leaders and administrators
4. Develop networks of state and institutional personnel and convene groups for mobilizing, designing, implementing, and evaluating math pathways in each state
5. Collect and analyze appropriate high-level data to evaluate progress

The depth and breadth of AMPSS engagement with states will depend on which Phase of activity a state is in. In Phase 1 (Building Awareness), AMPSS will have a broad but light interaction with a large number of states and organizations, communicating with and knitting together networks within states. As states become ready to move into Phase 2, AMPSS becomes more directly and deeply involved in their work. AMPSS facilitators engage and coach states in Phase 3 as they create enabling conditions. The final phase (4, Institutional Implementation) will see involvement of AMPSS in only a few states to begin with, and more only as they slowly reach that phase. As each state builds the conditions for sustainability, AMPSS’ role will gradually diminish as the state and its institutions design
and implement courses, take on increasing responsibility, and build structures for continuing successful utilization of math pathways. Table 2 displays a summary of AMPSS’ role in each phase of work with individual states, which is described in more detail in subsequent sections.

Throughout the process, AMPSS will coordinate and connect with related work of each AMPSS partner and other national groups that might be operating in a particular state, including work in remediation, transfer, advising, and degree completion.

Table 2: Roles of AMPSS and AMPSS partners in each phase of a state or region’s work.

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<tr>
<td>• Implement a broad national communications plan, including the use of high-level metrics and local results to drive awareness of the issue</td>
<td>• The AMPSS Lead Collaborator organization for a state coordinates direct, ongoing technical assistance for that state by deploying a trained consultant to each state and providing the AMPSS practitioner’s guide.</td>
<td>• Lead Collaborator continues to coordinate and provide direct technical support, largely through assigned consultants.</td>
<td>• Lead Collaborator continues to coordinate and provide direct technical support for faculty and administrators in implementing, scaling, and evaluating pathways.</td>
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<tr>
<td>• Help to mobilize and connect constituents of AMPSS partner organizations (e.g., math faculty, public university leaders, etc.)</td>
<td>• Provide national and regional networking activities (convenings, online networks, etc.) in coordination with the Lead Collaborators</td>
<td>• AMPSS partners and other groups provide legitimization; updates and connections with other states; and motivation to remain engaged.</td>
<td>• Review data regularly to understand impact and make any necessary changes</td>
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<td>• Assess all states’ readiness and assign each state that is ready for Phase 2 to a single Lead Collaborator organization from AMPSS (using a process outlined in the narrative). The Lead Collaborator designs a plan to begin work with that state.</td>
<td>• Continue to engage additional stakeholders</td>
<td>• With the Lead Collaborators, monitor state progress and determine which have entered Phase 3</td>
<td>• Share early results to help maintain momentum and create the enabling conditions</td>
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<tr>
<td></td>
<td>• Collect baseline metrics and continue to mobilize key actors around the existing outcomes</td>
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Outline of a coordinated national action plan:

The general outline of our action plan is to engage and build awareness broadly across all 50 states, while assigning a specific AMPSS partner to serve as the Lead Collaborator and point of contact for each state as it becomes ready for concerted action and to enter Phase 2. The Lead Collaborators would lead our coordinated efforts to support and assist each state through the next 3 phases of its work, making use of a common strategy and common resources for training and deploying consultants and monitoring progress. This assistance to states would be coordinated nationally by an AMPSS center and guided by plans for engagement, communications, and evaluation that would involve every AMPSS partner organization.

The key components of the AMPSS action plan are as follows, and a summary is depicted in Figure 5:

● AMPSS will be a coordinated effort with distributed responsibilities by partners.
● Building on the work already underway by AMPSS partners, we will identify a lead AMPSS partner organization for each future state joining our effort, to provide a consultant/facilitator to coordinate, guide, support, and to steer resources and links to assistance by other AMPSS partners.
● AMPSS partners will establish and use common objectives, data frameworks, and consultant training, aligned with the above Theory of Change, to work with states and create a consistent movement across the nation, building on the combined talent/attributes of individual partner organizations.
● We will develop approaches to regularly share updates, convene leaders across states to learn from one another as appropriate, provide mutual guidance, address challenges, and reach key education and math leaders to take advantage of the overall reach of AMPSS partners.

Figure 5: The AMPSS Action Plan for advancing mathematics pathways across the nation.

The details of how AMPSS would engage key players and provide direct support to states are described in the two following sections.
6. Communications and engagement plan

Broadly, building awareness across the nation

Broad publicity and awareness will be critical to building the momentum for math pathways in every state. AMPSS will coordinate communications as an overlay on existing projects and messaging by individual partners. AMPSS will establish regular communications with partners, affiliates, and other interested parties through a newsletter and a web site that serves as an “annotated portal” to the extensive information on partner sites.

An early step will be to commission a concise guide to options for states and institutions considering transforming math pathways. We believe AMPSS partners have framed an effective and flexible approach to assessing and undertaking the development of enabling conditions critical to establishing math pathways across institutions in a state (corresponding roughly to Phases 1-3 as sketched above). However, there are a number of key options available to institutions in selecting curricula and associated supports (in the latter stage of Phase 3 and Phase 4), as well as how their approach might fit in with broader student success initiatives already underway by institutions and states. Here are further elements of our communications efforts by phase:

Phase 1: Networking and connecting key players in each state

AMPSS partners will work to inform, identify, and connect specific interested people within each state. This collective networking will be facilitated/enhanced and compiled by AMPSS centrally. Partners will help to mobilize their constituencies, make them aware of math pathways’ value, and connect them with each other by convening members, incorporating sessions on math pathways for appropriate leadership groups in each of their national meetings, and through AMPSS material distributed directly to their members or constituents. One of the key purposes will be to identify math, system, and state leaders in each state who are interested in pursuing this effort. This work will take place broadly, and also more directly with specific states as multiple contacts in a state become connected with us. AMPSS staff has begun building a central database of partner contacts in specific states and will grow this shared resource as more interested leaders come forward.

As appropriate champions are identified in each state – whether a college president, a well-known mathematics leader, a state education leader, and so forth – AMPSS will coordinate further engagement to stimulate and assist in building a critical mass for beginning an effort on a state-by-state basis. Involvement in complementary student success efforts within a state could be used as a starting point for discussing beginning math pathways with them.

AMPSS outreach also will include regular updates on progress and “look at what’s happening here” communications to a wide array of constituents. This will supplement individual partners’ work with their own constituents, largely in Phase 1 states but also in states involved in other phases, to keep them engaged in the process.
To solicit engagement by additional states and to facilitate their advancement to Phase 2, we propose an AMPSS Request for Proposals (RFP) to be sent to key contacts in each state, offering direct support from AMPSS through its partners for a long-term process of redesigning math pathways. We would target state coordinating boards, college and university system offices, or groups of institutional leaders, depending on the state (per CCA’s and Dana’s experiences). We expect to send out RFPs each year, but the number of states we take will depend on our capacity— we might have fewer states in the first year or two as we build capacity. These Phase 1 activities should lead to a greater demand for task force support in Phases 2-4.

Phases 2-4: Ensuring continuous engagement of key players in each state

Communications as described in Phase 1 would continue, including stories in AMPSS and partner media, with Op-Eds in math and education media as more progress is made. Progress reports, including from Carnegie, Dana, and CCA, as they work with states in later phases, will continue to inform other AMPSS partners on successful practices and perhaps which departments, institutions, or systems might need extra engagement. Legitimization of a state task force’s proposed changes and building overall national momentum will be helped by AMPSS engaging the NASH, AASCU, APLU, AACC, and TPSE Math constituencies. Communications will also target other Core Principles partners, the National Association for Developmental Education (NADE), and Institutional Research associations that assist and motivate their members. Particularly important will be to describe how states are integrating work on math pathways with overall student success initiatives for AMPSS partners as well as Core Principles and other aligned efforts.

During Phase 2 and beyond, it will be helpful to convene leaders of state efforts, perhaps during regularly scheduled meetings and conferences of individual AMPSS partners, to allow them to build a community in which to share experiences, challenges, and approaches.

7. Direct work with states: How AMPSS will help states advance math pathways

In addition to connecting key players in states and motivating and engaging with them, AMPSS will need to provide direct support to states and regions in designing cohesive plans and implementing them at scale. This section describes:

- how AMPSS will select states for this direct support,
- the role of a Lead Collaborator organization for each state,
- the training and support of consultants deployed to each supported state,
- resources for state work,
- the specific types of support AMPSS will provide to states,
- national coordination of state-level work, and
- the central role of data for making decisions and evaluating progress.
State selection

Following on our efforts to engage key stakeholders in each state and solicit proposals from them (via our RFP process, described above), AMPSS partners will collectively assess which states are most ready to work directly with us in each year. This assessment will be based on several sources of information about the state’s current related initiatives and environment for change, including:

- The state’s application submitted in response to our RFP
- AMPSS’ Inventory of Initiatives (Appendix A) and List of State Characteristics (Appendix B)
- Other information gathered from AMPSS partners and other groups (such as the Core Principles for Remediation organizations)

Selection will further be determined by AMPSS partners’ capacity in that year.

Lead Collaborator organization

To ensure that each selected state has a single point of contact with AMPSS, and to coordinate the assistance provided by AMPSS to that state, AMPSS will distribute responsibility among partners by assigning a single AMPSS partner organization to be the Lead Collaborator for that state.

AMPSS will determine collectively which partner should be the Lead Collaborator for each new state. The decision will be based on:

- existing relationships between the state and any AMPSS partner(s);
- an assessment of what the state’s needs and capacities are;
- AMPSS partner capacities; and
- the state’s preference for a certain partner, if any.

In most cases, this Lead Collaborator will be either the Carnegie Foundation, Complete College America, or the Dana Center, due to their ongoing key roles in providing direct support to states and institutions related to math pathways. CCA is most experienced at supporting states in Phases 2 and 3, Carnegie supports efforts in Phases 3 and 4, and the Dana Center will continue to work with states in Phases 2, 3, and 4. States already working with an AMPSS partner, regardless of what phases they are in, will remain with that partner as their Lead Collaborator, but will benefit from the additional resources and connections that AMPSS will provide.

Once assigned, the AMPSS Lead Collaborator for a state will then assign a consultant to that state (see below) and work with that consultant to design and implement a state-specific strategy (usually beginning by helping them form a state math pathways task force). This organization, often through the designated consultant, will serve as the point of contact for the state throughout the state’s progress through the phases. This consistent point of contact is important so that relationships and trust can develop and so that data collection can be more consistent. Any necessary handoffs of states from one Lead Collaborator to another will likewise be determined collectively as the need arises.
AMPSS will develop systematic communications among Lead Collaborators and other AMPSS partners on state progress to ensure appropriate engagement and messaging at the annual partner convenings of their respective math and institutional leaders.

Consultant training and support

Given the different Lead Collaborator organizations directly assisting states, AMPSS will ensure consistent quality of this assistance by developing and using common strategies across all partner organizations. These common strategies, each aligned with our Theory of Change, include consultant training and support, written resources, and evaluation and metrics. This subsection describes consultant training and support.

Drawing on AMPSS partners’ significant experience and knowledge of training and deploying consultants to support math pathways redesign, AMPSS will design a common training and support program for consultants (or coaches) who will work directly with personnel in each state. The common strategy will help ensure that consultants will be able to provide consistent and effective support to state task forces and accurately convey the range of strategies and options (for such resources as math curriculum, e.g.) represented by all AMPSS partners and others.

Consultants will be trained collectively by AMPSS and then deployed to selected states and supported by Lead Collaborator organizations.

The main roles of the consultants will be to assist with all aspects of redesign, usually beginning with the development of a statewide math pathways task force in Phase 1. Consultants will be able to use - and guide states in using - common resources for design, implementation, and evaluation (described in the subsections below).

Consultants will be in regular communication with the Lead Collaborator and will be networked with each other as organized by AMPSS. This will allow them to be informed of partners’ relevant activities (such as meetings that might be important for the consultant to tell their states about) and receive additional on-the-job training and resources for helping states address unforeseen challenges that will come up (related to data collection and evaluation, new leadership, etc.).

AMPSS partners, particularly the Lead Collaborators for states, will regularly discuss progress in each state and how the consultants are doing, whether additional training is required, whether institutional leaders are appropriately engaged, and what changes or additional support might be needed.

A Practitioner's Guide and other resources

Per our Theory of Change, state task forces and leaders planning reform of remedial and gateway mathematics at scale need a trustworthy guide for strategic planning and for setting their plan’s elements in motion. States will want to learn from the examples and findings of states that are far along in the process (especially Ohio, Georgia, Indiana, Tennessee, and Texas) as well as the earlier strategies of North Carolina and Virginia. AMPSS partners already have a wealth of knowledge and experience that could be put into
a useful, written form, to supplement the knowledge of the consultants. Some have referred to such a resource as a “practitioner’s guide.”

In Year 1, AMPSS will design such a Practitioner’s Guide, as well as other resources, to be used in common by partners and consultants with states. Building on the Dana Center’s Implementation Guide and similar resources from other AMPSS partners (which serve a somewhat different purpose), the Practitioner’s Guide would go farther and include an assessment process that might be used to identify appropriate evidence-based curricular materials, strategies and pedagogies for implementing them, potential sources of additional funding, tools for advising and placement, etc. This assessment process would include a guide for how to review the evidence behind different resources and what might be their suggested or measured impact on different populations of students in different kinds of institutions. The practitioner’s guide would be developed by AMPSS partners with assistance from an expert consultant.

One important part of the Practitioner’s Guide would provide an objective way of assessing the dozen or so high quality math pathway curricular options and associated professional development strategies, and for making considered choices among them, starting from such features as cost and scalability. Both Carnegie and the Dana Center have curricula and design principles for statistics and quantitative reasoning pathways, but there are several others that may be better options in some states, including those of the California Acceleration Project, the Accelerated Learning Program at the Community College of Baltimore County, and Accelerated Study in Associate Programs at CUNY. Our Guide would include some basic information on different curriculum and professional development providers (including costs, scalability, evidence of effectiveness in different contexts, different objectives and audiences, etc.), but would largely promote foundational criteria and principles for states and institutions to make decisions.

Other resources will be designed or obtained for use with states by all Lead Collaborators and consultants, including frameworks and templates for making key decisions and plans, collecting and analyzing appropriate data, designing pathways and placement methods, and implementing those designs. Consultants will be trained to help states use the Practitioner’s Guide and other resources.

**Types of support AMPSS will provide to states**

The AMPSS Lead Collaborator for a state coordinates technical assistance for that state, including deploying AMPSS-trained consultants and providing resources, and bringing in other AMPSS partners for specific tasks as needed (for example, the Dana Center might bring CCA in with one if “its” states to help mobilize state leadership, or APLU to connect with leadership at a flagship university.) This partner organization would continue in this role all the way through full, sustained implementation (until our support is no longer required and the institutions and states are able to support their own ongoing work). Throughout the process, AMPSS would help make sure the statewide effort is faculty led, administratively supported, policy enabled, and culturally reinforced.
The first task of the consultant would be to help interested parties in the state (presumably those who had responded to the RFP) form an appropriate statewide team or task force to devote itself to redesigning math pathways (in Phase 1). Then, with support from the Lead Collaborator and AMPSS as a whole, the consultant would help the task force to connect with other key players in the state, collect data, identify specific issues, and form and set visions (the key tasks of Phase 2).

AMPSS and its partners will periodically run orientations and other hands-on workshops for multiple state task forces and their assigned consultants throughout Phases 2, 3, and 4, so that the states may learn by interacting with each other.

In Phase 3, the Lead Collaborator continues to design and provide customized technical support that increasingly includes policy and strategic support. For example, CCA and the Dana Center help states with policy like facilitating processes around learning outcomes, transfer, placement, and others, as well as with larger state-level policy issues.

As a state enters Phase 4 (Institutional Implementation), AMPSS will shift into the role of helping states to assist their individual institutions. The Lead Collaborator and assigned consultants will continue to support state teams or whatever new structures the state has developed to advance implementation across institutions in part or all of the state. (For example, Ohio has now created several subcommittees that are leading different parts of the work.)

For institutions (and in some cases, for systems or states), consultants would help states navigate important choices and remaining policy barriers for implementing and scaling redesigned math pathways across each program of study on a campus. Both the Carnegie Foundation and the Dana Center already provide a rich array of resources and services for institutions in this phase, including in curriculum development and direct support to faculty, assistance for adjusting transfer policy, and support for registrars, advisors, institutional researchers, and others.

**National coordination of state-level work**

The lead AMPSS partners working directly with states will meet monthly to share information about each state’s efforts and coordinate any required changes in provision of service to each state, including bringing in new or different AMPSS partners to assist with a particular task and adding new states to our efforts as they are ready. For example, they will inform the other AMPSS partners of which institutions or individuals might need additional engagement.

To measure a state’s progress along these phases, we will make use of the Dana Center’s State Readiness Assessment, which describes benchmarks for state action in different categories (e.g. leadership and commitment, pathways creation, transfer, placement), and our own State Characteristics inventory (Appendix B), which is a rougher view of the landscape and activities in each state.
In addition to multi-state workshops described above (led by Lead Collaborators), AMPSS as a whole will coordinate and provide regional and national convenings for state math pathways teams or other overlapping groups (e.g. math faculty, community college leaders, etc.) to learn more about key strategies, share information, and network with each other. A portion of these convenings will occur during regularly scheduled partner organization annual meetings with math and education leaders, as appropriate. AMPSS will also set up and direct several online networks for different groups, for the same purposes.

Evaluation: Measuring progress and success

An important part of our National Strategy is a methodology for assessing changes and their impact on student success, both for institutions and states to use in their efforts and for AMPSS to use on a national scale.

To track progress and ensure success, it is important for states implementing math pathways to understand their current student behaviors and be able to measure any changes. To facilitate this, the AMPSS partners will work with states and institutions to collect a minimum common set of metrics. In addition to informing states’ efforts, these data will allow AMPSS and others to evaluate the collective impact of this national work and report findings and results. In addition to the minimum set defined, participating states are encouraged to examine other measures of progress and quality to further enable continuous improvement and accountability within their own state. This will help ensure that the pathways as implemented achieve the desired characteristics (e.g. rigor, transferability, applicability, readiness, alignment), and that they are having the desired impacts (completion, equity).

The AMPSS team will also measure progress and the nature of the reforms implemented through surveys and other mechanisms meant to assess factors such as breadth of support, depth of engagement, and the extent of the changes.

A framework for institutional and state-level progress

To support these evaluation efforts, we have developed a framework for the evaluation of math pathways redesign at the institutional level which defines outcomes of math pathways work. This framework includes leading indicators as well as short-, medium-, and long-term metrics in each of four general activity areas:

- Creating new math pathways, or better defining or improving existing ones
- Aligning pathways to programs and placing students
- Aligning pathways across 2- and 4-year institutions
- Addressing remediation issues

The full framework is displayed in Appendix C and is summarized below.

Required and optional reporting

At a minimum, states directly supported by AMPSS will be asked to examine pre- and post-reform data related to creating the pathways and defining existing ones. Table X defines these metrics, which should be reported by race/ethnicity, Pell eligibility status, age, and
gender, where possible. A standard template will be used, and data collection for each state will be coordinated through the AMPSS Lead Collaborator assigned to that state.

Table 3: Indicators and outcomes of creating or refining math pathways (from the full framework in Appendix C). Collecting data associated with these outcomes comprises the minimum set of metrics for evaluating progress.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Outputs or Leading Indicators</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create or Redefine Pathways</td>
<td>Change in course offerings</td>
<td>Increased Enrollment in new pathways</td>
<td>Increased first year math gateway completion</td>
<td>Increased completion</td>
</tr>
<tr>
<td></td>
<td>Training on pathways for faculty and advisors</td>
<td>Decrease in College Algebra enrollment</td>
<td>Increased fall to fall retention</td>
<td>Increased representation in STEM degrees</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increase in the % of students enrolled in college algebra who go on to successfully complete a Calculus Sequence</td>
<td></td>
</tr>
</tbody>
</table>

States will be strongly encouraged to collect and report data related to the other general activity areas outlined in the framework (alignment, transfer, remediation). The data collection infrastructure will support the reporting of these metrics as well; where there is sufficient interest, we will work to share these data across states. Additionally, each state will be encouraged to define measures and collect data that apply to local efforts among its institutions, and to make use of existing state-level data sources for decision making and measuring progress.

*Further value in data collection and analysis*

The data collected as part of the evaluation process is a key tool in all aspects of implementing this national strategy, and goes beyond simply measuring outcomes. Data can be used by state task forces to inform all the decisions required for moving through the phases of change to full, sustained implementation. High-level data will be used to build awareness broadly, and state- and institution-level baseline data will be used to mobilize action at those levels. Early outcomes data will help create the conditions for change, and further evaluation will help inform implementation efforts.

From an evaluation perspective, there are a number of benefits to collecting common measures across participating states and systems. First, these efforts will allow AMPSS to track progress across different but related efforts. Second, it will provide just-in-time insight into the effectiveness of particular state task force plans, allowing opportunities for greater investment in designs that are working and course correction for those that are not. Finally, the wealth of data will provide insight into the full implications of this national
strategy, allowing AMPSS partners, funders, other organizations, and individual states to analyze the impact that these efforts may have on helping them to reach attainment goals.

Using data to inform our work is at the heart of the AMPSS project. The framework outlined here will continue to be a working document informed by state work, while at the same time providing a standard that can unite those embarking on math pathways redesign with a clear understanding of the essential components and the outcomes associated with each of those components.

Practically speaking, to support states in collecting, reporting, and using data, AMPSS partners will work together to further refine and implement this coordinated data and evaluation strategy. The purpose of this strategy is to ensure a consistent and pragmatic approach to collecting data from participating institutions and states, to create tools that facilitate data use, to build consultants’ capacity to work with states in using their data, and to perform analysis to track implementation and monitor outcomes across the nation. This must align with existing data infrastructures utilized by the AMPSS partners and the states.

How AMPSS fits into the ongoing related work of each AMPSS partner and other entities

Working directly with states in this way, AMPSS will be in the position to coordinate state and institutional efforts on math pathways with the related efforts and goals of AMPSS partners’ other initiatives, such as AASCU’s Reimagining the First Year or CCA’s Guided Pathways. As the AMPSS partners collectively track states’ progress in math pathways, they will simultaneously assess states’ and institutions’ engagement in these related initiatives, to identify opportunities to advance the work and barriers to be addressed. The goal of such coordination is that all partner efforts to modernize math pathways is undertaken by participating in or drawing on an AMPSS national network, regardless of the larger initiative that the math pathways reform effort might be part of.

Similarly, we expect that AMPSS will provide the math pathways support for similar aspects of aligned larger efforts undertaken by national organizations such as Jobs For the Future, Achieving the Dream, and other signers of the Core Principles for Remediation.

Role of AMPSS hub or center

In addition to coordinating the regular communications among partner organizations and others described above (both connecting key players within states and monitoring and evaluating progress in each state), a central AMPSS office would take on a loose convening role for the national network of states. The AMPSS center would also be able to chart overall national progress.
8. Detailed Timeline and Strategy

To ensure we meet our goal of reaching 30 more states and helping the first 10-12 to advance their efforts, we will design a five-year plan. The plan will include identifying:

a) resources each state will need, including:
   ● funding, determined partly by the size of the public undergraduate student body and which phase of progress it is in,
   ● consulting
   ● other support

b) resources AMPSS would need to make it happen, including:
   ● seed money for states
   ● funding for partners to provide facilitation and consultant support to states
   ● modest funding for AMPSS hub functions, including national convenings, networking activities, and evaluation

c) strategies for interstate connections/networks

d) more specific roles and activities of partners (currently summarized in Table 4) and how they contribute to each state at each phase of activity, and how they track progress across phases.
Roles of specific AMPSS partner organizations

Table 4: Roles of AMPSS partner organizations, individually and collectively. Additional detail is provided in the narrative and in Table 2.

<table>
<thead>
<tr>
<th>Partner</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>All partners together</td>
<td>Committee of all partners meets monthly to coordinate national outreach, direct work in specific states, assignment of states as they are ready to a Lead Collaborator, and do other work of substance like create practitioner’s guide and design consultant training</td>
</tr>
<tr>
<td>Each partner individually</td>
<td>Engage constituencies in all phases (particularly in Phase 1, per AMPSS communications plan above)</td>
</tr>
</tbody>
</table>
| TPSE Math | - Continue to motivate mathematicians in later phases (in coordination with the Lead Collaborators)  
- Organize national and regional networking events for mathematicians |
| AASCU, APLU, NASH | - Continue to motivate key constituents among institutional and system leaders in later phases (in coordination with the Lead Collaborators)  
- Organize national and regional networking events for higher education leaders |
| Dana Center | - Lead the design of consultant training and help train consultants to be deployed by all Lead Collaborators  
- **Work directly with approximately 10 states over five years (5 at a time) in Phases 2-4** (as Lead Collaborator)  
- Hire and deploy consultants to those states  
- Assist other Lead Collaborators as needed |
| CCA | - Help to design consultant training and help train consultants to be deployed by all Lead Collaborators  
- **Work directly with 8-13 states in Phases 2 and 3** over five years (as Lead Collaborator)  
- Hire and deploy consultants to those states  
- Assist other Lead Collaborators as needed |
| Carnegie | - Help to design consultant training and help train consultants to be deployed by all Lead Collaborators  
- **Years 1-2: Work directly with 8-10 states in Phases 3-4** (as Lead Collaborator)  
- **Years 3-5: Work directly with 15-20 additional states in Phases 3-4** (as Lead Collaborator)  
- Hire and deploy consultants to those states  
- Assist other Lead Collaborators as needed |
| AMPSS hub | Roles described in narrative sections, including working with Lead Collaborators to arrange regional and national convenings as necessary, supporting consultants and Lead Collaborators with emerging data and evaluation questions, logistics, communications, budget, finance, etc. |

**Brief sketch of timeline:**

*Year 1*
- Design program for training and supporting consultants
- Hire initial set of consultants and train them
- Create Practitioner’s Guide and Web site
- Create and populate contact database
- Identify states ready for direct support and key contacts in each
- Design and disseminate first Request for Proposals (RFP) to key contacts in each state that is ready
- Select states from among applicants and assign each to a Lead Collaborator organization
- Deploy consultants and begin other direct support with selected states
- Build awareness and make key connections (Phase 1) among states nationwide, per communications and engagement plan
- Track interest and progress in all states
- Collect baseline data and create reports to help build a case and mobilize

**Years 2-5**

- Continue nationwide work to build awareness and make key connections, per communications and engagement plan
- Continue to track interest and progress in all states, including state readiness for direct support
- Continue direct support to states already working with AMPSS, except those who no longer need it
- Disseminate new RFP annually to states deemed ready
- Select applicants for direct support and begin working with them
- Collect data and evaluate the overall national effort to date, using results to inform ongoing awareness-building and direct state support

We expect to directly support 20-25 states in Years 1-2, and 30-40 states in Years 3-5. We expect that with the implementation of this national strategy, state work to modernize math pathways will advance significantly.
Appendices

Appendix A: National Inventory of Mathematics Pathways and Related Initiatives

This section summarizes the existing math pathways work across many organizations and states, compiled by AMPSS in December 2016.

In October 2016, the AMPSS Inventory Team interviewed key contacts from 14 organizations with involvement in collective approaches to reforming math pathways for college students. Together, these organizations are working in 27 states. We were able to identify 18 public university systems and 382 individual campuses where math pathways are being actively explored or scaled up, or have been fully adopted. We know that the universe of specific institutions involved in these efforts is much higher, as a number of the organizations are working with multiple campuses but were not able to provide us with campus lists. At the end of this report, you will find links to spreadsheets documenting the findings from these interviews and the questionnaires that were completed by the interviewers. What follows here is a thumbnail sketch for the math pathway work in each of these organizations.

AMPSS Partner Organizations

AMPSS partner organizations each have a major focus on math pathways. In all but three cases, math pathways are being promoted as part of a larger student success agenda.

Carnegie Foundation Math Pathways

Carnegie Math Pathways is a growing national network of two- and four-year colleges who work together to deliver and continually improve a set of math pathway and professional learning services and resources. They have developed quantitative reasoning and introductory statistics pathways that can take students from three course levels below college-level and successfully move them through their college level courses in substantially less time than traditional remediation course sequences. Work is primarily at the campus level, with some system involvement. A rich array of resources and services are provided, especially in curriculum development and direct support to faculty. Implementation at the campus level ranges from exploratory to full adoption. There is a major effort to scale up implementation at community colleges in the SUNY System, with a few four-year institutions in the planning stages.

Charles A. Dana Center Math Pathways

The Dana Center Math Pathways project supports implementation of math pathways that create “coherence without uniformity” across a system. A model of four broad, overarching principles based on research and input from leaders in the field provides the coherence. Beyond that, leaders at different levels of the system make decisions about how the model will be implemented. This allows for customization based on local needs and empowers faculty, staff, and administrators to take ownership, innovate and improve over
time. The Dana Center is engaged at the national, state, campus and classroom levels. Extensive resources in technical assistance, toolkits, research and advocacy are available to participants. Current work is focused on cohorts of state teams working at both the policy and institutional implementation levels.

*Transforming Postsecondary Education in Mathematics*

TPSE is a mathematics organization focused on improving math education, with math pathways as one of their four priorities. It is advocating for math pathways nationally and regionally at higher education convenings, and providing support and connections to mathematicians at TPSE’s own events, working closely with the Dana Center and CBMS. TPSE has held five regional meetings of math department chairs, where math pathways have been a major focus.

*Complete College America*

CCA is has partnered with the Dana Center to implement Math Pathways in six states, with the goal for all states to have clear plans for implementing their math pathways strategies at institutions by Fall 2017. Math pathways is a primary component of CCA’s effort to reform remedial education through co-requisite support. CCA provides resources and guidance to state-level education agencies or systems and to state level task forces to develop a set of recommendations for implementing math pathways and support for the implementation through professional development opportunities for faculty, administrators and staff. They also facilitate data collection and analysis for both designing the pathways and measuring their impact. Tennessee is a prime example of statewide implementation of co-requisite remediation in math, particularly in the Tennessee Board of Regents system of institutions.

*NASH: Taking Student Success to Scale*

For the past two years, NASH has developed a major initiative, Taking Students Success to Scale (TS$^3$). This is a network of twenty-five systems and nearly two hundred campuses focused on scaling up three evidence-based student success strategies (math pathways, predictive analytics, and high impact practices). NASH TS$^3$ is using a collective impact approach to leveraging the power of systems through a networked learning community, with the goal of adoption at scale leading to an increased number of degrees awarded. Approaches to math pathways being adopted in these systems include co-requisite remediation, Quantway/Statway, Dana Center’s New Math Pathways, and locally developed curriculum reforms. To date, most of the work has been virtual, with an annual network convening.

*AASCU: Reimagining the First Year of College*

AASCU designed, and is directing, a national project entitled Re-Imagining the First Year of College (RFY) which includes forty-four AASCU member institutions. These campuses are undertaking a variety of projects and programs in the first year to improve student retention and success. One of the signature initiatives is the design of pathways to facilitate student progress towards a degree. Within the attention to Pathways, the Math Pathways will be the most prominent and the best developed pathway that will be implemented. Working with academic leaders, AASCU is deliberately creating a rapid dissemination
approach to ensure that innovations in the RFY are quickly disseminated to all AASCU campuses. Further detail on math reform will emerge as this work proceeds.

**APLU and AASCU: Project Degree Completion**

Project Degree Completion (PDC) is APLU’s and AASCU’s overarching initiative/goal to increase the number of undergraduate degrees awarded at member institutions while maintaining educational quality and costs. Given the centrality of mathematics within the core of American higher education, and particularly in encouraging the development of high-order reasoning skills, academic achievement within mathematics sequences is an important piece of the overall student success puzzle. This approach is focused at gleaning evidence-based innovations and practices at the institutional level to increase undergraduate degree completion in order to synthesize, curate, and disseminate that information for adaptation at other institutions across their membership. Nearly 500 public colleges and universities have committed to work together to achieve this goal.

**APLU: Collaboration for Change**

Collaboration for Change is a six-year student success initiative focused on scaling innovative practices in urban-serving universities in five areas: engaging faculty; rethinking financial aid; leveraging community assets; aligning and engaging employers; and strengthening K-16 systems. Three institutions involve math partially: Florida International University, Georgia State University, and Portland State University.

**Related Initiatives**

The following initiatives beyond the AMPSS Partnership were identified for their substantive involvement in math pathways work, at either the policy or the implementation levels.

**Achieving the Dream**

Achieving the Dream has worked with both Uri Treisman (Dana Center) and with Tony Bryk (Carnegie Foundation). Any new institution gets a general introduction to the math pathways. The Dana Center will provide an in-depth briefing. Those who want to go deeper can get technical assistance from the Dana Center and Achieving the Dream coaches. They use the Dana Center principles and let campuses use whatever actual curriculum they wish. Achieving the Dream currently works with 190 community colleges. They estimate that three-quarters of these campuses talk about math pathways, half have remedial pathways efforts, and 12-15 have a full-blown effort underway. Many of these campuses are working with the Dana Center.

**Aspen Institute**

The fundamental goals of the Aspen Institute’s College Excellence Program are to identify and elevate practices and policies broadly that contribute to significant improvements in student outcomes. In particular, they work with community colleges on developing and implementing coherent plans to improve student success through internal change and strategic external partnership. For some number of these colleges, math pathways and math course redesigns are critical components of those student success agendas. They identify and celebrate where these efforts are contributing to improvements in student
outcomes, but do not take a particular stance in advocating for or supporting those redesigns.

**California Acceleration Project**

CAP’s focus is on getting a larger proportion of community college students completing a transfer level math and English course through emphasis on three high-leverage acceleration strategies. The first strategy is Placement: Many students are placed into remediation who don’t need it and would be better off if allowed to enroll directly in college courses. The second strategy is Co-Requisites: Students are more successful when allowed to enroll in college-level courses with extra support, instead of remedial courses. The third strategy is students enroll in accelerated pathways where developmental courses are tailored to college-level requirements. With respect to math, this is a statistics pathway where remediation is completely integrated and contextualized in a statistics pathway. CAP provides workshops, professional development and technical assistance to community colleges in California.

**Community College Research Center**

The Community College Research Center (CCRC) has conducted and continues to conduct research that is informing efforts nationally to rethink teaching of math and other foundation skills, and to connect those efforts to broader efforts to redesign academic programs and student support services on the guided pathways model. This includes applied research to support efforts to implement math pathways tied to broader programmatic pathways by state and regional systems, institutions involved in national initiatives and the field more generally.

**Education Commission of the States**

ECS is now the fiscal agent and knowledge manager for the six partners implementing the Core Principles for Transforming Remediation, which include math pathways (AACC, CCA, JFF, ATD, Dana Center, ECS). A group of funders have established pooled funds. ECS is the hub of connectivity for specific projects that each partner is individually leading -- they are the intermediary between the philanthropic community and the other supporters of the core principles. Uri Treisman has been chairing the group for the past 18 months and will continue for perhaps another year. As a result ECS is not doing as much of the specific projects in the content work, but working in the aggregate, ensuring the national partners have the funding they need from the pooled funds. They are something of a clearinghouse – to describe and to ensure a minimum amount of duplication.

**Jobs for the Future**

Jobs for the Future partnered with Achieving the Dream in 2005 to create a state policy network, as part of their larger goal of building educational pathways to improve college completion. In 2012 they designed and incubated the Student Success Center model described below. JFF supports Student Success Centers (SSCs) in thirteen states. These are small offices housed in a system office, such as a Higher Education Coordinating Board or the Texas Association of Community Colleges. These centers engage all community colleges in a state and work towards coherence in their programs. JFF brokers technical assistance to the SSCs to help with education pathways implementation, primarily on transfer; math
reform is involved in some cases. JFF shares information across the network on the latest research, policies and practices. JFF also supports implementing co-requisite courses which combine developmental education content with college-level content.

Independent State Work

**Maryland**

The University System of Maryland and its institutions, Maryland Community Colleges and the other independent higher education in Maryland, are collaborating to address the mathematics “pipeline” issues that have created a significant bottleneck for postsecondary students. The First in the World (FITW) Maryland Mathematics Reform Initiative (MMRI) is a joint effort to develop, implement, and evaluate a new statistics pathway in order to accelerate developmental students’ progress into credit-bearing postsecondary courses and help more of those students reach certificate or degree completion effectively and efficiently. The new pathway is designed to be more relevant to students’ courses of study and chosen career paths while also ensuring that the new courses have sufficient mathematical integrity and rigor to be deemed “college-level.” Project goals include reducing costs and time to degree for students who will not have to languish in developmental courses and saving the state and higher education institutions at least a portion of the estimated $72 million spent annually in Maryland on developmental education. To meet those goals, the FITW MMRI program supports the creation of a new developmental statistics pathway course that leads to a general education statistics course.

**Oregon**

The Oregon Board of Higher Education is working closely with the Oregon Board of Education (K12) on their high priority of alignment of the K12--community college--university pathway. They see math as a key element in this. They have attempted to streamline paths from high school to college in the past, and they are returning to this priority again. Their focus at this point is on what students need in high school (applied math or calculus) and how to get them ready to meet university requirements. They are currently assessing where all of their institutions are in this regard.

**Note:** We also reviewed the following organizations and found that their work, while related, did not have a substantive focus on math pathways: Completion by Design, HCM Strategies, Public Agenda, State Higher Education Executive Officers Association, and University Innovation Alliance.

**States**

This inventory identified six states with considerable interest and activity in math pathways; these states have not been in a CCA or Dana Center cohort. These are:

<table>
<thead>
<tr>
<th>Maryland</th>
<th>Oregon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota</td>
<td>Utah</td>
</tr>
<tr>
<td>New York</td>
<td>Wisconsin</td>
</tr>
</tbody>
</table>
Twenty-three states have little coordinated activity. There are connections to the organizations described above in some cases, usually from just a few individual institutions.

<table>
<thead>
<tr>
<th>Alabama</th>
<th>Kentucky</th>
<th>North Dakota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>Louisiana</td>
<td>Pennsylvania</td>
</tr>
<tr>
<td>Arizona</td>
<td>Maine</td>
<td>South Carolina</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Michigan</td>
<td>South Dakota</td>
</tr>
<tr>
<td>Delaware</td>
<td>Mississippi</td>
<td>Vermont</td>
</tr>
<tr>
<td>Florida</td>
<td>Nebraska</td>
<td>Virginia</td>
</tr>
<tr>
<td>Iowa</td>
<td>New Jersey</td>
<td>Wyoming</td>
</tr>
<tr>
<td>Kansas</td>
<td>North Carolina</td>
<td></td>
</tr>
</tbody>
</table>

Twenty-one states have worked at the state level with CCA, the Dana Center, or both. Some of these states have little ongoing contact with CCA/Dana and may not have achieved full implementation yet. Many of these states are also involved in initiatives led by other partner organizations. Upon deeper review with the larger team, some of these states may be candidates for further work.

<table>
<thead>
<tr>
<th>Arkansas</th>
<th>Indiana</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Massachusetts</td>
<td>Oklahoma</td>
</tr>
<tr>
<td>Colorado</td>
<td>Missouri</td>
<td>Rhode Island</td>
</tr>
<tr>
<td>Georgia</td>
<td>Montana</td>
<td>Tennessee</td>
</tr>
<tr>
<td>Hawaii</td>
<td>Nevada</td>
<td>Texas</td>
</tr>
<tr>
<td>Idaho</td>
<td>New Hampshire</td>
<td>Washington</td>
</tr>
<tr>
<td>Illinois</td>
<td>New Mexico</td>
<td>West Virginia</td>
</tr>
</tbody>
</table>
Appendix B: Characteristics of States Relevant to Mathematics Pathways Redesign

This Appendix is intended to summarize the landscape of higher education reform relevant to redesigning math pathways in each state, so that AMPSS might better understand the particular needs and resources of each state and design customized support. AMPSS partners identified a number of key characteristics and estimated each state’s position on each characteristic, to the extent known. Below is our list of relevant state characteristics. The corresponding table, with detail for each state, is available online at this link.

This is not meant to be a set of formal measures – just a rough estimate, based on the knowledge of AMPSS partners only, of what’s going on in each state. Additional information about each state will later need to be gathered and used by partners to customize the strategies used.

1) **Complexity and capacity**: Higher education landscape in the state:
   a) Central agency or system(s) of public higher education
      i) How many such actors are there in the state? (e.g. state agency and two systems, or just one or zero entities)
      ii) How much governing authority does it have over campuses?
      iii) What proportion of public institutions does it cover (e.g., just 4-years)?
      iv) State/system collects data on math course enrollments and success (if known)
   b) Number of institutions in AMPSS Inventory (which includes various math pathways related categories)
   c) Membership in APLU, AASCU, NASH, AACC (from websites)
   d) Level of collaboration among 2- and 4-years generally (if known)
   e) Strength of policies and structures to support transfer (if known)

2) **Math pathways activity**: Level of activity around math pathways
   a) Existing state task force that meets regularly and has some official recognition (yes/no)
   b) Published or drafted recommendations for statewide math pathways work (yes/no)
   c) Number of public institutions in the state working on math pathways independent of any possible statewide effort (from our Inventory)
   d) Multiple math pathways for gateway and developmental courses established, even if they need more work on transfer, placement, acceleration, etc. (for all/some/no meta-majors).
      i) If yes, then these pathways need more work on transfer, placement, acceleration, etc. (lots/some/none)
3) **Other Initiatives** (relates both to readiness and complexity/landscape): Other structures and initiatives relevant to math pathways (to the extent we are aware of them)
   a) Level of statewide efforts to accelerate remediation, including co-requisite remediation (high/low/none), and with whom?
   b) Guided Pathways initiatives (lots/little/none) with whom?
   c) Level of other undergraduate math reform work across state (high/low/none)
   d) Any significant degree-completion initiatives that impact most of the state’s institutions (lots/little/none) (part of a national effort? With whom?)
## Appendix C: Data Framework for Measuring Mathematics Pathways

### Redesign

<table>
<thead>
<tr>
<th>Activities</th>
<th>Outputs or Leading Indicators</th>
<th>Short-term outcomes</th>
<th>Medium-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create or Redefine Pathways</td>
<td>Change in course offerings</td>
<td>Increased Enrollment in new pathways</td>
<td>Increased first year math gateway completion</td>
<td>Increased completion</td>
</tr>
<tr>
<td></td>
<td>Training on pathways for faculty and advisors</td>
<td>Decrease in College Algebra enrollment</td>
<td>Increased fall to fall retention</td>
<td>Increased representation in STEM degrees</td>
</tr>
<tr>
<td>Align pathways to programs and place students</td>
<td>Change in advisor attitudes/training</td>
<td>Students enrolled in the correct pathway within 1 year</td>
<td>Fewer students change majors outside of a meta-majors (within a threshold)</td>
<td>Pathway enrollment mirrors program completion</td>
</tr>
<tr>
<td></td>
<td>Change in math required for programs of study</td>
<td>Math pathway enrollment should mirror program enrollment</td>
<td>Fewer students enrolled in general studies/undecided.</td>
<td>Decreased credits and time degree for all students</td>
</tr>
<tr>
<td>Align pathways across sectors</td>
<td>Community college courses fulfill 4-year math requirements (for general ed. as well as for specific programs of study)</td>
<td>Fewer transfer students take gateway math at the 4-year institution</td>
<td>Increased transfer to 4-year institutions</td>
<td>Decrease credits and time to degree for transfer students</td>
</tr>
<tr>
<td><strong>Align and address remedial need</strong></td>
<td><strong>advisors, faculty, and students</strong></td>
<td><strong>Increase in the number of students enrolled into a college level math in 1 year</strong></td>
<td><strong>Increased first year math gateway completion by remedial students</strong></td>
<td><strong>Increased completion by remedial students</strong></td>
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<td>Corequisite courses are developed</td>
<td>Faculty have been trained to teach them</td>
<td>Decrease in the number of students required to pass college algebra prerequisites to enroll in a college level courses</td>
<td>Increased fall to fall retention by remedial students</td>
<td>Increased STEM success by remedial students</td>
</tr>
</tbody>
</table>