SOLVING FOR EQUITY IN PRACTICE:

NEW INSIGHTS ON ADVANCING COLLEGE MATH OPPORTUNITY AND SUCCESS

By Rogéair D. Purnell and Pamela Burdman

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JUST // EQUATIONS

ACKNOWLEDGMENTS

The authors could not have completed this important work without the willingness of the administrators, faculty, and other college professionals who shared how they are working to ensure equitable student math access and outcomes (see Appendix for a complete list of interviewees). We are grateful for the time they spent with us and were inspired to learn about the approaches they designed and implemented to support students, particularly those who do not believe they can be successful math students and who have had limited exposure to and positive experience with quantitative reasoning coursework. Thank you to Darla Cooper, PhD, who partnered with the authors to gather feedback, insights, and recommendations from students and college professionals, and who provided useful edits and suggestions to strengthen this report. To the students who agreed to participate, we express special appreciation. We are grateful to Jenn BeVard, Just Equations' director of operations and programs; copy editor Jane Steinberg; proofreader Yael Katzwer; and designer Christopher Artalejo-Price for bringing the report to fruition. The final version is stronger thanks to the experts who provided insights and suggestions on an initial draft: Kathy Reeves Bracco, Mina Dadgar, Amy Getz, Katie Hern, and Vanson Nguyen.

ABOUT JUST EQUATIONS

Just Equations reconceptualizes the role of mathematics in ensuring education equity for students. An independent resource on the equity dimensions of math education in the transition from high school to college, Just Equations advances evidence-based strategies to ensure that math policies give all students the quantitative foundation they need to succeed in college and beyond. Just Equations' work is supported by the College Futures Foundation, the Bill & Melinda Gates Foundation, and The James Irvine Foundation.

ABOUT THE AUTHORS

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EXECUTIVE SUMMARY

Initiatives to modernize mathematics pathways through high school and college have opened up new opportunities for students to deepen their quantitative literacy skills in ways that are relevant to their educational and career interests. New pathways in areas such as statistics, data science, and quantitative reasoning—together with postsecondary reforms to ensure access to college-level[1] courses—can contribute to equitable math outcomes, but only if they are implemented in ways that focus on equity. In particular, they need to be designed intentionally: Rather than reinforcing traditional patterns of tracking, they need to attract historically excluded groups into STEM and other lucrative majors, such as business and economics, that require calculus.

Solving for Equity in Practice examines implementation of new math policies in California colleges and universities to delve more deeply into understanding how college and university professionals think about and address the equity implications of redesigned math pathways. The goal is to ensure that students have access to college-level math courses, including those that prepare them to enter STEM fields. Based on conversations with 27 college professionals and 50 students at six institutions, this report is organized by four strategies, identified in earlier Just Equations research, *Solving for Equity*:

- Using **inclusive notions of rigor and relevance** in the design of math pathways.
- **Replacing prerequisite remedial courses** with corequisite courses and other forms of embedded support.
- Institutionalizing practices that **foster students' math identity** and sense of belonging.
- **Actively recruiting and providing support** for Black, Latinx, and other historically excluded students to enroll and succeed in STEM pathways.

STARTING POINT: AN EQUITY MINDSET

As California college and university professionals described their efforts to improve math opportunity and success, the following four principles illustrated their equity mindset:

1. The college is committed to **proactively understanding and meeting each student's needs**, both academic and nonacademic, to ensure student success.
2. The college assumes responsibility for **creating and sustaining a college culture** that is student centered and equity driven.
3. The college **prioritizes equitable practices in the classroom**.
4. The college **uses data and feedback from students** to design reforms, assess their effectiveness, and inform future efforts.

EQUITY IN CONTEXT

Under the new California policies, Assembly Bill 705 and Executive Order 1110, both the California Community Colleges and California State University campuses were reducing or eliminating all remedial math sections, placing most or all students into college-level math courses. Along with new placement practices, the institutions were adopting concurrent supports, including corequisite courses, to ensure that students have the best chance of successfully completing quantitative-reasoning requirements early in their college career. These strategies, together with a de-emphasis on algebra-centric prerequisites for students pursuing non-STEM pathways, have been tied to stunning improvements in outcomes in both systems early in their implementation (Mejia et al., 2020; Bracco et al., 2021).

EQUITY IN PRACTICE

Interviews with college professionals illustrate progress as well as challenges in implementing the

[1] Unlike in some states, California community colleges offer some college-level courses that do not transfer to universities. Because this report is for a national audience, we use the term "college-level courses" to refer to transfer-level courses. When the term "transfer-level" appears in a quotation from a college professional or a student, we leave it as is.

four *Solving for Equity* strategies. College professionals had the most to say about the second strategy, **replacing prerequisite remedial courses with corequisite courses and other forms of concurrent support**, which is also most directly tied to the new state policies.

Using Inclusive Notions of Rigor and Relevance to Design Math Pathways. College professionals were aware of the importance of having several math pathway options so that irrelevant math requirements wouldn't serve as an obstacle to students' educational progress. They adopted such practices as tailoring math course recommendations to students' majors and using corequisite sections to ensure that the math courses students enrolled in align with their academic objectives. Many institutions designed visuals to help students navigate their options. Counselors and advisors work closely with the math department to remain current on institutional policies and practices and how best to support student needs.

Replacing Prerequisite Remedial Courses With Corequisite Courses and Other Types of Concurrent Support. College professionals were enthusiastic about how corequisite strategies could support more equitable math outcomes for students who previously would have placed into remedial courses. Many pointed to the removal of remedial-level courses in and of itself to illustrate their commitment to equity. To fulfill that commitment, colleges created momentum, built capacity, and made a convincing case for the new approaches, using research and data to demonstrate that students can succeed in college-level courses. They embarked on collegewide efforts to design their new placement processes, as well as the structure and scheduling of new supports, such as corequisite classes. Nevertheless, students had varying responses to corequisites. While some welcomed the additional support, others seemed confused about the purpose of the additional class.

Institutionalizing Practices That Foster Students' Math Identity and Sense of Belonging. Teaching during the COVID-19 pandemic heightened professors' awareness of student needs and reshaped their notions of equity. One result was an emphasis on humanizing interactions, ranging from how professors introduce themselves to the students via a syllabus to how they reach out to students who don't turn in assignments. Because student social networks can contribute to success in mathematics, some colleges have supported students in the creation of peer support systems or assigned students to the counseling/advising center. Equity-minded faculty development is also an important way to improve students' math class experiences. Colleges' faculty development efforts often focused on sharing ownership of courses through communities of practice or coordination across multiple sections of the same course in order to enhance equity by limiting variation by section. Collaboration between instructional faculty and counseling professionals—including having counselors present in corequisite courses—also contributes to ensuring students receive the support they need.

Actively Recruiting and Providing Support for Students Traditionally Underrepresented in STEM Pathways. Although recruiting Black, Latinx, and other underrepresented students was not explicitly mentioned in interviews as an equity strategy, college professionals shared a fundamental concern about colleges' responsibility to ensure that all students were accessing counselors and advisors effectively.

Students echoed that concern, with some noting that they needed more guidance to understand their math pathway options. In fact, the expansion of modernized math pathways tied to majors and careers has led college professionals to recognize the need to provide more and earlier support for students concerning their majors and career choices. Some suggested incorporating career exploration into math classes. In some community colleges, these moves align with efforts to build "guided pathways" that map programs to career and transfer outcomes to help students stay on track and complete their programs efficiently. Having counselors or advisors dedicated to STEM majors was considered a positive strategy by both college professionals and students. Students, who reported mixed experiences with counselors and advisors, also favored the idea of having a dedicated counselor or advisor, rather than consulting different professionals each time they needed guidance.

EQUITY IN THE CONTEXT OF COVID-19

Despite the challenges presented by COVID-19 to students and college professionals, both groups noted that **some aspects of remote learning and other responses to the COVID-19 pandemic are worth preserving**. Colleges have become more aware of the

hardships their students face and better equipped to help them. Practices interviewees felt could remain beneficial to students post-pandemic include:

- Instructors' video recordings of lectures.
- Increased responsiveness of instructors, including online office hours at a variety of times.
- Instructors' use of engaging and supportive online tools and resources.
- Easier access to counselors, advisors, and tutors, including outside of regular business hours, and online scheduling and appointment options.
- A focus on addressing students' academic and basic needs, including technology needs.

EQUITY WORK IN PROGRESS

Ensuring that math is not a barrier to college success, particularly for students who historically have been excluded from STEM fields, requires an equity-driven culture. To better serve students, colleges need to innovate and take risks.

The institutions that participated in this study exhibited a commitment to eliminating barriers to math success. While they had taken concrete steps toward implementing all four of the *Solving for Equity* strategies, they were much further along in implementing the first two. All had adopted alternatives to the traditional Calculus pathway, allowing students to meet their math requirements with **college-level courses relevant to their program of study**. They had also eliminated some or all prerequisite remedial math courses, providing concurrent support when needed to students in college-level courses.

The colleges all have more work to do, as none have completely eliminated racial/ethnic gaps in gateway math completion. Going forward, the colleges have the most opportunity to deepen their efforts by focusing on strategies three and four. Though professionals supported the idea of **inclusive practices that cultivate students' math identities** and fostering **opportunities for traditionally excluded students to pursue STEM disciplines**, they had fewer accomplishments to share in these two areas.

RECOMMENDATIONS FOR COLLEGES:

Based on institutions' work to advance equity through math education, as well as their unfinished agendas, colleges should do the following (for complete list, see full report):

- Adopt a **clear equity vision** that incorporates race-specific efforts to dismantle structures that impede STEM pathway access and success for Black and Latinx students.
- Foster a **culture of inquiry** that includes:
  - Using disaggregated data to track progress toward improving outcomes for marginalized students.
  - Gathering and using student voices and perspectives to inform redesign.
- Promote **inclusive learning environments** that foster students' math confidence and math identity by offering professional development to support faculty in employing culturally responsive teaching and recognizing and addressing implicit bias.
- Provide **effective guidance for students** through:
  - Frequent and transparent communication about math pathway options, requirements, and placement processes.
  - Readily accessible counseling, including strategies for encouraging or mandating regular check-ins with a counselor.


SOLVING FOR EQUITY IN PRACTICE

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The movement to make mathematics a foundation for future learning, rather than a filter that narrows students' educational chances, is well underway. Initiatives to modernize mathematics pathways through high school and college have opened up new opportunities for students to deepen their quantitative literacy skills in ways that are relevant to their educational and career interests (Burdman et al., 2018; Charles A. Dana Center, 2020). New pathways in areas such as statistics, data science, and quantitative reasoning—together with postsecondary reforms to ensure access to college-level[1] courses—can contribute to equitable math outcomes (Ran & Lin, 2019; Mejia et al., 2020), but only if they are implemented in ways that focus on equity (Brathwaite et al., 2020; Dadgar et al., 2021).

Focusing on equity reveals particular challenges within postsecondary education, given the racial stratification students experience before college. Black, Latinx, and other marginalized students often face limited access to advanced math courses and high-quality instruction. As a result, they encounter greater hurdles to reaching college and, once there, succeeding in required math sequences. The meritocratic narrative and exclusionary practices that typify many undergraduate math and science programs (Seymour & Hunter, 2019; Riegle-Crumb et al., 2019) complicate efforts to broaden access to STEM (science, technology, engineering, and mathematics) majors for marginalized students.

While the move away from traditional algebra-intensive courses as a blanket requirement for college admission and placement represents a positive direction, it is essential that new pathways not be used to reinforce inequitable patterns. In particular, the pathways—as well as the messages surrounding them—need to be designed intentionally, to avoid tracking historically excluded students away from STEM and other lucrative majors, such as business and economics, that require calculus.

The recent implementation of new math policies in California colleges and universities presents an important occasion for examining and learning from institutions' approaches to this challenge. These policies broaden access to nontraditional math content, such as statistics and quantitative reasoning, and limit stand-alone remedial math courses that delay students' progress toward a degree. Within that context, Just Equations has engaged in a series of studies over the past 18 months to shed light on how students are supported to choose appropriate math pathways and succeed in them:

- *In March 2020,* Go Figure: Examining Equity in Students' Math Pathway Choices *(justequations.org/go-figure-20) offered a preliminary look at* ***how California students choose their math pathways****. It identified structural barriers, such as limited access to or awareness of available supports, as well as educational practices that contribute to math anxiety on the part of students.*

- *In August 2020,* Crossing Signals: What College Websites Tell Students About Taking Mathematics *(justequations.org/cross-signals-20) examined* ***how colleges communicate online with students about their math pathway*** *options. It revealed that, at the time, California colleges and universities were doing only a moderate job of communicating transparently to students about their math course options under new policies. In fact, many college websites gave students the false impression that they were required to take remedial math courses.*

[1] Unlike in some states, California community colleges offer some college-level courses that do not transfer to universities. Because this report is for a national audience, we use the term "college-level courses" to refer to transfer-level courses. When the term "transfer-level" appears in a quotation from a college professional or a student, we leave it as is.

- *Most recently,* Solving for Equity: Design and Implementation of New Postsecondary Math Pathways (*justequations.org/sfe-21*), *released in May 2021, examined ways of embedding equity goals—including the goal of increasing the STEM participation of historically excluded students—within the implementation of math pathways. Based on a literature scan and expert interviews, it underscored four key strategies:*

    - *Using* ***inclusive notions of rigor and relevance*** *in the design of math pathways.*
    - ***Replacing prerequisite remedial courses*** *with corequisite courses and other forms of embedded support.*
    - *Institutionalizing practices that* ***foster students' math identity*** *and sense of belonging.*
    - ***Actively recruiting and providing support*** *for Black, Latinx, and other historically excluded students to enroll and succeed in STEM pathways.*

The current study, undertaken over the past year, uses these strategies to delve more deeply into understanding how college and university professionals think about and address the equity implications of redesigned math pathways—with a particular focus on access to college-level math courses, as well as courses that prepare students to enter STEM fields. It complements those findings with student perspectives on the experience of enrolling in and taking math courses.

RESEARCH OVERVIEW

This report summarizes conversations with administrators, instructional and counseling faculty, and other college professionals, as well as students from five California community colleges and one California State University (CSU) campus. In all, 27 college professionals and 50 students participated in interviews or focus groups. Together, their insights and experiences illustrate the progress to date, as well as the continuing challenges, in solving for equity within math pathway implementation.

The institutions that were chosen to participate had demonstrated some early momentum in implementing math reforms (see Appendix for details on selection of colleges). Because research for this report coincided with the COVID-19 disruption, remote learning conditions created particular challenges for recruiting students for focus groups. The unique context made it challenging to explore some intended lines of inquiry but also provided new awareness of ways to serve students equitably. (See Appendix for more discussion of this and other limitations of the study.)

STARTING POINT: AN EQUITY MINDSET

Prior Just Equations reports build on a notion of equity in which students' math outcomes cannot be predicted based on characteristics such as race, ethnicity, income, gender, and English-learner status (Gutierrez, 2012). Achieving such equitable outcomes requires changing the architecture of math opportunity, which is grounded in popular misconceptions—such as the idea that only some people can do math—that interfere with math learning. An emphasis on math as a collection of procedures and a myopic focus on correct answers come at the expense of deeper learning and positive math mindsets. Systemic factors such as poorly resourced schools and differential access to good teaching further limit opportunities along racial and income lines. And the disproportionate use of mathematics achievement to ration educational opportunities, often in arbitrary ways, is a further source of stratification.

While the California college and university professionals interviewed for this report expressed a deep commitment to equity for historically excluded students, they often articulated their vision of equity in more race-neutral terms. In describing their work to improve math opportunity and success, four elements of an equity mindset emerged:

(1) The college is committed to **proactively understanding and meeting each student's needs**, both academic and nonacademic, to ensure student success. This entails making sure that, in addition to academic support when needed, every student has shelter and access to sufficient and healthy food.

> *We define equity as ... giving everybody the tools they need to succeed. So whatever we can give students to help them succeed, we want to do that for them.*

> *We define [equity] as really providing support for students who need it.... Through no fault of their own, they're experiencing inequitable practices, and they may have had these inequities throughout high school, throughout elementary school.*

> *We have counseling, math, English, and ESL representatives who are sharing what's happening across campus, because it's amazing to me how often we see parallels.... This is happening in math. Well, the same thing is happening in English. And so we can talk about ... why might [a student] be failing in a class? How can we ... promote student success? How can we give them the study skills, the soft skills ... address the affective domain in a way across campus that will help students?*

(2) The college assumes responsibility for **creating and sustaining a college culture** that is student centered and equity driven.

> *We do have an equity statement ... that ... acknowledges the issue of institutional racism ... and other barriers that need to be acknowledged. And that is the institution's responsibility: to address these barriers ... to make ... college doable for students.*

> *We've sort of shifted.... We don't say that students have equity gaps.... Our students are experiencing equity gaps. It's not something that they have and that they are doing to themselves. It's ... what they are experiencing due to the environments that they're in. And so it's really thinking about, "How can we change the environment? How can we change the structure?"*

(3) The college **prioritizes equitable practices in the classroom**.

> *The institution is working on diversity plans and is going to be requiring faculty to incorporate cultural sensitivity within their classroom.... We have way too many students who are graduating thinking all science and math came from Europe.*

> *There have been ... formal teaching programs set up for the faculty to learn how to teach with equity in mind.... I've gone to some of the workshops and things outside of our college as well, to learn more about it and then learn things about how to make your syllabus better for all students. Just little things like that that really do make a big difference.*

(4) The college **uses data and feedback from students** to design reforms, assess their effectiveness, and inform future efforts.

> *We look at the data every semester. We look at it broken down by groups, specifically Latinx and African American students, low-income, and foster youth ... and we want to see how we are doing in terms of narrowing those gaps.*

> *We've been working very in tune with our institutional research [office].... They've been helping us a lot. They provide us data every semester. We're able to do student surveys at the end of every semester on how the corequisite classrooms are going in math ... what kinds of things work, what kinds of things students like, what they don't like, what would help them in their learning.*

> *A lot of schools are still offering remedial classes. Take a hard look at the data of which students are making it through those sequences, and compare that to other schools and look at how many more students are able to get through and be just as successful in a college-level class and then continue on to get their degree.*

> *I think the biggest thing that people need to keep in mind is that you have to be willing to throw something out if it doesn't work.*

EQUITY IN CONTEXT

College professionals' insights into equitable math pathways were also informed by their policy context, including significant reforms that substantially changed how each system executed its math requirements. Under the new policies, Assembly Bill 705 and Executive Order 1110, the two systems eliminated most or—in the case of CSU—all remedial math sections. They also adopted **new placement practices and instructional supports** to ensure that students, particularly those needing to strengthen their academic and nonacademic skills, have the best chance at successfully completing quantitative-reasoning requirements early in their college career.

- **Placement:** The multiple-measures placement processes for the community colleges vary by college. They are often brief questionnaires that ask about high school GPA, high school math courses and math grades, and anticipated major or area of interest. The CSU system has a common rubric used by all campuses to determine placement. However, some CSU campuses continue to use an assessment for placement into Calculus courses.

- **Corequisites:** The most common form of instructional support is the corequisite model, in which students enroll in a college-level course in combination with a support course or lab to scaffold the course material, review prerequisite content, enhance study skills, and/or build students' sense of confidence and math identity. Corequisites are recommended or required based on a student's high school transcript and responses to the placement questionnaire. In both systems, corequisites can be required for some students and optional for others.

These strategies, together with a de-emphasis on algebra-centric prerequisites for students pursuing non-STEM pathways, have been tied to stunning improvements in outcomes in both systems early in their implementation. In fall 2019, the first semester that the new community college law was in place, 31,000 more community college students successfully completed a college-level math course than in fall 2015, largely because of increased access rates. Forty percent of first-time math students succeeded in a college-level class in their first semester, compared with just 14 percent four years earlier (Mejia et al., 2020).

Meanwhile the CSU's decision to enroll all freshmen in college-level math courses, regardless of their prior preparation, also yielded stark improvements in outcomes when first implemented in fall 2018. Instead

A California law passed in 2017, Assembly Bill 705 (AB 705), requires that community colleges implement multiple-measures placement—based on high school courses and grades—to increase the probability that community college students take and complete college-level English and math courses in their first year. Fully implemented in the fall of 2019, AB 705 was informed by research that found that students who were placed into remedial classes seldom advanced into college-level coursework, while students placed into college-level courses with support were more successful in realizing their educational goals (Bahr et al., 2019; Mejia et al., 2020; Ran & Lin, 2019). Implementation also builds on initiatives to broaden math pathways to align with students' areas of study, rather than expecting all students to take STEM-oriented courses such as College Algebra and Precalculus (Burdman et al., 2018).

Similarly, the CSU system launched a major math reform effort in 2017, when then Chancellor Timothy P. White enacted Executive Order 1110 (EO 1110), eliminating CSU's math placement test and stand-alone remedial courses. Like AB 705, EO 1110 required that campuses use high school grades and test scores to determine English and math placement. A parallel order, Executive Order 1100, facilitated the change by ending the use of prerequisite math courses whose content is not required for success in a general education math course. That meant, importantly, that a remedial course such as Intermediate Algebra could no longer be treated as a prerequisite for Statistics. It also supported articulation of community college math courses for transfer students.

of being placed into remedial courses, students considered "not ready" for college-level mathematics were supported to succeed in college-level courses. As a result, about 7,000 students who previously would have been considered "not proficient" passed college-level math that fall, compared to fewer than 1,000 the prior year (Burdman, 2019). The proportion of students completing a college-level math course in their first year increased from 60 to 73 percent (Bracco et al., 2021).

EQUITY IN PRACTICE

As California educators implement the new policies, they are grappling not just with how to comply with requirements, but also with how to do so in ways that best serve their students and advance their equity goals. The interviews with college professionals illustrate progress as well as challenges in implementing the four complementary strategies highlighted in *Solving for Equity*.

College professionals had the most to say about the second strategy, **replacing prerequisite remedial courses with corequisite courses and other forms of concurrent support**. This is not surprising, because progress in eliminating developmental courses was one of the criteria for selecting colleges. This strategy was also the most reflective of the institutions' equity visions. Since that strategy was a direct result of state-level policy reforms, this finding may illustrate the role of evidence-based policy change for shifting attitudes.

The students' perspectives shed additional light on practices that best supported their success, including what they felt institutions were doing well and what they felt was missing.

1. USING INCLUSIVE NOTIONS OF RIGOR AND RELEVANCE TO DESIGN MATH PATHWAYS

The intention of broadening math pathways is to prepare students for their futures, rather than to sort or track students. As such, clear and inclusive definitions of rigor and relevance are a foundation for the creation of multiple pathways. The institutions chosen to participate in the research for *Solving for Equity in Practice* had already established multiple math pathways, with courses including Calculus, Business Calculus, Statistics, and, in some cases, Liberal Arts Math. The interviews revealed that college professionals were aware of the importance of having several math pathway options so that irrelevant math requirements wouldn't serve as obstacles to students' educational progress.

For example, college professionals were wary of the past practice of assigning most students to Intermediate Algebra or College Algebra courses.

> *A lot of the material that's in Intermediate Algebra, for example, you do not need any of it for Statistics.*

As a result, in order to avoid having students enroll in unnecessary courses, many college professionals reported a strategic decision to present students with only those course options most closely aligned with their majors. For students who have not yet decided on a major, recommendations are based on whether a student is interested in a STEM field (in which case Precalculus or Calculus would be suggested) or a non-STEM field (Statistics would likely be recommended).

The corequisite is also a place where an instructor can confirm that a student has embarked on the right pathway.

> *On the first day, [our faculty] ask students to wear a name tag, and the student puts their major under their name. That's helpful because then the faculty can scan the room and see, "What's this music major doing in Precalc?"... So then they can talk to that student one-on-one and encourage them to go see a counselor and check if they're in the right place.*

At some institutions, the general counselors and advisors[2] work closely with the math department to help both stay current with the latest information and institutional changes. One college representative talked about key players from multiple departments—the deans for math and English, an admissions representative, the counseling team, and staff from the tutoring and STEM centers—getting together to figure out how to implement the new system and what visuals to give the students to help them navigate it. The results of these cross-division meetings included revamped webpages and resources, such as maps or flowcharts, generated by the math department for use by counselors during one-on-one educational-planning meetings with students (Burdman & Purnell, 2020).

Having the math faculty in the room as we [designed the] placement was incredibly helpful, because the math faculty participated in that conversation about where to place students. And it wasn't a guessing game. I think before that a lot of it was, "Here's our placement chart. Now you just enforce our placement chart," and counselors felt like they weren't being respected as counselors and that their job is to help a student to decide. They were given something that any student could look at and say, "I fit here. I have to take this." So I think having that mutual respect and getting in the same room and discussing these student profiles was really helpful for them to see where the other one was coming from, so that the counselor could say, "Here's why I would suggest this." And math faculty could say, "Well, here's why we think this would be a better class for the student."

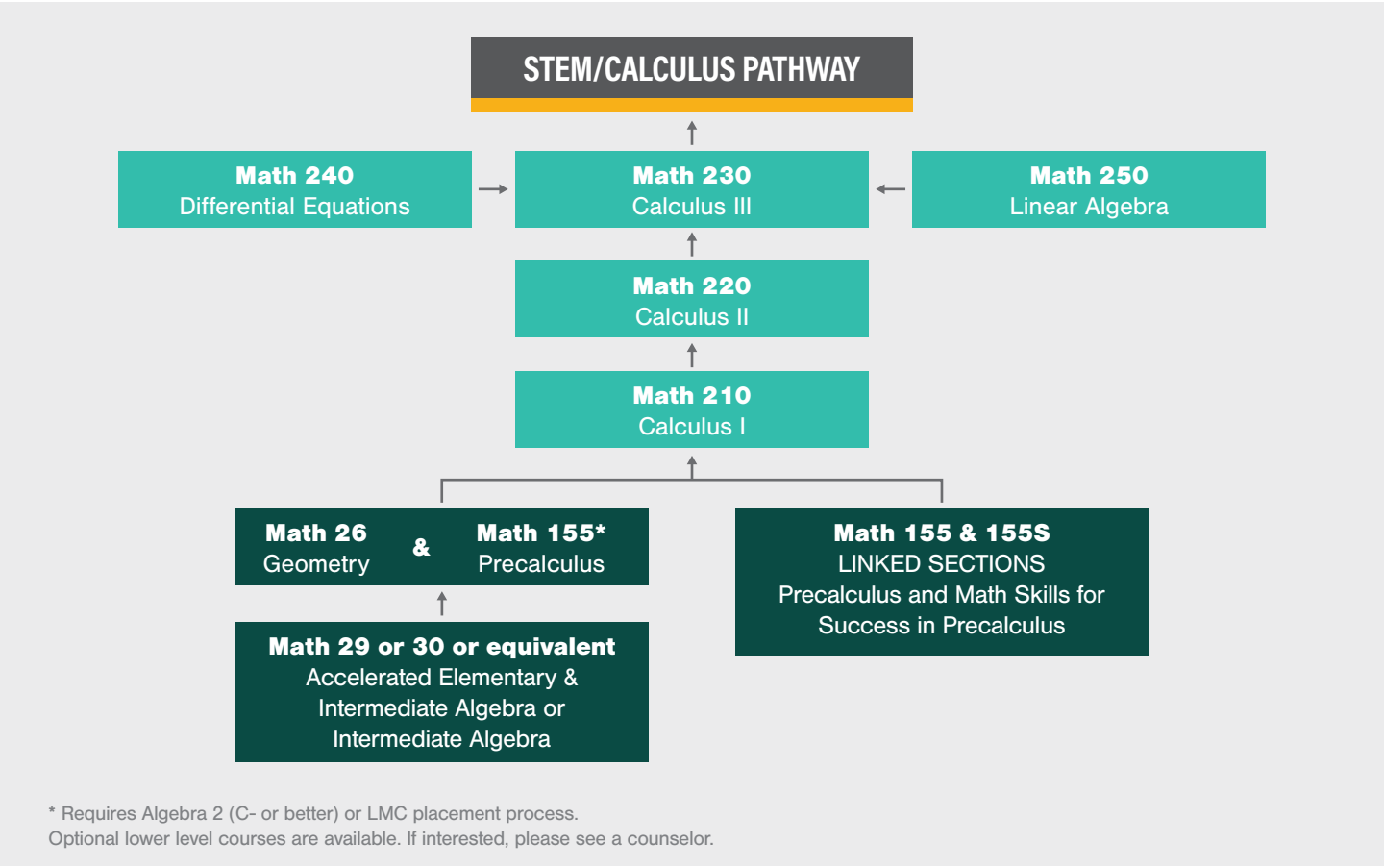
PROMISING PRACTICE:

Los Medanos College's Move From Transit Map to Clear Pathways

Los Medanos College created a map that presented students and college professionals with every possible math pathway based on a number of different majors. Modeled after a subway map for Bay Area Rapid Transit, the depiction, which included academic "stations" that could be reached by particular paths on the "transit" map, was an improvement over what the college previously used. However, the information display was overwhelmingly comprehensive, making the map difficult to navigate. The latest iteration of their math pathway maps emphasizes transfer-only courses for the four core math paths: K-8 Education, Business, Social and Health Sciences, and STEM/Calculus (although one of the STEM path options includes remedial courses). The Social and Health Science and STEM/Calculus math pathways are presented below.

* Requires Algebra 1 with 2.8 GPA or LMC placement process, or Math 27.
Optional lower level courses are available. If interested, please see a counselor.

[2] While some institutions have advisors and others have counselors, when an institution is not identified, the report may use the term "counselors" to refer to counselors and/or advisors.



* Requires Algebra 2 (C- or better) or LMC placement process.
Optional lower level courses are available. If interested, please see a counselor.

2. REPLACING PREREQUISITE REMEDIAL COURSES WITH COREQUISITE COURSES AND OTHER TYPES OF CONCURRENT SUPPORT

Overall, the elimination of long remedial math course sequences simplified the placement process, reducing confusion for the students. The optics of this change were important to each college's equity agenda, signaling that all of their students are college ready and that, if they need support, they would receive support in a college-level course. The college professionals interviewed were generally enthusiastic about how corequisite reforms could support more equitable math outcomes, particularly for students who previously would have placed into remedial courses. Deep into the process of implementing reforms, many of the college professionals pointed to the removal of remedial-level courses in and of itself to **illustrate their commitment to equity**.

> *AB 705 has helped our college to better close equity gaps that we were seeing. So now ... our students are able to finish their freshman-level ... math in the first year.... I can't believe the success rates, how much they've gone up and how much of a difference it's made for students.*

> *We're not funneling the majority of our students of color into remedial black holes.... Giving them access to the transfer-level courses to begin with ... is a huge step in the right direction.... I don't have any proof, but I believe that we lost a lot of students simply by telling them you had to start two or three or four levels below [college-level math]. They probably never stepped foot on campus. They never took a math class. So I think, by admitting to ourselves and to [students] that they're college ready, that is doing a huge push to making it a much more equitable situation.*

> *I definitely am a huge fan of the corequisite.... I think it's an acknowledgement and understanding that students can enter a course and be successful with additional resources.*

Interviewees shared the ways in which colleges **created the momentum as well as the capacity** to

implement the changes, using data and ensuring collaboration. They confronted numerous decisions and challenges involved in implementing corequisites effectively. These ranged from big-picture concerns, such as confronting skepticism and breaking down silos, to more logistical matters, such as course scheduling and use of class time.

First and foremost, colleges needed to **make a case for the new approaches**. To do so, some colleges used research and data to demonstrate that all students can succeed in college-level courses. Sharing research that led to the passage of the law, as well as data that confirmed its positive effects on students' math success, helped to sway early skeptics. Sharing data and highlighting the positive changes in access to and success in math courses for students who would have been relegated to a remedial math sequence helped to change mindsets.

> *As we were implementing AB 705, [the focus was on] really helping [faculty] understand the damage that those remedial courses were doing to our students. A lot of it was just educating them to how unsuccessful those courses were and ... that the students really were better off just trying transfer-level courses and that we would be here to support them, not just with our support courses, but with our expanded Math Success Center and things like that. So a lot of it was just convincing them that these changes were the right thing to do, so that they wouldn't encourage students to go somewhere else.*

> *We had a lot of people really upset with us that we were first considering and then deciding not to offer ... the [remedial] courses. And they were arguing that it was an equity issue and that we were just going to widen the equity gaps ... no matter how much we tried to show them the data ... [that] first of all, the students that are taking these remedial classes, they're not getting to the college-level class ... so [they] don't even have an opportunity to show that they can do this.*

> *We decided, how could [student math outcomes] be worse? I mean, honestly, how could it be worse?*

> *There was a concern among faculty early on in adoption ... that they were seeing a lot of attrition, students just dropping the classes.... But in the grand scheme of the data, it's showing better outcomes than what we had been seeing prior.*

Secondly, effective **implementation required a collegewide effort**. This meant engaging faculty and administrators, even skeptics among them, in developing new courses, placement strategies, and supports. While faculty took a lead role in outlining and clarifying the redesigned math pathways and course schedules, counselors and advisors had to be knowledgeable about the new options to know how to communicate them to students.

Regular and ongoing meetings involving the math faculty and those who advise students were critical to ensuring common messaging and guidance related to math placement and course selection, including corequisite support courses. These collaborations help both stay current with the latest information and institutional changes. In some cases, they also supported buy-in, trust, and, therefore, better implementation.

The structure and scheduling of corequisites also have equity implications. In many cases, support courses are scheduled right after the core course, in order to make it easier for students to participate, and to provide additional time for the instructors to work with students or for students to work together to grasp core course content. Since corequisites are open to students who aren't directed to them, college professionals observed that some students—possibly as a result of math anxiety or low math confidence—enroll in these courses, even when their math background suggests they do not need them. One administrator found that the presence of these

students in support courses seemed to have a positive effect on the learning environment for all students.

> *We had ... about half the class who could have taken the stand-alone class and chose to take it with the corequisite.... The whole class had a better work mentality, because you had students who were taking the class just because they were very conscientious students, and that helped to make the atmosphere in the class very different.*

Still, the new practices could create new burdens for some students. To address accessibility concerns, one administrator planned to have the placement questions reviewed to ensure that English-language learners could easily understand them. Some students have constrained budgets, so requiring additional class time and tuition dollars raises equity questions as well. One college made the decision as part of its equity agenda to limit the support course to one-half or one unit instead of two units, so that students who were receiving financial aid could add another course to complete their educational plan.

Porterville College offers a mini bridge program called JumpSTART to help students who were directed to a corequisite enroll directly in the college-level course without concurrent support. Although data are still being analyzed, from summer 2018 to winter 2020, 64 percent (44 of 69) of JumpSTART participants completed college-level math.

PROMISING PRACTICE:

Porterville College's "JumpSTART" Into Core Math Course Without Corequisite

Porterville's JumpSTART is designed for students recommended for a corequisite course who would prefer to enroll in the college-level course without the two-unit corequisite lab. The free four-day workshop provides students with the opportunity to strengthen their math and problem-solving skills. Students who complete the workshop can challenge the recommendation to enroll in the corequisite course. If successful, they are allowed to take the college-level math course without the corequisite. "We're not trying to make students take the coreq," noted one interviewee. "We want them to just take the class so they could get in and out quickly.... Those students who go through JumpSTART tend to do very, very well."

Lastly, some college professionals stress the need to be clear about **the instructional intent of the corequisite**. Though the corequisites vary from institution to institution or professor to professor, in general, instructors are directed to avoid using the support course as an opportunity to extend their lectures and instead to focus on the affective realm, such as time management, study skills, and math anxiety.

> *The big elephant in the room with [corequisites] is that the variation between instructors on all these issues is just going to be massive. Some instructors do a really good job of building affective components into their courses without a support course. Some instructors utilize that support course with those affective pieces really well. And others view it as more time to lecture.*

> *We're very clear about what the corequisite is.... It's not more time for [the instructor] to be on the stage.*

> *The students need the extra time to process. That's why they're in the support class. That's the whole point, right?... Sometimes ... the students aren't understanding something that is a requisite knowledge. And so I can actually bring that in. Then I've got the time to say, "OK, I see that you're all struggling here." Not that I wouldn't do that in a class without the support, but I have a lot more time in a class with support.*

> *We were also trying to instill in the faculty that this is not time you're supposed to be lecturing at students. This is time that you're supposed to be engaging students with the material. You're there to support them during that time.*

Perhaps because colleges are still refining their corequisite strategies, students also had varying responses to them. While some welcomed the additional help, others were unclear about the purpose of their corequisite courses.

> *I went to speak to my counselor, and she recommended that I take the statistics with support because I ... hadn't done math in a while. So she said that maybe it would be helpful, and it turned out that it really was, because we worked with the group and our professor was really good. She explained everything. And then we got broken down into*

groups. We always did reviews before quizzes and then also reviews before exams. So that was really helpful that she was in-depth with everything.

It's not really support. I don't really get it. It's on the transcript that I have where it shows that I'm enrolled in two classes, but ... it just says a corequisite support for the Introductory Statistics, which I don't really understand.

3. INSTITUTIONALIZING PRACTICES THAT FOSTER STUDENTS' MATH IDENTITY AND SENSE OF BELONGING

Students' classroom experiences contribute significantly to their persistence in math and STEM courses. Research has demonstrated that student success in a given college mathematics course can vary widely by section (Smith et al., 2021). In fact, which professor a student has for a particular course is the single most important indicator of how successful the student will be in that course; this is particularly true for Black and Latinx students (Rosenberg et al., 2020). Instruction can differ greatly in terms of the degree to which it fosters a positive math identity and a sense of belonging in math class, key elements of math success that are often missing in the K-12 experiences of minoritized students (Childs, 2017; Walker, 2012).

When putting equity into practice, according to *Solving for Equity* (Dadgar et al., 2021), an institution needs to ensure that **instruction is contextualized and culturally relevant**, with an awareness of systemic racism and implicit bias. While faculty indicated an interest in cultural relevance and a concern about implicit bias, their discussion of classroom practices focused more on responding to the COVID pandemic, which was ongoing at the time of the interviews. They sought to adapt to the online environment in ways that engaged students and supported their learning. Professional development was also oriented toward helping faculty use new online tools and strategies. A few Porterville College faculty, for example, developed a series of videos[3] to support their colleagues in the transition to virtual teaching.

At the same time, the pandemic seemed to heighten professors' awareness of student needs and reshape

their notions of equity. One result was an **emphasis on humanizing interactions**.

[We] communicate with our students a little bit more to understand their context without judgment. Without starting a correspondence with something like, "I noticed you didn't turn this in," but instead starting with something like ... "I noticed you weren't in class. Are you doing okay?"

One of the biggest, most important things that I've gotten is understanding ... that I can't look at what a student does and make a judgment on that. I need to understand [the] context behind it.

This mindset extends to other communications, such as the course syllabus. One college had begun to move to online, "liquid" syllabi even before the pandemic as a better way for instructors to share information about classes and course requirements, and to introduce themselves to their students in accessible ways (such as including closed captioning). A liquid syllabus, unlike its traditional predecessor, is intended to be a warm, welcoming initiation into a class.

[3] Examples of the videos can be found here: https://quicktipsforonlinesuccess.weebly.com

PROMISING PRACTICE:

Being Liquid Humanizes a Syllabus at Cuyamaca College

A liquid syllabus is a web-based, user-friendly, and mobile-accessible overview of a course and its instructor. Rather than a printed document with a lot of text, a liquid syllabus often includes pictures and personable videos of the instructors, highlighting available resources on and off campus, and using engaging, positive, and student-centered language. Traditional syllabi sometimes have punitive messages, such as, "If you don't do this, you're going to fail," noted one instructor who changed their syllabus. "If you already go in feeling like you can't do it, and then you read a syllabus like that, then ... it's like you're already doomed from the beginning." The new tone is, "You will be successful if you do this...."

Here is a sample liquid syllabus for a quantitative reasoning course with corequisite[4]: https://sites.google.com/view/marshall-math-120-sp21/home.

Student social networks and peer tutors have been found to be particularly helpful ways for students to find both academic and nonacademic help. In addition, when students support their peers, it supports their own learning (Engstrom & Tinto, 2008). At one college, a student created a peer community using a virtual collaboration platform called Discord:

> *I got everyone in the class to join it, like all 50 people. And then it was very helpful because people could ask ... homework questions or other things, like ... "When's the test due?" [or] other questions relating to the class, and people would go on there and answer. And it was ... a helpful resource for me and other people in the class.*

However, in keeping with colleges' responsibility to foster equitable learning conditions, the formation of networks should not be left solely to students. Some colleges are developing strategies to support productive peer networks. Porterville College, for example, offers a program that recruits and trains students who have completed a particular math course to organize and run study sessions for students who are currently enrolled in the course, a practice that math researchers have found to be effective (Smith et al., 2021).

PROMISING PRACTICE:

Porterville College's Peer-Assisted Study Session Program

Porterville College instructors identify and recruit students who have done well in particular courses to be leaders in the Peer-Assisted Study Session (PASS) program. These PASS leaders host daily study sessions and act as role models for other students. One college professional called them "a different take on a tutor and a mentor, kind of combined. So a PASS leader is a student who's taken the class already, but they have taken the class with a specific instructor. So they are not only subject but instructor specific.... They have already done the classwork; they know how the instructor works, and how the assignments work."

One school actually has student assistants in its counseling center.

> *They're perfect for talking to the students. They know what the material is.... And they're a diverse group of students, too. So I think it gives the incoming students a sense of, "I can do this. That person did it."*

Implementing changes in the classroom requires **equity-minded faculty development**. In order to enhance students' experiences in the math classroom, it is essential to support faculty in learning about and adopting equitable practices. One component of professional

[4] Syllabus provided by Tammi Marshall of Cuyamaca College.

development with a focus on classroom equity is showing instructors how to use courses, especially corequisites, to **address the social-emotional aspects of learning**, including study skills, time management, and a growth mindset. Not enough math professors learn these skills in their graduate programs.

> *The math professors are the least prepared of all. We have excellent professors, knowledge-wise. I don't think we have excellent professors as educators. So when students do muster up the energy to go and talk to the professor and are told, "It's so easy," or [the explanation is] repeated the exact same way it was in the classroom, you haven't helped anybody. And now they're feeling less inclined to go visit you.... It's not just math. I think it's most science professors. And I blame that on our education system when you're getting your PhD, because there's no class on how to teach.*

Shared ownership of courses is another strategy that can help faculty teaching sections of the same course learn from one another about effective approaches, as well as decrease variations in expectations across sections. Communities of practice are one way of approaching shared ownership; course coordination can be another. While these approaches are typically designed to support instructional faculty, some colleges also involve administrators and support professionals.

> *All colleges really need to keep in mind ... the community of practice: It's just essential to the work. I don't necessarily think that a full college implementation team is needed, but whoever is leading the efforts ... if it's the math department chair, which it usually is ... they need to know that they're going to have to work with everybody across the college.... And that is going to take a lot of their time. And it's going to be something that is important in making this successful.*

PROMISING PRACTICE:

Citrus College's Communities of Practice for Corequisites

Citrus College professionals described the importance of communities of practice to facilitate collaboration between instruction and support services for corequisite classes. Communities of practice often include deans, vice presidents, admissions and records personnel, tutoring coordinators, counselors or advisors, instructors, and, in some cases, institutional researchers. These communities were critical to informing the college's design, implementation, and monitoring of math reform efforts to determine whether these efforts supported equitable math access and success. Each of Citrus College's three corequisite classes has its own community of practice. In the words of one administrator: "So statistics has one [with] about 15 participants. We have a precalculus one that has about 10.... It's a great support. They also invite the STEM counselor to their meetings at least once a semester to talk about the time-management workshop, but also to get some advice from her on what kind of things would counseling want to know about what we're doing in our classrooms?"

PROMISING PRACTICE:

San Diego State University's Course Coordination

One benefit of shared ownership of courses is that faculty use common approaches to pacing, exam content, and grading, thereby reducing inequities across course sections. San Diego State University, for example, coordinated its entire STEM math sequence, so that all students in a particular course take the same exams and are graded on the same scale. The department decided to "revamp really extensively our whole Calc program," noted one college professional. "So from College Algebra to Precalc to Calc I and II, that whole program is tightly coordinated. Students are taking the same exams." SDSU also conducts a three-day training for teaching assistants and undergraduate learning assistants before the semester starts. Compared with communities of practice, course coordination can be more hierarchical, with a faculty coordinator responsible for choosing a textbook, developing a syllabus, preparing class exercises, and training teaching assistants. However, the SDSU faculty teaching in the sequence also meet regularly, which ensures they have some input.

The corequisite also can be used to support adjunct faculty learning, as illustrated by one administrator.

> *In a lot of our corequisite classrooms, we have an embedded tutor. Often that embedded tutor will be an adjunct faculty member who's also teaching the class, and that's really been valuable, not only to support that adjunct, who is learning about how to teach this class by teaching it themselves, but also having a partner faculty who they are the embedded tutor for.*

Student-centered classrooms also need to be embraced by support service professionals. At some colleges, math instructors meet regularly with counselors or advisors, not just for placement purposes, but also to collectively analyze data on students' math enrollment and completion, as well as their success in subsequent courses. Such collaborations can help students, by ensuring that faculty are aware of supports available to students outside the classroom. Likewise, understanding the classroom context can help support service professionals identify opportunities to contribute—for example, by teaching executive skills.

PROMISING PRACTICE:

Citrus College Counselors Teach Time Management in Corequisite Courses

Academic counseling faculty meet students where they are by presenting in corequisite courses on relevant topics to strengthen students' affective skills. "We have counselors come in during week three or four and present a time management workshop.... It's giving students an opportunity to look at their schedule near the beginning of the semester, seeing how reasonable it is or does something have to give, like, are they working too much? Are they taking too many classes?... It's been something that I think is a really important part of students' success in our corequisite math class."

Ideally, when there is strong collaboration, a student won't fall through the cracks, either academically or otherwise.

> *A reason why sometimes we've been so successful on campus is that it's very much wraparound style and it's very streamlined. So when a student comes to us in the tutoring center, we can very easily ... walk them to the various instructors for office hours.... Maybe they need help accessing the food pantry, or they need help accessing the STEM counselor to talk about their classes. It's all there, and we're all very knowledgeable of those different services.*

4. ACTIVELY RECRUITING AND PROVIDING SUPPORT FOR BLACK, LATINX, AND OTHER STUDENTS TRADITIONALLY UNDERREPRESENTED IN STEM PATHWAYS

The use of diversified math pathways will not reach its goal of expanding college opportunity unless it addresses historical patterns of exclusion. Students of color have frequently been tracked into lower-level math courses beginning in middle and high school (Gao & Adan, 2016), which has curtailed access to STEM majors for many, regardless of their potential. To reverse this trend, the final strategy in *Solving for Equity* emphasized the need to recruit underrepresented minority students to pursue STEM majors and professions.

Although recruiting Black, Latinx, and other underrepresented students was not explicitly mentioned as an equity strategy, college professionals shared a fundamental concern about colleges' responsibility to ensure that all students were accessing counselors and advisors effectively.

> *We need students to get that placement information at their fingertips, instead of guessing or asking a friend, because, again, we have to operate under the assumption that they're not seeing a counselor. Because we have so many students, we don't have enough counselors, so we need to provide other ways, automated ways, for them to get that information.*

Students echoed that concern.

> *[What's important is] just making sure that students know different paths and not just one. I feel like ... my biggest complication is just that I didn't know that they were different, and that was partly my fault because I didn't know what college is going to be like as a [first-year student]. I didn't know if I should talk to a counselor and I did talk to a counselor, but I*

didn't know the pathways, but just knowing different ways of graduating, like knowing that it's okay to graduate in five years or it's okay to go to summer school and stuff like that.

With modernized math pathways more clearly tied to majors and careers, colleges are recognizing the need to provide more support for students around their major and career choices. This includes **emphasizing and devoting resources to career counseling as early as possible**, because students generally enroll in math courses in their first or second term. However, at most of the colleges, these approaches were less developed than corequisite implementation. College professionals expressed a desire to do more to build connections between career exploration and major selection, given the relationship between a student's major and their math pathway. In some cases, these moves align with community colleges' efforts to build "guided pathways" that map programs to career and transfer outcomes to help students stay on track and complete their programs efficiently.

We have new staff this past year in our career services, and we have a lot more resources there with guided pathways and everything. There has been a big shift on focusing on that career exploration on the front end.

We don't have a lot of career counseling ... [but] so much is riding on what a student chooses as their major and [how] what they choose as their major integrates with what math course they ... have to take.

I wish we had more of a focus on career choices at the beginning.... [Many of] our registered students are first-gen, and, really, they don't know what's out there. They don't know what's available. Being a small college, we can't offer every major.... We can't offer all the coursework. I wish there was more focus on understanding the available careers and the skills necessary for those careers, that exploration part of it. I wish we could really help the students in that selection process more.

Several college professionals noted that placement reforms and corequisite strategies make it easier for counselors and advisors to **share positive messages with students**: "You are able to start in college-level math, and if you need support we have it for you!" versus, "You tested into remedial math and you will need to take several classes before you can enroll in a college-level course." Encouraging messages can be important for building students' math self-confidence, as well as **supporting them in considering STEM pathways**, college professionals noted.

If you go to our counseling website, the first thing you see is a picture of our counselor saying, "We're going to get through this together." ... [On] our placement website ... one of the first things you see says, "You're ready for transfer math now."

I want students to be encouraged to go into the math and sciences and be really encouraged that they can do it. I worry sometimes that students get the impression from advising and counseling that they may present themselves as looking for the easiest path through the institution. I think it could be easy for a counselor to say, "Oh, well, then just take Statistics. That's going to be way easier."

Interviewees noted that having **counselors or advisors dedicated to STEM majors** can make a difference, as they are more familiar with STEM-oriented math requirements, as well as ways of addressing the barriers students in STEM may encounter.

I know that a lot of the students who are STEM majors, who do take a lot of math and science courses, they really utilize the STEM counselors that are housed in the building. We have two that are in the building, and I will say they are phenomenal. And there are probably only a couple of counselors

that students consistently tell me they really liked meeting with and that are actually very helpful in explaining the process to them, what classes they need to sign up for, not wasting their time with getting them in the wrong classes.

Students tend to agree. Those enrolled in special programs—e.g., for low-income students or for parenting students—benefit from the additional, more specialized counseling that accompanies these programs. However, not all students are able to benefit. Typically, students work with a STEM counselor only after making a decision to pursue a STEM major, which minimizes the chances for STEM departments to actively recruit students who might have an interest in STEM. In addition, many students don't have dedicated counselors and have to see different ones every time. Even apart from discipline- or program-specific expertise, students interviewed thought all students could benefit from having an **assigned counselor or advisor** as a general practice.

I wish we had a designated counselor based off our educational goals or ... even by last name or something. I just want somebody ... I could meet with so I could ... discuss ... how to exactly reach my goals and maybe ... get access to ... internships.... Maybe shadowing an actual psychologist or social worker, anything.... That'd be a helpful tool.

I wish there was ... a required advisor every ... semester that just checked in one-on-one and ... spent one-on-one time with a student. Because I was ... really stressed at times ... planning all of it by myself and looking up everything.

Because the pathways are designed to be aligned with students' programs of study, interviewees noted that counselors need **training about math pathways** in order to advise students most effectively and avoid bias in their recommendations. After revising math pathways, Cuyamaca College held multiple training sessions with counselors and created cheat sheets for counselors to refer to as they adjusted to the new system. It's important for counselors to be familiar enough with the math classes that they can help students know what to expect as they decide which math class to take and when to take it.

Porterville College used fictional student profiles during training sessions to help counselors and math faculty identify and mediate biases: "This is a single mom with two kids," they'd say, for example. "Does that make a difference in what we're recommending for the student? Should it make a difference?" The interviewee from this college found it "eye-opening why [counselors and advisors] think that students can't succeed at the transfer level."

Not all advising is created equal. Despite college efforts, students noted a need to improve the quality of advice students receive. They reported **mixed experiences with counselors and advisors** related to both the specificity and detail of the information they received as well as the nature of the interactions. Some students had very positive experiences with counselors or advisors, while others wanted more guidance about topics such as expected workload in math courses, how math courses relate to their major or career interests, and what other resources they could tap. Still others did not find counselors to be encouraging, helpful, or clear.

When I talked to [the counselor], she really got one-on-one and she actually helped me step-by-step as to what maths I needed to take and how I could split them up, and when I could sign up, and whatnot. She gave me tips and little tricks and stuff. So with the counselor that I had, I got lucky. So it was really beneficial.

[The advisor/counselor] didn't take me ... seriously as a student. They treat me like my education was going to be crap, especially during the COVID.... I appreciate that there's the support there, that they still have [the] college open ... but there still needs to be professionalism, at least during the COVID, and kindness.

Given the limited access to counselors, especially at community colleges, some interviewees promoted **technology strategies to get more information to students**.

The fact that students don't ... often see a counselor is an issue that I hope we can fix, because I think it's an equity issue. Maybe having a guided self-placement tool on our website would help, because then students will be clear on what they need to take.

We're planning on sending out messages to students ... every semester after they've completed certain specific classes, like Introduction to Business.... We're planning on sending a message to say, "Is your major ...? Is this still what you want to do? If not, here's how you change your major." And then there would be a step to contact a counselor.

Others talked about incorporating more **career exploration opportunities** into math classes to help reach students who do not see a counselor or advisor.

I would love it if we could put a huge amount of effort into creating really interesting College Algebra or first-year Precalculus ... that would be valuable to students ... and to help students find whether [their selected math pathway] is the right path.... [We are thinking about] how to embed some career exploration into the course without ... overwhelming the curriculum ... but we're trying to ... alter the college culture around career and identity development early.

Another approach was to move counseling and advising beyond the confines of the office. One college offered hourlong workshops on time management, goal setting, study skills, motivation, and learning styles. To encourage attendance, some math faculty gave extra credit for attending. Another college had a health center representative give an in-class presentation on available services.

PROMISING PRACTICE:

First-Year Experience Program at Pasadena City College

Pasadena City College's Pathways FYE program provides critical support to populations traditionally underserved and underrepresented in higher education. The goal is to smooth the students' progress to and through college. Focusing on students with fewer than 20 college credits, the program offers dedicated academic counseling and support, including comprehensive education planning, enrollment and registration assistance, and various events and workshops addressing financial aid, career, and transfer. Program counselors are aware of and promote students' completion of transfer-level math as an indicator of long-term academic success. Pathways FYE students are required to complete math and English by the end of their first year of college in order to remain eligible for certain services in their second year. If pursuing a STEM pathway, they are encouraged to begin in the summer before their first year, since those sequences can be longer.

As a critical support, **tutoring should also reflect inclusive practices**. Some colleges work to identify and recruit multilingual tutors and tutors who are people of color. As with faculty, tutors are introduced to all the resources that are available to students, so they can refer students to nonacademic supports.

When we train the tutors ... we talk about stereotype threat and microaggressions, and, depending upon the group, I may even have them do some work around implicit bias.

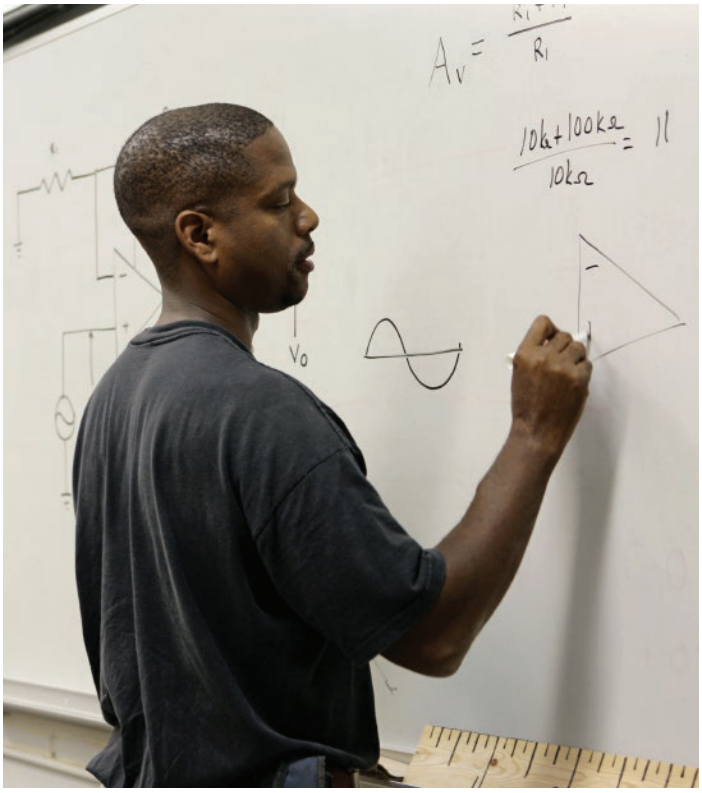
We've had a really concerted effort to try ... to find and acquire a Spanish-speaking math tutor.... We haven't been as successful as we would like, because a number of those students who attain the level of mastery in the subject who can tutor usually matriculate out.

Tutoring also needs to be accessible to students and integrated with instruction. One college created a single switchboard and common email for all of its tutoring centers, so students could have a single point of contact for help. Others had different ways of making sure students had easy access to tutors.

We created this math and statistics ... tutoring center. It has a really nice space in the library. We tried to make it really welcoming. We again are training the tutors, and the tutors are very aware of what our goals are in the classes.

[Our tutors] are trained by the math faculty that are teaching the courses. So there's a very tight integration there. In fact, the [faculty] also spend time in the tutoring center. So the faculty will have office hours over there. So, it's all to get students over there to do their homework, let alone, get help for their course.

Faculty can refer to tutoring.... The students are contacted by the [tutoring] center and informed how to make appointments with them, and then, once the tutor meets with a student, that referral gets closed out so that the faculty knows that they have been ... supported.... It allows the college to be a lot more intrusive with our students rather than hoping that they come in for services.



EQUITY IN THE CONTEXT OF COVID-19

When the pandemic took learning online in spring 2020, the concern in education was about what would be lost. This concern was valid, but discoveries were made, as well. College professionals and students noted that **some aspects of remote learning and other responses to the COVID-19 pandemic are worth preserving**. Colleges have become more aware of the hardships their students face and better equipped to help their students. For example, instructors reached out to students during the pandemic to determine what barriers they were facing that might have been hindering their academic success.

We don't know what they're facing every day. I've had [a] student tell me, "I got laid off and I have a little one," and we're trying to plan their classes.... Sometimes they just tap out because ... they gotta think about shelter and food.

At one college, faculty were able to contact the tutoring center to request support for struggling students. Interviewees highlighted other ways the institutions responded to the needs that arose during the pandemic, and how some of those new practices could benefit students after the pandemic concludes.

Practices interviewees hope will continue include:

- Instructors' video recordings of lectures.
- Increased responsiveness of instructors, including online office hours at a variety of times.
- Instructors' use of engaging and supportive online tools and resources.
- Easier access to counselors, advisors, and tutors, including availability outside of regular business hours, and online scheduling and appointment options.
- A focus on addressing students' academic and basic needs, including technology needs.

Students commented positively about having **access to video-recorded lectures**. These recordings allow students to watch lectures at times that are convenient to them and at a speed that allows them to review key concepts at their own pace. The recorded lectures are an approach that students hoped would continue even after campuses reopen.

When I wasn't working and I didn't have school, I was able to go back and watch it. And I was able to skip through the problems I knew or repeat the problems [I didn't].... It was nice being able to watch it on my own time and at my own speed.

I am an international student, so taking online classes help me to improve my English, because they have a recording of the lesson [and] I could go back to listen. So it helped me to improve my listening skills. Also, speaking and learning the math terms, how to say the word.

It's really helpful for the teachers to go out of their way and put up those Zoom videos.... Hearing it from the instructor ... themselves is much easier than reading the book alone. And [much easier than] just looking at slideshows with like no voice behind it. And it's just making the connections with the professors much easier than doing it on your own.

The participating institutions worked to maintain a connection between students and faculty. Increasing the **availability and responsiveness of instructors**, including expanding online office hours, was also valued by students.

Normally, the professors get back to me really quickly. So I really liked that.

Professors have office hours at various hours of the day. Several professors will stay in Zooms with students until they have a clear understanding of the material.

Remote learning also presented opportunities for instructors to use **engaging and supportive online tools** and resources. Some of the more successful aspects of online learning were breakout rooms, discussion boards, and Jamboards—online whiteboards that allow students to comment on one another's work and collaborate on assignments in real time.

Breakout rooms have been helpful for me when I get the people that I'm comfortable [with].

If we need help, we can call the instructor, but they usually just pop in to check up ... and ask questions or answer questions.

The Jamboards ... made it easier for us all.... I can interact with people. When I need help, I can ask somebody for help.

Students also reported that their instructors use e-textbooks, many of which were free to students, and math software programs such as MyStatLab and ALEKS, which provide more examples and alternative methods for solving problems. The move online also helped some students take better ownership of their learning, as they reported accessing not only the instructors' lectures, but other sites as well.

If I have any questions, [math software] has ... videos of ... an alternate way to do it. So I think it's helpful because, let's say that the teacher ... shows me one way to do a math problem and I'm not catching on, then [the software program] will break it down a different way. So I think that's really helpful because not everyone learns one way.

The disruption caused by the pandemic also underscored the **importance of access to counselors, advisors, and tutors**. In some cases, access to support professionals actually improved during the COVID-19 pandemic, because of special efforts made to ensure their availability at times when students were most likely to need them.

Another critical adjustment was **addressing students' academic and basic needs** through CARES Act funding and through offering food, supplies, and, at one campus, child care, by keeping the child care center open. Providing access to zero- and low-cost resources supports an equity agenda. Textbooks, laptops, and

calculators were often provided to students, to ensure they could fully participate in their coursework.

> *They went to pick up a calculator and a book for math, but how nice would it be to also get a chemistry book if they're taking chemistry, or a physics book.... All the students ... returned the textbooks.... It's not only going to be for this lockdown ... or throughout the pandemic, but it's something that we can continue using for future semesters.*

Technology needs came up frequently in interviews: Besides devices, students often needed Wi-Fi access or tech support. Two colleges had arranged or were in the process of arranging spaces on campus—including a parking lot and a socially distanced study hall—where students could access Wi-Fi.

> *There are students that it's either their internet bill or food for the week.... So if there's a way for us to provide some sort of high-speed internet place that they can go and do their homework ... that could help students.*

One college trained some students to help others address technology concerns that could hinder class participation and engagement.

PROMISING PRACTICE:

Porterville College's Navigating Tech with Equity in Mind

The Porterville College student PC Tech Navigators serve as liaisons between PC's information technology department and other students to ensure that students have access to the educational technology they need—including laptops and hot spots—to participate fully in online coursework. They are also trained to help other students address software challenges, from basic computer issues to navigating platforms such as Canvas, Zoom, and Discord. PC Tech Navigators can also help their peers use the college's online platform and app to view their schedule, find a campus map, and access resources from their smartphone. The PC Tech Navigators are recruited and trained with equity in mind, in order to be able to help all students—including evening students, Spanish-speaking students, and students who use American Sign Language.

Navigate app: https://www.portervillecollege.edu/navigate/navigate-students
PC Tech Navigators webpage: https://www.portervillecollege.edu/pc-tech-navigators-0

EQUITY WORK IN PROGRESS

To ensure that math is not a barrier to college success, particularly for students who historically have been excluded from STEM fields, requires an equity-driven culture. To better serve students, colleges need to innovate and take risks.

The institutions that participated in this study exhibited a commitment to eliminating barriers to math success. While they had taken concrete steps toward implementing all four of the *Solving for Equity* strategies, they were much further along in implementing the first two. All had adopted alternatives to the traditional Calculus pathway, allowing students to meet their math requirements with **college-level courses relevant to their program of study**. They had also eliminated some or all prerequisite remedial math courses, providing concurrent support when needed to students in college-level courses.

The use of these evidence-based practices partly explains why the participating colleges perform well in ensuring that students complete their gateway math requirements. The colleges also had adopted communities of practice and other vehicles for looking at student outcomes—disaggregated by race, ethnicity, and income—to monitor progress in implementing reforms, also an evidence-based practice.

The colleges all have more work to do, as none have completely eliminated racial/ethnic gaps in gateway math completion. Going forward, the colleges have the most opportunity to deepen their efforts by focusing on strategies three and four. Though professionals supported the idea of **inclusive practices that cultivate students' math identities** and fostering **opportunities for traditionally excluded students to pursue STEM disciplines**, they had fewer accomplishments to share in these two areas.

Their comments on instructional practices focused more on strategies for shared ownership of courses and collaboration between faculty and student services to implement new policies than on specific ways to foster more-inclusive classrooms. Perhaps because they were adapting to new conditions after the COVID-19 pandemic took them out of their classrooms, the educators offered few details about using—and training faculty to use—contextualized and culturally relevant instruction. They recognized the importance of providing more support for students in identifying their major and career goals early, as well as supporting more traditionally excluded students in entering STEM fields. At the same time, many felt confident that strategies they had adopted to support students during the pandemic served students well and would help advance equity when in-person learning resumes.

The third and fourth strategies may be harder to implement, because they go beyond structural changes, as noted by Brathwaite et al. (2020): "The equity-minded changes proposed are deeply entwined with cultural changes and must therefore address the underlying values and assumptions of faculty and administrators.... Cultural changes are unlikely to occur without core changes to fundamental beliefs." But the colleges' deep engagement around multiple math pathways and corequisite implementation has helped strengthen a collaborative culture and commitment to equity, both of which support future efforts. Their success also suggests a role for state policy in supporting local practice. Work to solve equity will remain unfinished unless colleges continue their efforts to adopt culturally responsive and relevant classroom practices and contextualized approaches that cultivate math identities as well as create more opportunities for traditionally excluded students to enter STEM disciplines.

RECOMMENDATIONS FOR COLLEGES

Based on institutions' work to advance equity through math education, as well as their unfinished agendas, colleges should:

- Adopt a **clear equity vision** that:
  - Incorporates race-specific efforts to dismantle structures that impede STEM pathway access and success for Black and Latinx students.
  - Reflects input and collaboration from across the campus.
  - Can be refined based on campuswide learning.
- Foster a **culture of inquiry** that includes:
  - Using disaggregated data to track progress toward improving outcomes for marginalized students.
  - Gathering and using student voices and perspectives to inform redesign.
  - Collaborating across functions to reinforce successful efforts and reject practices that don't support equitable outcomes.
- Promote **inclusive learning environments** that foster students' math confidence and math identity by:
  - Offering professional development that supports college professionals to recognize and address implicit bias inside and outside the classroom.
  - Promoting and supporting faculty to employ culturally responsive teaching and other classroom practices that help students see themselves as doers of math.
  - Prioritizing the hiring of racially diverse STEM faculty.
- Provide **effective guidance for students** through:
  - Frequent and transparent communication with students about math pathway options, requirements, and placement processes.
  - Readily accessible counseling, including strategies for encouraging or mandating regular check-ins with a counselor.
  - Dedicated counseling, so each student can work with an assigned counselor over time.
  - Technology solutions for scheduling and meeting with counselors, as well as accessing tutors and other support services.
  - Early career exploration and other strategies to attract more historically excluded students into STEM fields.

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METHODOLOGY

Five CSU campuses and six California community colleges were invited to participate in this study. Each of the invited institutions is considered to be an early and effective implementer of math reform by researchers who study math reform and students' math success. Among the reforms implemented at these institutions are corequisite courses and/or limiting the sequence of remedial courses needed to enter a college-level course.

In the absence of data from the California Community Colleges Chancellor's Office—which had been requested in partnership with the Research and Planning Group for California Community Colleges but not provided in time for this research to be conducted—we could not choose colleges based on student outcomes. Instead, we selected based on one or both of the following:

- Observations from math equity experts about math pathway success.
- Whether the college was considered a "strong" implementer of recent math reforms, based on published research (Hern et al., 2020).

For CSU campuses, we used data provided by the CSU Chancellor's Office to identify institutions where 50 percent or more of first-time Black and/or Latinx students had completed general education math requirements in their first year.

We sought to include colleges that had successfully implemented math pathway reforms in ways that supported student success—particularly Black and Latinx student success—in STEM and other pathways, in order to demonstrate the potential for implementing new pathways without tracking students by race or gender. Research has shown that Black and Latinx students, along with white female students, tend to be underrepresented in STEM pathways.

Among the California community colleges and CSU campuses that were initially contacted, administrators and faculty from one CSU—San Diego State University—and five community colleges—Citrus, Cuyamaca, Los Medanos, Pasadena City, and Porterville—agreed to share their stories and recruit students to participate in focus groups.

PARTICIPATING INSTITUTIONS

College	City	Region	Community	Size*	Diversity**
Community Colleges					
Citrus College	Glendora	Los Angeles County	Suburban large	Medium	Very diverse
Cuyamaca College	El Cajon	San Diego–Imperial	Suburban large	Small	Moderately Diverse
Los Medanos College	Pittsburg	Northern Inland	Suburban large	Small	Very diverse
Pasadena City College	Pasadena	Los Angeles County	City midsize	Large	Diverse
Porterville College	Porterville	Central	City small	Very small	Extremely Diverse
California State University Campus					
San Diego State University	San Diego	San Diego–Imperial	Urban	Large	Diverse

* Size of student enrollment: very small (fewer than 5,000 students), small (5,000-10,000 students), medium (10,000-15,000 students), large (more than 20,000 students).
** Diversity of student population, as defined by percentage of Black/African American, American Indian/Alaskan Native, Filipino, Hispanic, multiethnic, and Pacific Islander combined: moderately diverse (25 to 49 percent), diverse (50 to 65 percent), very diverse (66 to 75 percent), extremely diverse (more than 75 percent).

PARTICIPANTS

The research design involved 60-minute virtual interviews with at least three college professionals (administrators, faculty members, and other professionals) at each of the participating institutions and up to three 90-minute focus groups with students at each institution.

The purpose of the interviews with college professionals was to investigate equity-oriented structures, policies, and practices associated with math-related guidance, counseling, and support inside and outside the classroom. The professionals interviewed were knowledgeable about how the college or university had implemented recent reforms, including the information, guidance, and support offered to students.

Across the six institutions, 27 professionals participated in interviews. They included eight coordinators or directors, including research directors, special program directors, and tutoring- or assessment-center leaders; six administrators (e.g., deans); four faculty members; and three each of the following: math chairs, counselors and advisors, and staff (e.g., outreach). In some cases, two or three individuals were interviewed in the same session.

Administrators and faculty helped to identify two cohorts of students to recruit for participation in the study. The first cohort comprised students who:

- Were currently enrolled in a math course (regardless of whether they had selected a major).
- Were in at least their second term at the institution.

Given our focus on groups historically underrepresented in the STEM fields and in majors such as business that require some calculus, a second cohort oversampled the following student groups:

- Black, Latinx, and female students from among the math course sections associated with business and STEM majors.

The participating students received $50 Amazon gift cards in appreciation for their time. Three colleges invited students to participate in the focus groups using SignUpGenius, an online scheduling platform. The research team managed student outreach for the other three institutions. In all, 43 students participated in focus groups. To engage a few more student respondents, the research scope was expanded to include additional outreach at three of the five participating community colleges, to invite students to be interviewed. Although 19 students signed up, only seven completed one-on-one interviews.

In all, 50 students—35 of whom used she/her/hers pronouns, 14 of whom used he/him/his pronouns, and one who used they/them/their—spoke to one of the two researchers during the focus groups or individual interview slots. Student participants ranged in age from 17 to 50 years old. Many student participants were early in their college career, while others reported having started their postsecondary education five to 12 years earlier.

Of the 39 students who indicated their race/ethnicity, 38 percent identified as Latinx, 28 percent as white, 21 percent as Asian American, and 13 percent as multirace. Though most of the multirace students identified as Black and another race, none of the participants identified as solely Black, despite the oversampling.

The student focus groups (as well as a small set of 60-minute student interviews) were guided by 20 questions designed to explore students' experiences selecting, enrolling in, and completing math courses, as well as to elicit their suggestions for ways to help students select and complete their math coursework.

Appendix cont'd

The interviews and focus groups were conducted and recorded via videoconference calls between October 2020 and January 2021 and transcribed for analysis. The two researchers then coded the transcripts to identify key themes, highlight promising practices, and make recommendations with a focus on policies, practices, and structures that promote equitable access to information, entry, and success in various math pathways (Bensimon et al., 2016; Dadgar, 2021).

INTERVIEW PARTICIPANTS BY COLLEGE

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Michael O'Sullivan, Professor and Chair, Department of Mathematics and Statistics

LIMITATIONS

The information shared by the participating college professionals and students is the main source of data for this report. Though the report uses the four *Solving for Equity* strategies to organize the findings from this study, the interviews and focus groups were not framed around those strategies. As originally conceived, the community colleges selected to participate in this study would have been those with the most equitable outcomes in gateway math courses, including STEM math courses. However, because we were not able to obtain the data needed to identify those colleges in time to conduct the interviews, we cannot say whether the participating colleges have more effective practices than other community colleges. However, we do have evidence that these colleges (as well as the participating CSU campus) have diverse student bodies, a set of established math pathways, and signs of commitment to students' math success.

Recruiting students presented a challenge, perhaps because the study coincided with the remote-learning situation brought on by the COVID-19 pandemic. We had originally sought to include up to 30 students from each institution, but far fewer participated, despite multiple recruitment attempts and an increase in the amount of the gift card from $20 to $50. Some students may have been struggling to balance school, life, work, and family during uncertain times, or simply needed a break from their computer screen. At least two administrator interviewees shared similar struggles engaging students to participate in campuswide surveys. One focus group comprised mainly high school students taking a college math course as part of a dual-enrollment program, though they were not a population we had intended to recruit.

We sought to speak to students who were pursuing a variety of majors. However, most respondents were business, engineering, nursing, or science majors who were taking or had taken Calculus or more advanced math courses. Only seven of the 50 students indicated that they were pursuing non-STEM fields. We saw a similar pattern when conducting an earlier study, *Go Figure*. We hypothesize that STEM students are likely to be more confident in their math ability and more interested in math—and therefore more willing to participate than non-STEM students. Others have also found that students who were doing well in a math course (Calculus) were more likely to participate in math-related research (Bressoud et al., 2013).

Given the small number of students who volunteered from each college, students' insights and feedback are summarized across institutions, rather than used to compare and contrast practices by institution. In addition, because only one CSU campus participated in the study, we do not identify areas of contrast between community colleges and universities. For the most part, the ideas and practices we highlight apply across the institutions that participated. Because of this, we sometimes use the term "college" to refer to colleges and universities.

Lastly, the research design was developed before the COVID-19 pandemic arose. Distance-learning conditions made it challenging to explore some intended lines of inquiry but also provided new awareness of ways to serve students equitably. Because research for this report coincided with the COVID-19 disruption, responding to the pandemic was a natural topic for our interviewees. Practices arising in response to the pandemic are noted to the extent that they are relevant to the overarching inquiry.

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