COMPLETE COLLEGE AMERICA

JANUARY 2025

Formula for SUCCESS

How to Support Every Student Through Math Pathways

No matter what path students pursue in postsecondary education and in life, they need to be able to problem solve and think critically. The study of mathematics involves more than learning how to solve equations—it teaches skills and habits of mind that are an essential part of the formula for students to succeed in further studies and in their careers. Requiring all students, regardless of the degree or certificate they are seeking, to take at least some math is one way postsecondary institutions ensure that students master these skills.

But as states, systems, and institutions look at ways to increase completion rates and help students meet their education goals, recognition has grown that students in different programs of study require different math knowledge and skills. For example, students in the social sciences might benefit from focusing on statistics or data analysis, while students in science, technology, engineering, and math (STEM) fields might need to focus on algebraic skills. Aligning the math students learn with the skills and knowledge required for their program of study helps students understand the purpose of the coursework, fostering productive academic mindsets so they can overcome challenges, build momentum, and persist to meet their goals.

To ensure that students are exposed to the math content they need, Complete College America (CCA) is supporting systems and institutions as they implement math pathways. This work is part of CCA's efforts to address policy, perspective, and practice to drive systemic changes that lead to higher college completion rates, more equitable outcomes, and greater economic and social mobility.

Creating these pathways was an important start. But many institutions still have policies and structures in place for math pathways that inadvertently close doors and prevent students, particularly those interested in STEM fields, from accessing some programs of study. Full implementation of math pathways requires additional steps to remove these barriers so that all programs of study and aligned math pathways are available to every student.

This brief focuses on the next phase of the math pathways work—math pathways 2.0. This phase includes the steps postsecondary institutions need to take to ensure that students, including those pursuing STEM fields, have access to and are set up to succeed through math pathways, including:

- Ensuring that the designated entry-level, credit-bearing (or gateway) course for each math pathway covers the necessary knowledge and skills for the corresponding program of study.
- Revising the placement process so that students start by identifying their goals and choose a program of study based on those goals, then defaulting students into the appropriate gateway math course for that program of study.
- Providing the supports students need to succeed in the gateway course and beyond.

Math faculty and college and system leaders can use this brief to broaden their understanding of how to build on the work they have already done and are doing to support student success in math pathways and advocate change at their institutions.

ABOUT COMPLETE COLLEGE AMERICA

Complete College America (CCA) builds movements for scaled change and transforms institutions. Specifically, CCA drives systemic change that leads to better college completion rates; more equitable outcomes; and greater economic and social mobility, especially for historically excluded students. CCA operates at the federal, state, and institutional levels and works with its national network of forward-thinking state and higher education leaders. Since its founding in 2009, CCA and its network have introduced bold initiatives that help states and institutions implement data-driven policies, student-centered perspectives, and equity-driven practices.

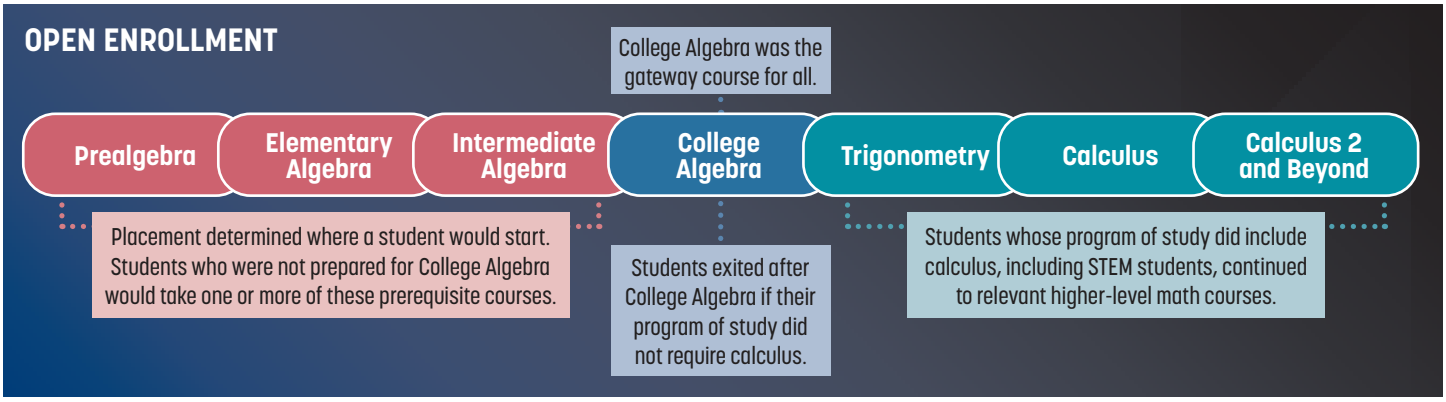
A DEEPER DIVE INTO MATH PATHWAYS

Starting with the gateway course, math pathways, particularly for STEM fields, may look different for different types of institutions in response to the varying needs of their student populations. At open enrollment institutions, for example, many students may have had only a single year of algebra in high school. At many highly selective colleges, most students have had at least the equivalent of a second year of high school algebra, and many have taken Precalculus, Calculus, or beyond.

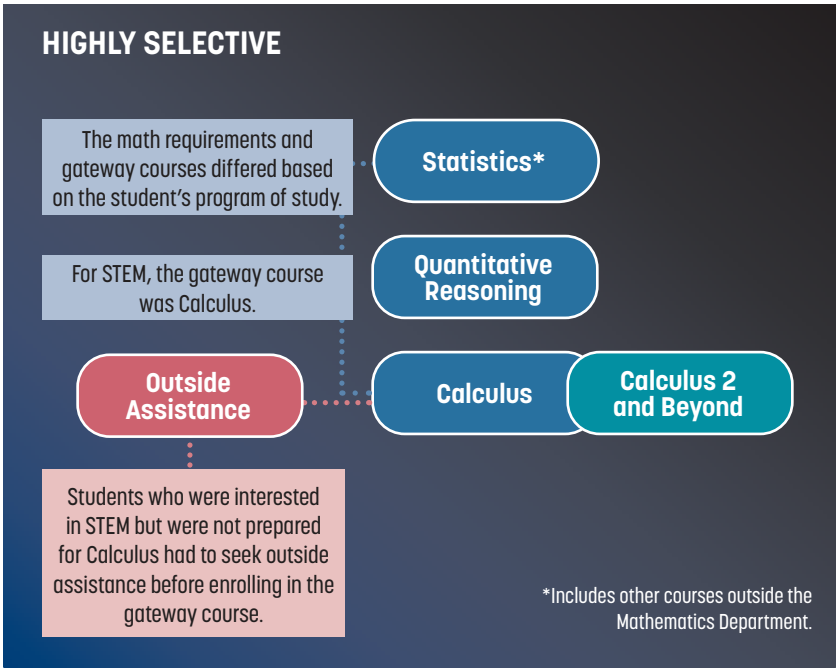
Following is a look at examples of how the path leading up to and through the gateway math course has evolved at open enrollment and highly selective institutions and what it would look like with full implementation in math pathways 2.0.

BEFORE MATH PATHWAYS

Before they implemented math pathways, most open enrollment institutions required students to take College Algebra. This course functioned as the gateway course regardless of a student's program of study. With this approach, many students were required to take prerequisite, noncredit-bearing courses and/or math that was not aligned to their program of study or career, creating a barrier that could cause them to unnecessarily struggle and then possibly stop out or drop out.



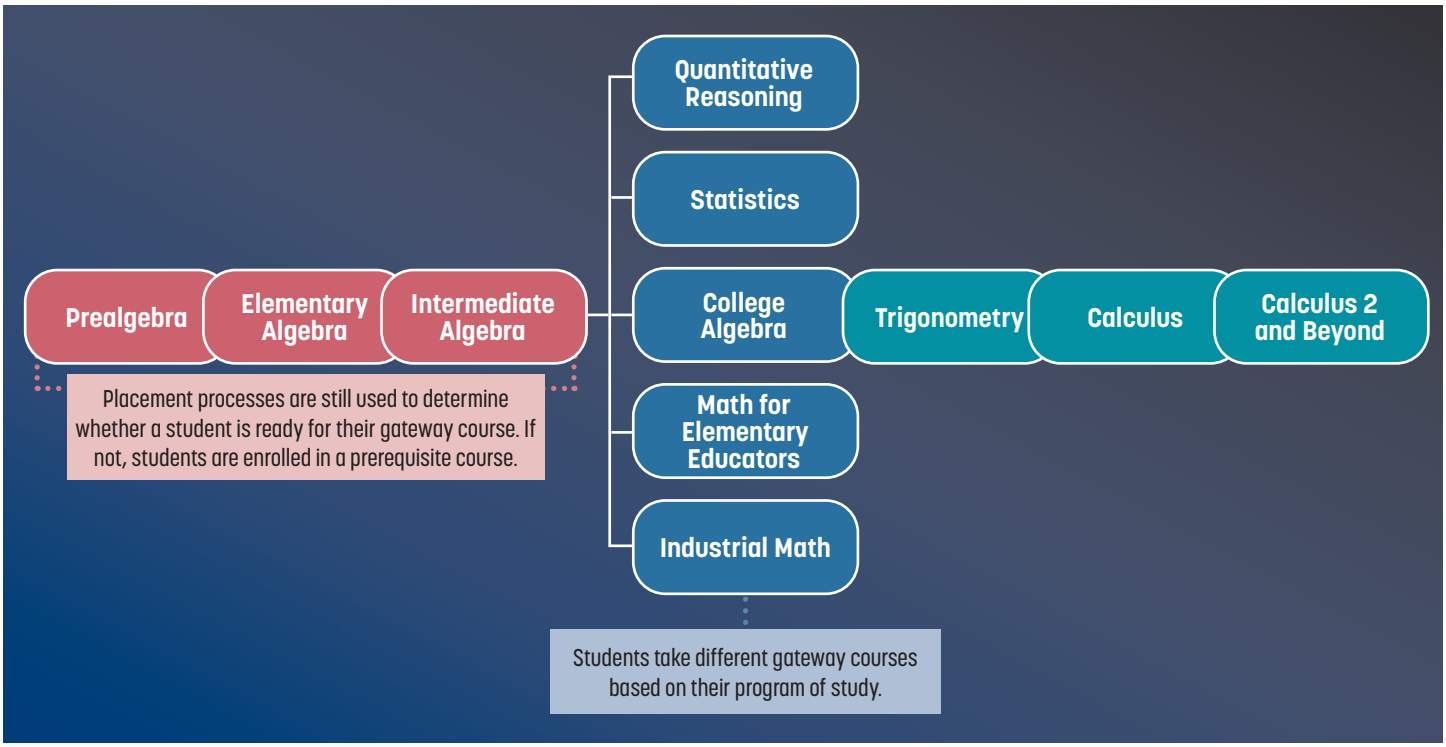
At highly selective colleges, the entry-level expectations and course requirements were different. For students who were not pursuing STEM fields, a wide variety of courses often satisfied their math requirements, and those courses did not have prerequisites. For STEM students, the gateway course was Calculus, and there were no prerequisite courses. Students who were not prepared to start in Calculus were asked to "get themselves ready" by taking courses at a local community college or online or by studying on their own—thus effectively closing the door to these programs for many students.



MATH PATHWAYS 1.0

To help more students succeed, in the first phase of math pathways work, institutions created different sequences of courses that teach students relevant math content while developing essential skills and habits of mind. These pathways not only ensure that students gain the math knowledge they need but also lead to a more positive experience and prepare students for future courses in all subject areas in their program of study. This foundation helps them build the confidence and momentum to persist and complete their postsecondary education, which also helps institutions and states meet their equity and completion goals.

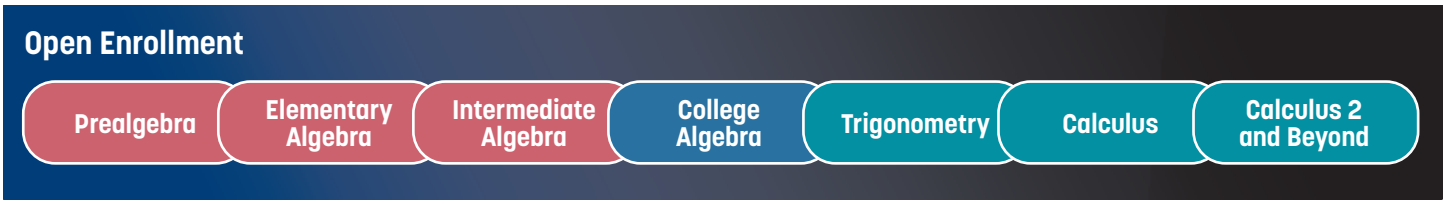
The math pathway for each program of study looks different, starting with different gateway courses. Students now enroll in College Algebra only if their program of study ultimately requires calculus. To emphasize this change, some colleges and systems have renamed their College Algebra course Precalculus (see sidebar, page 5).

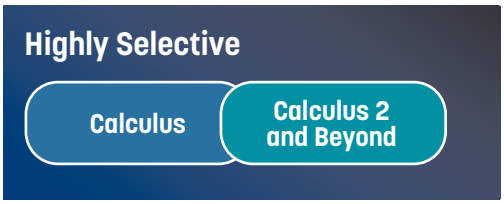


For some programs of study, the gateway course may be the only math course students need to cover essential math content and skills, such as problem solving and thinking critically, that are vital in further postsecondary studies and their careers. Programs of study such as psychology may require a second course covering statistics or research methods. Fields such as elementary education might require a sequence that includes statistics, geometry, reasoning, and problem solving. But generally the gateway course and subsequent math pathway for these programs of study are consistent across both open enrollment and highly selective institutions. Students know what to expect and are more likely to be able to successfully continue their path if, for example, they decide to transfer to another institution.

STEM PATHWAYS

However, the designated gateway course is less consistent across types of institutions for students pursuing STEM or other programs that require calculus. At open enrollment institutions, the gateway course is still likely College Algebra (see sidebar for more on the name of this course). At highly selective institutions, the gateway course for these programs is still generally Calculus.





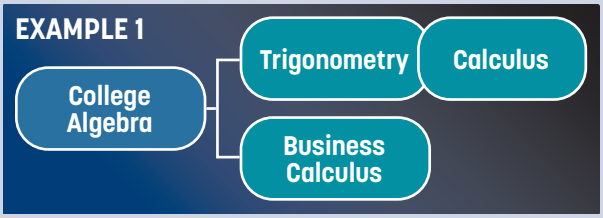
Compounding the issue, not only do different institutions have different gateway courses for the same program of study, but also sometimes courses that have the same name cover different content from institution to institution. These variations cause confusion in the field and can create difficulties when students try to transfer.

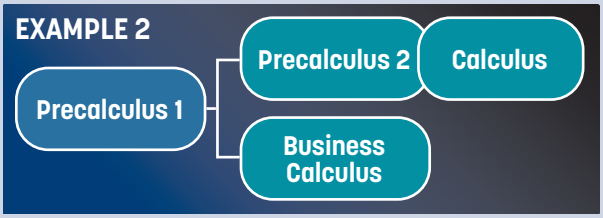
MYTH: ALL PRECALCULUS IS THE SAME.

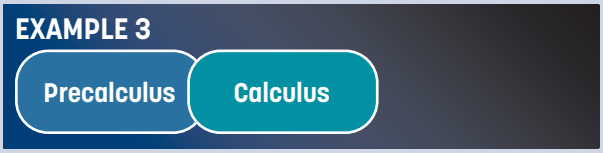
FACT: The content that is covered in courses called Precalculus varies from institution to institution. Additionally, some courses that cover the same content have different names across institutions.

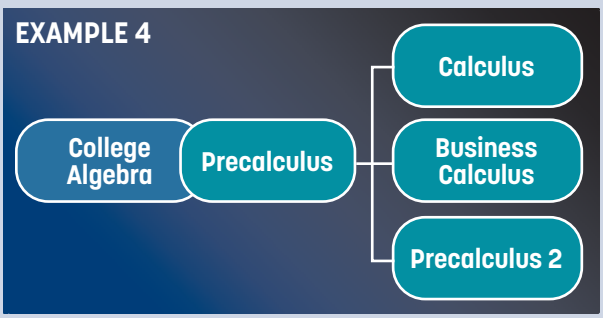
For example, some institutions call the algebraic material from precalculus College Algebra, meaning that students who pass this course could then enroll directly in Business Calculus (example 1). Some colleges have renamed their College Algebra course Precalculus 1 (example 2) or offer a single course called Precalculus that combines both the algebra and trigonometry needed for a student to proceed directly to Calculus (example 3). Others call the immediate algebra prerequisite to Precalculus College Algebra. Students at these institutions would then take Precalculus before proceeding to the appropriate calculus course (example 4).

These variations can create barriers for students attempting to transfer and muddy discussions in the field about math pathways. This brief will use the term "Precalculus" to refer to either a comprehensive Precalculus course (e.g., example 3) or the algebraic portion of precalculus (e.g., examples 1 and 2).



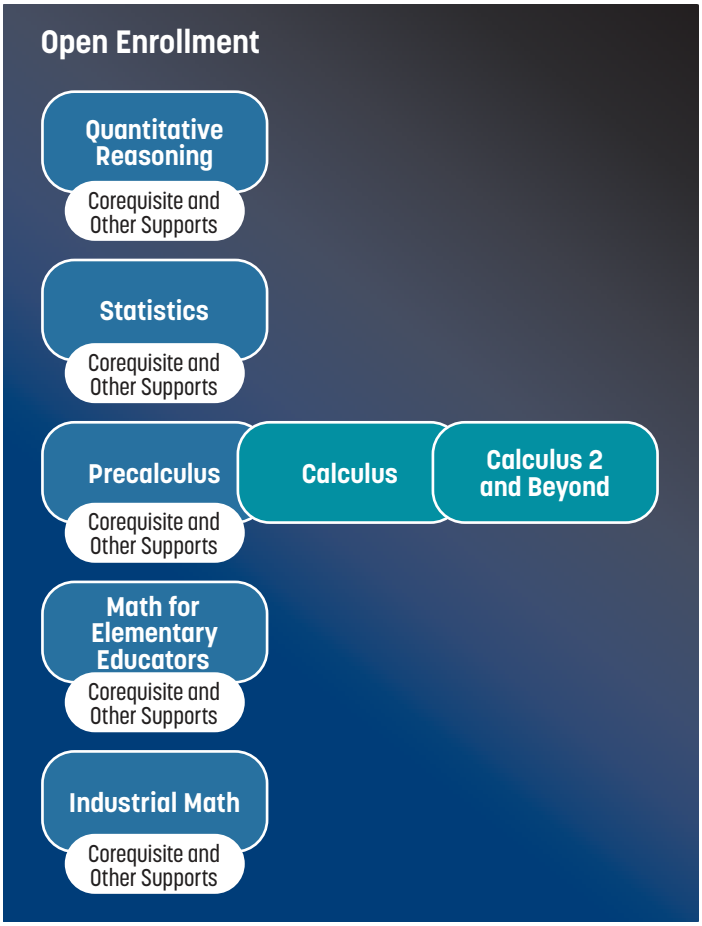


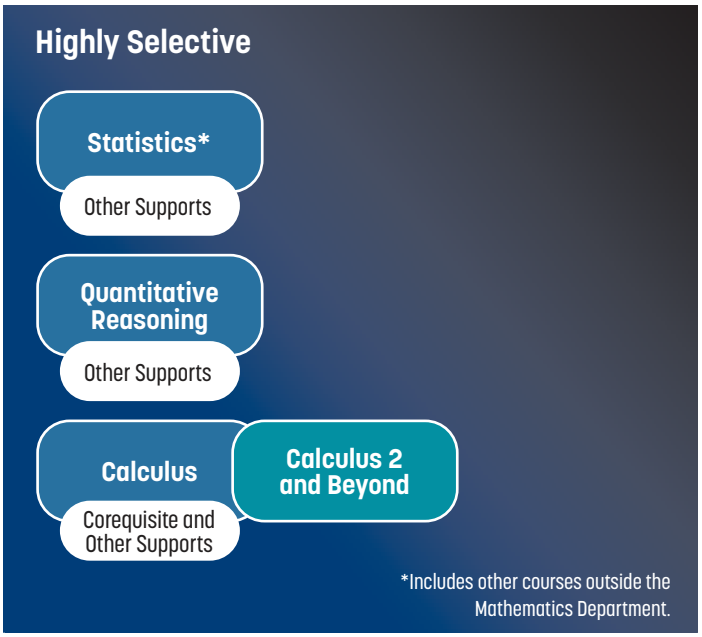




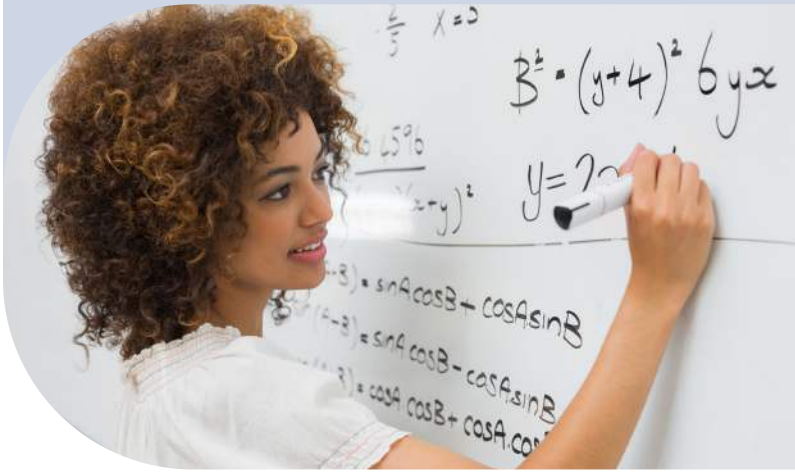
MATH PATHWAYS 2.0

With multiple gateway courses in place, the next phase of this work involves revising policies and structures to ensure that every student at every institution has the support they need to access and succeed in the math pathway that aligns with their program of study, no matter what level of preparation they received in high school. This work includes revising the placement process so that students start by identifying their goals and then choose a program of study based on those goals. The institution then defaults students into the appropriate gateway math course while providing corequisite and other supports students need to succeed in that course in their first year.





Creating math pathways is the first step. If your institution has not yet created math pathways or is working to implement them, contact CCA for technical support and resources.



IMPLEMENTING MATH PATHWAYS 2.0

The following steps build on the work states, systems, and institutions have already done in the first phase of math pathways work. These steps address policies, practices, and structures to open doors and ensure that all students, particularly those from groups that have been historically excluded, have access to all programs of study and the aligned math pathways.

ENSURE THAT THE DESIGNATED GATEWAY COURSE COVERS THE NECESSARY KNOWLEDGE AND SKILLS

Designating the gateway course for each program of study was a critical step to help students succeed right from the start of their math pathway. But ensuring that the gateway course actually covers the relevant content is also essential.

In well-designed programs, courses in a program of study build on the knowledge and skills of previous courses and prepare students for subsequent courses. Ensuring that the gateway math course covers the right content requires backmapping—reviewing the content in subsequent courses in all subject areas of the chosen program of study and working backward to the gateway math course to assess whether it provides the appropriate foundation for students to succeed in those subsequent courses.

The backmapping process is relatively straightforward for students who have short math pathways. For STEM pathways, the process is less straightforward because the sequence of courses that depend on mathematical knowledge is longer and varies depending on the specific field a student is pursuing.

Issues to consider when backmapping in STEM include:

- Because the sequence of courses stretches over years, some topics covered in the gateway course may not be used again until several years later. For example, colleges might identify topics in Precalculus as being critical even though students will not use them until Calculus 3. Institutions will need to think about the limits of knowledge transference and whether it makes sense to teach topics in a gateway course that will not be seen or used again for two years.
- With the new role of technology, institutions need to consider how to avoid designing courses that train students to do things that technology can do better and faster. For example, in programs in which technology plays a larger role or conceptual understanding is prioritized over algorithmic fluency in the calculus sequence, a true backmapping process will spotlight the algebraic skills students need to be successful and will likely not include many common precalculus or even intermediate algebra topics.

REVISE THE PLACEMENT PROCESS AND DEFAULT STUDENTS INTO THE APPROPRIATE GATEWAY COURSE

Many colleges start the placement process with an assessment that is intended to evaluate a student's level of knowledge and skill. The college then determines whether to place the student directly into college-level, credit-bearing courses. Results of this assessment, particularly in terms of math, cause some students to choose programs of study (or be encouraged into programs of study) based on their placement instead of their goals.

For example, many students from historically excluded groups, particularly BILPOC (Black, Indigenous, Latinx, People of Color) students who often do not receive the preparation colleges expect for credit-bearing coursework, get placed in math pathways that require fewer math courses or are steered away from pathways that require calculus. Because STEM and technical fields require calculus, steering students away from these math pathways compounds the problem of lack of diversity in these fields, where BILPOC students and women already are underrepresented.

To open doors for students, colleges should both revise the placement process so that it starts with students identifying their goals and ensure that students have the information they need to choose programs of study that align with their goals. After they choose a program of study, students should be defaulted into the gateway course for that math pathway, allowing students to pursue their interests and build momentum without wasting time and money on courses that do not count for credit or are not relevant to their goals. The focus of the placement process can then shift to identifying the supports students need to succeed in their chosen program of study and the gateway course for the corresponding math pathway.

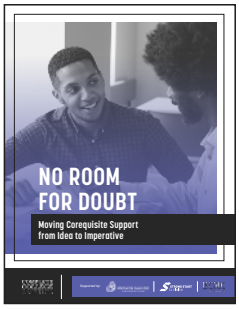
PROVIDE THE SUPPORTS STUDENTS NEED TO SUCCEED IN THE GATEWAY COURSE AND BEYOND

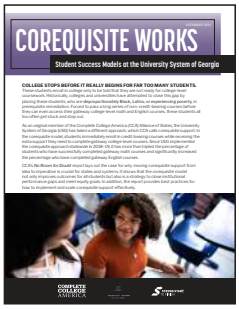
As institutions default to placing all students directly into gateway courses, some faculty have expressed concern that the content may be too challenging, especially for STEM students. They worry that placing students directly in these courses may cause students to fail and/or drop out. But as a recent study by California Community Colleges showed, students can succeed with direct enrollment. The study examined the success rate for students who were directly enrolled into Calculus for Business and found that they passed the course at higher rates than students who were placed into prerequisite courses, no matter their level of preparation in high school.[1]

Furthermore, a strengths assessment or multiple measures placement process can identify appropriate supports to maximize a student's chance of success and identify how the institution can focus limited resources. Some types of support include:

COREQUISITE SUPPORT

Research has shown that students who are placed directly into gateway courses and receive corequisite support—in which students receive just-in-time, student-centered supports to review, practice, and work through concepts as the concepts come up in the gateway course—complete their gateway course and go on to complete their certificate or degree at far higher rates than students who receive more traditional forms of prerequisite remediation. (See CCA's *No Room for Doubt: Moving Corequisite Support from Idea to Imperative* and *Corequisite Works: Student Success Models at the University System of Georgia* for more details.) For each math pathway, the process of backmapping described on page 7 can also help institutions develop appropriate corequisite supports to maximize student success.





[1] California Community Colleges & The RP Group. (2023, May). *Maximizing calculus completion for students seeking the business administration degree.* https://rpgroup.org/Portals/0/Documents/Projects/MultipleMeasures/AB705_Workshops/MaximizingCalcCompletionForBusinessAdminDegree_May2023.pdf?ver=2023-05-16-072731-540

Even though the data is clear, some colleges still have the prerequisite remediation sequences in place that were designed to prepare students for College Algebra, and students who need extra support (regardless of their program of study) are being asked to complete these sequences before they enroll in their gateway courses.

Among the colleges that still require prerequisites, some have determined that the algebra needed to be successful in a course such as Math Literacy or Introductory Statistics is different from the algebra that students in a pathway such as STEM need. These colleges have created exit ramps so students can skip the last prerequisite algebra course if they are headed to a course other than Precalculus. Others have designed whole new prerequisite sequences specifically for students who are not in STEM.

Even among institutions that have embraced the practice of corequisite support, implementation for gateway math courses is uneven:

- Some institutions have a fully implemented corequisite approach. Their students default into the gateway course that is aligned with their program of study and simultaneously receive support to complete the course.
- Some institutions have replaced some or most prerequisite remediation with corequisite classes but have left prerequisite courses in place for some pathways or for some student populations.

With corequisite support, open enrollment institutions that previously required students to take noncredit prerequisite courses and highly selective institutions that offered no options to students who needed additional math preparation can open doors to math pathways and aligned programs of study, rather than turning students away or steering them into other programs.

Support for Faculty

This brief focuses on support for students. As institutions continue to implement math pathways and take the actions described in this brief, they also will need to provide support for faculty. Maximizing student success will require faculty to develop engaging courses with the relevant content identified in the backmapping process that will meet the needs of a diverse student population. To create these courses, faculty will need not only time but also professional development in curriculum design and pedagogical improvement to incorporate culturally relevant practices.

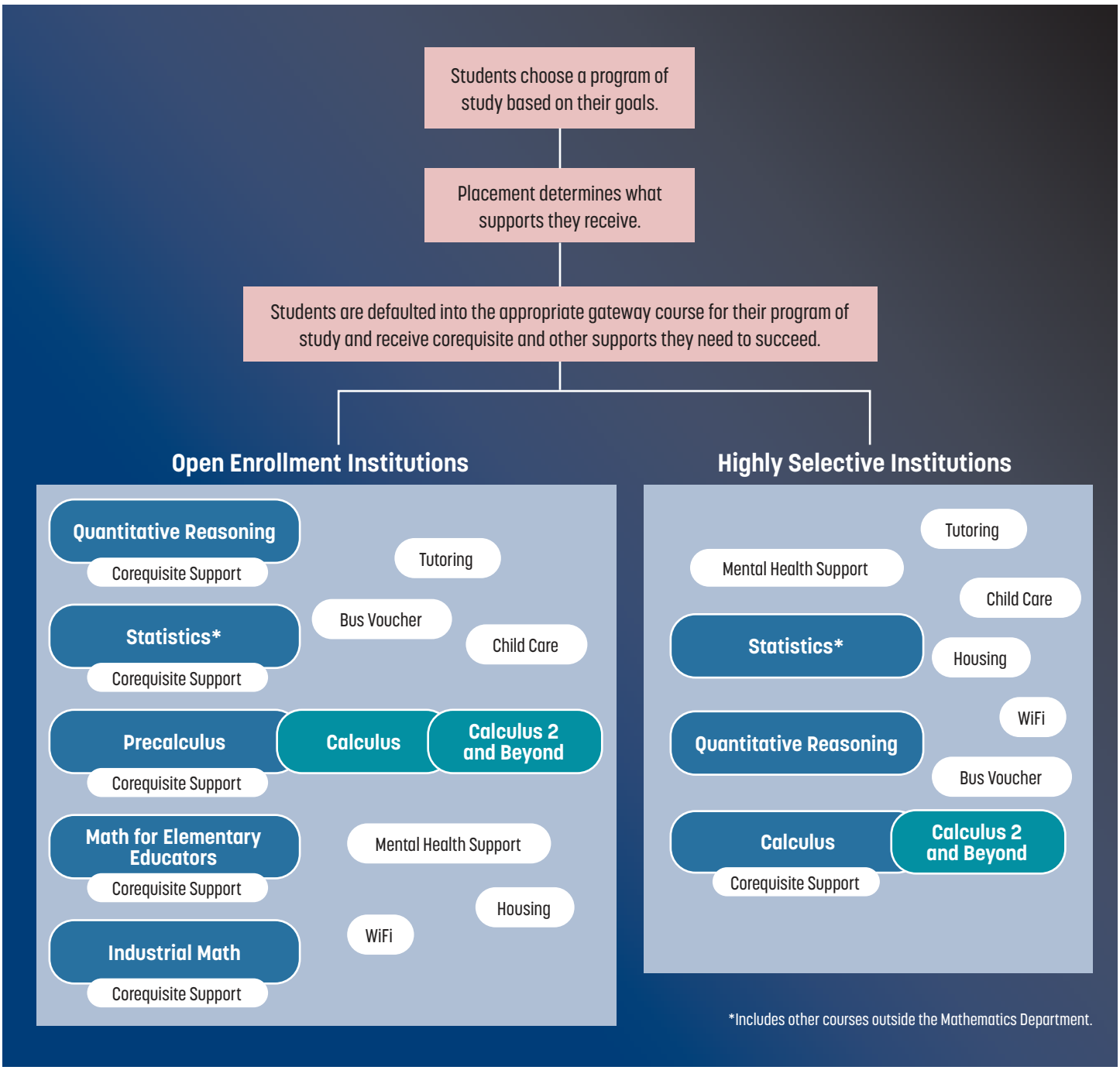
Cuyamaca College is an example of an open enrollment institution that originally chose Precalculus as its STEM gateway course based the college's belief that students would succeed. It now provides corequisite Calculus as an option to help more students start in Calculus rather than Precalculus, shortening their math pathway and time to degree.

OTHER SUPPORTS

Although placement in gateway courses with corequisite support should be the default, in some instances colleges may need to provide additional support beyond corequisite courses. A strengths assessment administered as part of the placement process could identify whether students need additional academic supports such as assistance with developing growth mindset, peer tutoring, or supplemental instruction. It can also help colleges assess whether students need services such as child care, transportation aid, mentoring, or mental health counseling.

For open enrollment institutions with sometimes exceptionally underprepared students, summer boot camps, parachute courses, or adult basic education may help students develop the foundational knowledge and skills they need to succeed in math pathways for any program of study, including STEM. If institutions provide these options, however, measuring student success will be critical to ensure that these options lead to students completing the gateway course within one year at rates that are equal to or higher than students being defaulted into gateway courses with corequisite support.

MATH PATHWAYS 2.0 IN ACTION



MEASURING SUCCESS

The ultimate measure of success is whether students complete their degree or credential on time. But to ensure that students are on track and the structures and supports are having their desired outcome, measuring earlier milestones, especially math success, is helpful.

For students who are not pursuing STEM, institutions can look at look at how many students who choose a program of study get to and through the gateway math course. For STEM pathways, institutions may need to consider multiple milestones. They will still want to consider how many students enroll in and pass the gateway course within the first year, whether that is Precalculus or Calculus. But for programs that require multiple courses beyond Calculus, they may also want to measure how many students persist and succeed in Calculus 2 and beyond.

CONCLUSION

The recommendations in this brief build on the strong foundation laid by institutions across the country in the first phase of math pathways work. CCA stands ready to continue to help institutions, systems, and states set up the structures, policies, and practices that will be needed to fully implement and support student success through math pathways. This work will focus on the nuance and challenges of math pathways, especially in STEM fields, to close institutional performance gaps and address inequities. And it will encompass critical areas such as advising, which will be key to revising the placement process so that students have the relevant, timely information they need to choose programs of study when they enter college.

Implementing these action steps will remove barriers and open doors for students, helping them meet their individual goals and ultimately leading to institutions, systems, and states meeting their completion and equity goals.

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