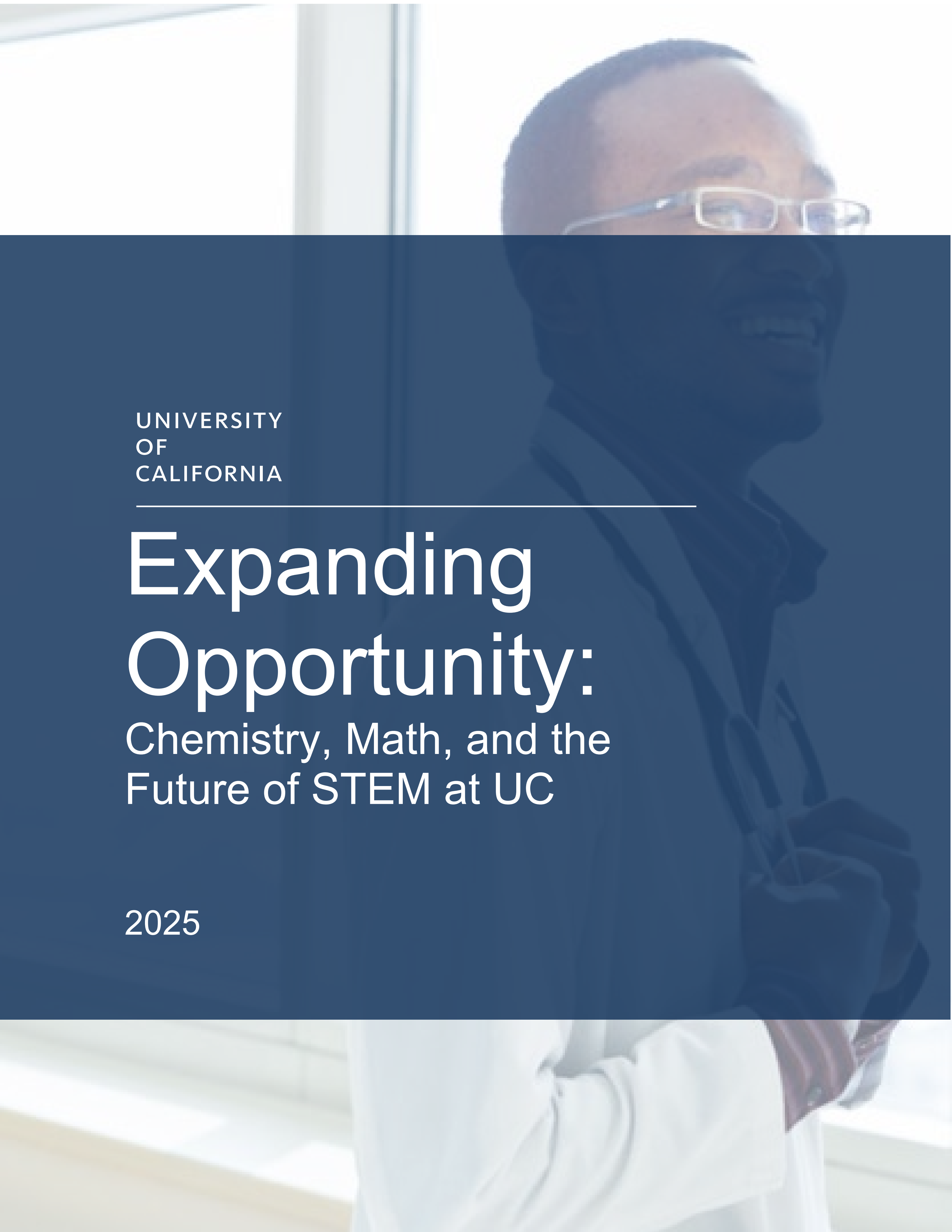


UNIVERSITY
OF
CALIFORNIA

Expanding Opportunity:

Chemistry, Math, and the Future of STEM at UC

2025

CONTENTS

Expanding Opportunity: Chemistry, Math, and the Future of STEM at UC

EXECUTIVE SUMMARY

The University of California is uniquely positioned to lead in expanding access to high-quality STEM education. As the state's public research university system and a network of minority-serving institutions, UC is committed to equity and student success. This includes not only expanding who enters STEM, but ensuring students have the tools and support they need to complete their degrees.

For some students, the path to a STEM degree may be disrupted as early as the first math or chemistry course. These foundational "gateway" courses, intended to launch students into science and engineering fields, can instead serve as gatekeepers. Success often hinges on prior educational experience, reflecting systemic inequities in access to advanced coursework, resources, and support. UC is tackling these challenges through innovative, inclusive approaches to STEM education.

What's working

Redesigned STEM pathways improve placement, curriculum, and pacing in entry-level math and chemistry to support equitable student success.

Application-based instruction uses real-world content and active learning to boost student engagement and deepen understanding.

Expanded peer and cohort support fosters belonging, normalizes help-seeking, and strengthens learning across disciplines.

Sustaining and scaling innovation takes long-term investment and systemwide coordination—building shared infrastructure, expanding collaboration, and turning promising ideas into lasting change.

Across the UC system, faculty and departments are rethinking how students enter and move through introductory STEM coursework. A wave of campus-level innovations is reshaping placement, curriculum, instruction, and support to better reflect the needs of today's students.

Several campuses have redesigned how students move through their calculus and chemistry coursework. For example, UC Santa Barbara introduced a new preparatory chemistry course that has reformulated instruction and increased pass rates.

UC San Diego combined an expanded preparatory math sequence with a support center offering individualized learning plans.

At UC Riverside, revised placement cutoffs have moved more students into credit-bearing math, while a foundational workshop was converted to award workload credit, ensuring that it contributes to degree progress.

Departments are also tailoring course content to students' academic and career paths. At UC Davis, a grant-supported redesign created a calculus course specifically for social science majors, with labs and data applications drawn from fields like sociology and economics.

UCLA's *Mathematics for Life Sciences* series focuses on dynamical systems and real-world modeling. This approach was adopted by UC Santa Cruz in its *Mathematics for Life and Environmental Sciences* course and is under consideration at UC San Diego and UC Santa Barbara.

These changes go hand-in-hand with pedagogical reforms. UC Riverside's mastery grading model in general chemistry has shifted student outcomes and experience, while UC Irvine has introduced a math co-course to shore up understanding of the quantitative foundations in chemistry.

At UCLA, an enhanced chemistry course adds an extra weekly hour of peer-led discussions and inquiry-based learning strategies designed to increase interaction and improve outcomes.

Out-of-class support also plays a vital role. Programs like learning communities, cohort models, and peer instruction help students build connections, navigate hidden curricula, and develop a sense of academic belonging.

At UC Merced, a set of cross-disciplinary grants enabled the integration of peer learning across STEM fields, while UC San Diego developed a two-year cohort model that combines course alignment with mentoring and advising.

The College of Chemistry at UC Berkeley offers structured peer mentoring, creating a sense of community and academic identity for students navigating demanding coursework.

Today's future scientists, engineers, healthcare professionals, environmental researchers, and tech innovators increasingly come from communities historically excluded from STEM. The University of California is committed to building inclusive pathways that support their success.

Enabling and sustaining innovation

The success of these efforts depends on institutional infrastructure. Across UC, change is propelled by workgroups, teaching professors, and centers for teaching and learning—each playing a distinct role in advancing innovation. At UC Santa Barbara, for example, a campuswide study of student pathways contributed to data-driven reforms throughout STEM curricula.

Many of the most promising efforts have been made possible through external funding. Grants from agencies like the National Science Foundation, Howard Hughes Medical Institute, and California Education Learning Lab have provided the resources and flexibility needed to launch pilots, train peer instructors, and redesign curricula.

These investments have produced valuable materials and insights, but sustaining them will require deeper, more permanent commitments.

The opportunity ahead

This moment presents a critical opportunity. The work underway across UC demonstrates that meaningful change is possible—and already happening. What is needed now is a shift from isolated innovation to shared infrastructure.

Systemwide resource sharing, collaborative evaluation, and strengthened networks could help scale what works and reduce duplication of effort.

With coordinated support, UC can continue to lead not just in access to STEM, but in the design of a more equitable and effective model for undergraduate education.

1 INTRODUCTION: EQUITABLE ACCESS TO STEM CAREERS

The University of California plays a vital role in advancing the state's economic future and ensuring that the benefits of a college education are accessible across its diverse population.

As California's public research university system, UC is charged with preparing the next generation of scientists, engineers, and innovators, and doing so in a way that enacts the University's values of inclusion and opportunity.

One of the clearest intersections of these responsibilities is in expanding access to careers in science, technology, engineering, and mathematics (STEM). California's future workforce will increasingly rely on strong STEM talent, and it is imperative that students from all backgrounds—especially those historically excluded from these fields—have the opportunity to pursue and succeed in STEM majors.

The University's long-term goals, including those outlined in the UC 2030 framework and its commitments as a system of Minority-Serving Research Institutions (MSRIs), call for meaningful increases in degree completion, particularly among first-generation college students, students from low-income backgrounds, and students from racial and ethnic groups that are underrepresented in STEM fields.

To meet these goals, the University must address one of the most persistent structural challenges in undergraduate education: the role of foundational STEM courses as both gateways and gatekeepers.

This challenge is not unique to UC. A 2025 consensus report from the National Academies of Sciences, Engineering, and Medicine (NASEM) puts the issue plainly: "The nation cannot reach its full potential without doing the critical work of addressing inequity in undergraduate STEM education." The NASEM conclusions recognize high-quality STEM instruction as a national priority—essential to participation, innovation, and our ability to meet future global challenges.

This report examines how UC is rising to that challenge. It focuses on introductory chemistry and math instruction across the system and highlights promising efforts underway to increase equity in STEM degree attainment.

About this report:

This report draws on systemwide data, published research, and interviews with faculty and staff from all nine undergraduate UC campuses. Conducted in fall 2024 and spring 2025 by UCOP Institutional Research and Academic Planning, these conversations explored local approaches to chemistry and math instruction. The findings are supplemented by program documentation and publicly available data.

Who gets in, who gets through: access and completion at UC

Foundational chemistry and mathematics courses serve as critical entry points for STEM majors. These introductory classes are intended to build the conceptual knowledge students need for advanced study in fields like biology, engineering, and physics. But for many students, they can become high-stakes filters—courses whose structure, pacing, or expectations may not fully align with the varied educational experiences students bring with them.

As a result, students from groups historically underserved in education are often disproportionately impacted, not because of a lack of potential, but due to longstanding challenges in how early STEM instruction supports diverse pathways to success. Unequal access to advanced coursework and well-resourced learning environments in K–12 education can have lasting effects, influencing how students navigate the transition to college and whether they persist in STEM fields.

Early math access is unequal

In California, 87 percent of students attend high schools that offer a diverse range of AP classes—but just 58 percent attend middle schools that offer algebra in the eighth grade.

Taking algebra in eighth grade is often crucial for staying on track to complete precalculus in high school.

Source: EdTrust, Advanced Coursework in Your State

These disparities often reflect broader systemic patterns and are more likely to affect Black, Hispanic/Latinx, and Indigenous students, those from low-income backgrounds or rural areas, as well as other communities that have historically faced barriers to educational opportunity.

The COVID-19 pandemic further compounded these inequities. As instruction shifted online and support systems frayed, students who already faced barriers encountered additional academic challenges, magnified by uneven health and economic impacts across California communities (PPIC, 2020).

While the urgency of reform was magnified by the pandemic, calls for improving undergraduate STEM instruction preceded it by many years. In 2011 the Association of American Universities (AAU) launched an initiative to improve STEM instruction at research universities, highlighting the role of introductory courses in driving attrition. Findings from a five-year study of the initiative underscore the urgency of moving away from flawed models toward equity-centered, evidence-based teaching. (UC Davis, UC Irvine, and UCLA were all members of the initiative.)

More recently, national bodies such as the Association for Undergraduate Education at Research Universities (UERU) and the National Academies of Sciences, Engineering, and Medicine (NASEM) have urged major overhauls in undergraduate STEM education, recommending a shift from traditional lectures to active, inclusive approaches grounded in learning science.

Tracing math learning loss

The COVID-19 pandemic disrupted learning across subjects—but the consequences for math instruction were especially steep, particularly for students still building foundational skills.

California Smarter Balanced Assessments for 2021–22 showed a 6.9 percentage point drop in the share of eighth graders meeting or exceeding math standards, as compared to 2018–19, the last pre-pandemic year. (By contrast, the decline in English language arts for the same cohort was 2.8 points.) These eighth graders were in sixth grade when the pandemic began—a pivotal year for deepening understanding of fractions and laying the foundation for formal algebraic reasoning.

Because math learning is cumulative, disruptions at this stage can ripple into high school and beyond. Falling behind in eighth grade can make it harder to succeed in Algebra I or Geometry—critical gateways to college-level coursework and STEM opportunities.

Evidence of this disproportionate impact to math skill development is also visible in UC classrooms. A 2025 UCOP analysis found that between the 2020 and 2021 entering freshman cohorts, average GPAs in math and statistics courses declined by 0.2 grade points, compared to a 0.1 point decline across other subjects.

To truly expand opportunity in STEM, California must treat early math recovery not as a K–12 issue, but as a shared responsibility across educational systems.

Progress in access, uneven outcomes

Over the past decade, UC has made progress in expanding access to STEM degrees for students historically underrepresented in these fields. Students who identify as women, nonbinary, trans, or a self-described gender identity now represent a larger share of new STEM enrollees than a decade ago, alongside Black and Hispanic/Latinx students. As shown in Table 1, these gains—visible in both overall and STEM-specific enrollment—reflect years of focused effort to make STEM more inclusive and accessible across the University.

But progress is uneven. The share of low-income and first-generation students entering the University has declined since 2014. The share entering STEM has also declined—though by a somewhat smaller margin. STEM enrollment for Native American and Pacific Islander students in STEM has been stagnant.

When it comes to completion, some groups—notably Hispanic/Latinx students—are earning a larger share of undergraduate STEM degrees than a decade ago. However, the share of STEM degrees earned by low-income and first-generation students has fallen. For low-income students in particular, the decline is steeper than what is seen in their enrollment numbers. Outcomes across other groups are mixed.

Taken as a whole, these patterns point to structural barriers that affect student success after enrollment, which can include access to academic support, inclusive teaching practices, and a strong sense of belonging.

Who is entering and completing STEM pathways?

	Overall New Enroll 2014	2024	Change	STEM New Enroll 2014	2024	Change	STEM Degree 2014	2024	Change
Overall	58,712	71,302	**12,590**	22,257	29,064	**6,807**	18,055	27,035	**8,980**
Black	3.7%	5.0%	**+1.2%**	2.7%	4.0%	**+1.2%**	2.03%	2.84%	**+0.8%**
Hispanic/Latinx	22.9%	27.2%	**+4.4%**	20.0%	25.4%	**+5.3%**	12.28%	18.71%	**+6.4%**
Pacific Islander	0.3%	0.2%	**-0.1%**	0.2%	0.2%	**--**	0.18%	0.18%	**--**
Native American	0.7%	0.7%	**--**	0.6%	0.6%	**--**	0.58%	0.34%	**-0.2%**
Women, nonbinary, and self-described	53.2%	55.7%	**+2.5%**	45.9%	49.2%	**+3.3%**	43.84%	46.50%	**+2.7%**
Low income (Pell)	40.8%	36.8%	**-4.0%**	39.6%	36.0%	**-3.6%**	44.92%	35.72%	**-9.2%**
First generation	43.5%	36.7%	**-6.9%**	41.7%	35.4%	**-6.4%**	34.88%	32.98%	**-1.9%**

Table 1 Changes in UC undergraduate STEM participation by student group, 2014–2024

The table shows changes in enrollment and degree attainment for key demographic groups in STEM pathways over time, compared to changes in overall enrollment for the same period. Because many students enter UC without a declared major and later switch fields, enrollment and degree patterns can offer a clearer view of overall participation than traditional measures of persistence.
Source: IRAP analysis of internal UC student data

Note: Gender data are reported in aggregate for this table, combining women with nonbinary, trans, and self-described students; for a more detailed discussion of gender-related outcomes, see page 7. Disaggregated data by race/ethnicity, gender identity, income status, and first-generation status are available at the UC Information Center.

While examining individual groups can be helpful, a fuller picture emerges when we consider student identity in its complexity. Many UC students navigate STEM pathways as members of multiple groups that have not been equitably supported—such as being both first-generation and low-income, or a woman of color in a technical field.

These overlapping experiences don't just add up; they interact in ways that can shape students' access to resources, their sense of belonging, and their ability to persist in STEM.

Foundational courses, in particular, can amplify these dynamics—functioning as critical entry points for some students and major roadblocks for others. This underscores the importance of examining not just who enters STEM pathways, but how students fare once inside them—a focus of the next section.

STEM starts here: why intro courses matter

Calculus and general chemistry are widely recognized as foundational courses for STEM majors. Mastery in these subjects is essential for progress in fields like biology, engineering, and physics—but they are also known for high attrition. Nationwide, many students earn low or failing grades in these courses or switch majors after encountering challenges.

At UC, similar structural challenges translate into persistent disparities in course outcomes. DFW rates—grades of D, F, or withdrawal—are consistently higher in general chemistry and calculus than in other lower-division courses. Not only do these courses have lower pass rates overall, they also show greater disparities in outcomes based on students' demographic characteristics—such as income, first-generation status, and race/ethnicity (Figure 1).

A range of factors contribute to these disparities, including unequal access to pre-college coursework like AP chemistry or high school calculus. While some students arrive with extensive preparation and place directly into general chemistry or calculus, others are routed into preparatory pathways.

Placement systems—often based on AP scores, exams, and prior coursework—are designed to assess readiness but can unintentionally reinforce inequities. When these systems consistently place students from historically underserved groups into non-credit-bearing or extended sequences, they may delay progress, increase cost, and amplify discouragement or stigma.

The COVID-19 pandemic further intensified these dynamics at multiple levels. Disruptions to high school instruction and the shift to remote learning disproportionately affected students from under-resourced schools and communities. As a result, incoming preparation has become more variable—and more difficult to assess—just as student needs have grown more complex.

Trends in DFW rates at UC reflect these shifting conditions. Overall rates increased during the pandemic but showed signs of recovery in 2023–24. In general chemistry and calculus, the shifts were more abrupt, with larger disparities across student demographic groups. These patterns persist, suggesting that some structural challenges may be more deeply embedded or less responsive to short-term interventions.

Across the UC system, there is growing recognition that traditional models of placement, pacing, and instruction may not adequately respond to the diversity of today's student population. To achieve greater equity in STEM, campuses are rethinking how foundational courses are structured—designing new models aimed at supporting student learning and success, rather than screening for it.

The calculus gateway

Read more about structural barriers to calculus success—and how redesigned placement and instruction models across California higher education systems support a more diverse STEM workforce—in *Charting a New Course: Investigating Barriers on the Calculus Pathway to STEM* (Just Equations and the California Education Learning Lab, 2021).

Intersecting identities, unequal outcomes in foundational STEM courses

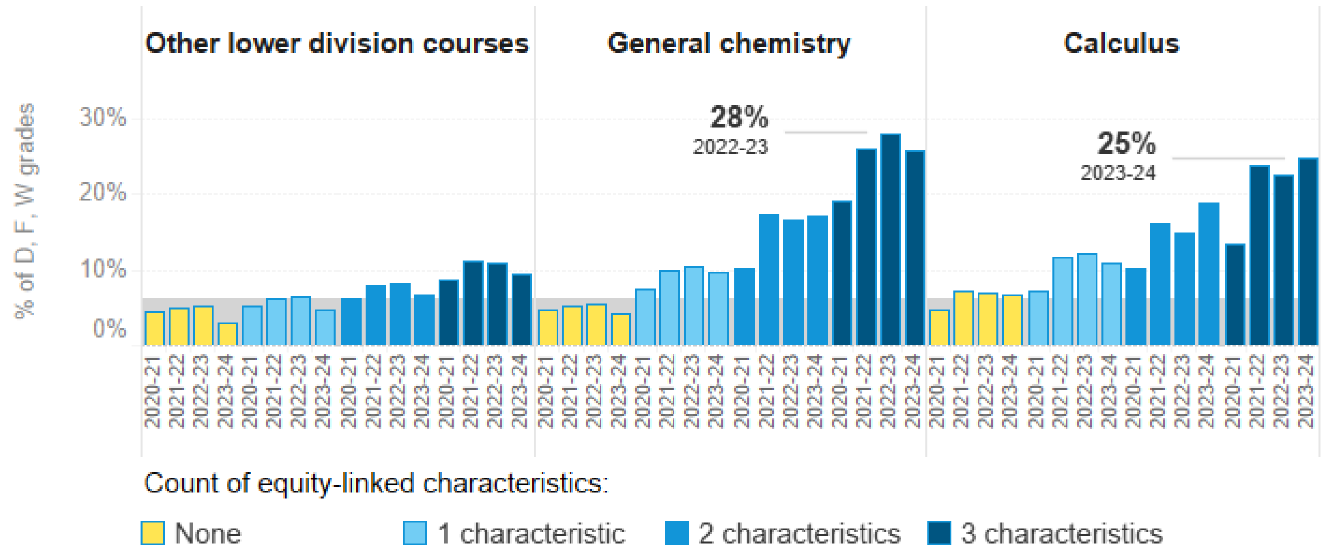


Figure 1 Course DFW rates by number of equity-linked characteristics, 2020-21 to 2023-24

The percentage D, F, or W (withdrawal) grades assigned in chemistry, calculus, and other lower-division courses increases with the number of **equity-linked characteristics** a student holds—defined as being first-generation, low-income, or from an underrepresented racial or ethnic group (Black, Hispanic/Latinx, Native American, or Pacific Islander). Disparities are greater in general chemistry and calculus.

Note: The shaded area represents the average DFW rate across all lower-division courses and all student groups from 2020–21 to 2023–24 (6.24%). For a list of chemistry and calculus courses, see Appendix 2.

Source: IRAP analysis of internal UC student data

Why disaggregate this way?

STEM outcomes aren't shaped by a single factor, and student identities are complex. Structural barriers affect students who are first-generation, low-income, and from underrepresented racial or ethnic groups in distinct but compounding ways. The data in this section disaggregates course outcomes by the number of "equity-linked characteristics" associated with each student, highlighting how intersecting factors relate to DFW rates in foundational STEM courses.

Why it matters:

- Avoids one-size-fits-all assumptions about any single group
- Acknowledges the complexity of identity, rather than treating race or income as monolithic
- Focuses on systems, not students—highlighting how course structures shape outcomes

While the preceding analyses centered on race, income, and first-generation status, gender identity is also a key dimension of equity in STEM. UC has made progress in recent years, with growing representation in STEM enrollments and degree attainment among women, nonbinary, trans, and self-described students (Table 1). But the balance varies across fields. In 2024, men remained heavily represented among graduates in engineering and the physical sciences, while women, nonbinary, trans, and self-described students were concentrated in the life sciences (Figure 2).

Gender disparities are not just about who enters or completes a STEM degree—they also show up in classrooms and course outcomes. Figure 3 highlights differences in DFW rates across lower-division STEM courses. Rates for nonbinary, trans, or self-described students are consistently higher, particularly in general chemistry and calculus. Disaggregating these groups from women helps surface these patterns, but deeper analysis is limited by small numbers, as well as shifts in data collection over time—a reminder that data invisibility can itself be a structural barrier.

Which STEM degree?

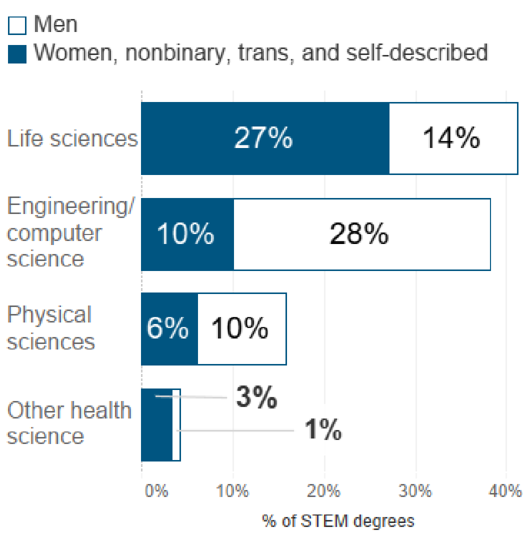


Figure 2 UC STEM bachelor's degrees awarded by gender and discipline, 2023–24

Women, nonbinary, trans, and self-described students are concentrated in the life sciences. (Chart values sum to 100%.)

Source: IRAP analysis of internal UC student data

Differences by course

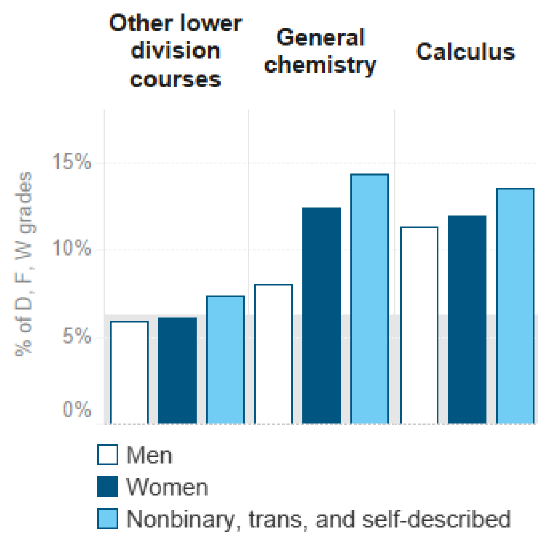


Figure 3 DFW rates in lower-division courses by gender identity, 2020-21 to 2023-24

DFW rates for men and women are similar across most lower-division STEM courses, except in general chemistry and calculus. Rates are consistently higher for students who are nonbinary, trans, or have self-described their gender identity. The shaded area reflects the overall four-year DFW rate across all courses (6.24%).

2 A NEW FORMULA: INNOVATION AT UC

In response to persistent equity gaps in foundational STEM courses, faculty and departments across the UC system are rethinking how students are placed into and progress through introductory math and chemistry. These changes are informed by a growing body of national research, alongside local evidence, pointing to the limitations of traditional models. Across the system, new approaches are emerging that better recognize the diversity of students' prior experiences and provide more intentional support at critical entry points.

Reimagining placement and preparation

Many of these efforts center on placement and preparatory coursework—critical moments that can shape a student's entire academic trajectory. Rather than assigning students to remedial pathways that delay degree progress, campuses are finding ways to place students more appropriately and support them more effectively.

The 2020 elimination of standardized testing requirements for UC undergraduate admissions has added new complexity to this work. Math SAT scores, known to reflect systemic inequities, nonetheless offered utility as a shared reference point for readiness. In their absence, campuses are relying more on diagnostic tools, prior coursework, and targeted supports to help design entry points. While this shift requires rethinking placement systems, it also creates opportunities to design more equitable approaches.

At UC Santa Barbara, for instance, a newly designed preparatory chemistry course has shown promising results. The course was developed in response to data revealing that students experiencing one or more "effectors of opportunity"—a campus-defined framework for understanding marginalization—were less likely to pass general chemistry than their peers. By offering an on-ramp that builds foundational knowledge without the stigma or cost of traditional remedial models, the course has helped narrow equity gaps later in the chemistry sequence (UCSB-internal analysis).

Placement into math has also seen reform across the system. At UC San Diego, the math department introduced a preparatory course in 2017 that precedes precalculus. As the number of students placing into this course has grown, the department has adopted an online format to expand access. Importantly, this was paired with the launch of a new support center, ASC@Math, where students engage in individualized learning plans. The overall approach is an effort to meet students where they are, offering targeted, just-in-time academic support.

A similar recalibration has occurred at UC Riverside. The campus transformed a non-credit bearing workshop into College Mathematics Fundamentals and Problem Solving (MATH 003), a workload credit-bearing course. This change, combined with an adjustment to placement thresholds, has led more students into credit-bearing algebra and precalculus rather than foundational math without degree credit.

UC Davis offers CHE 1V, an online preparatory chemistry course that introduces foundational concepts through real-world issues like pollution, climate change, and sustainability. Designed to support students who do not meet the general chemistry placement threshold, the course is primarily offered during summer session to help students start the general chemistry sequence on track in the fall. However, to meet growing demand, the offering has been extended into fall quarter. The campus is exploring additional cross-campus supports—including outreach and success coordinators—to strengthen placement and preparation in both chemistry and math.

Some campuses have introduced flexible, modular solutions that respond to students' evolving needs throughout the term. In 2024-25, UC Berkeley piloted a short, half-semester course (*Foundations of Lower Division Math)*, which focused on precalculus concepts and ran alongside the standard calculus course. Students could opt into this co-course at the beginning of the term or later in the semester, a valuable option for students who may have fallen behind or earned a low grade on a midterm.

While each of these examples reflects a local response to campus-specific needs, they share a common philosophy: that students' prior experiences should inform—not limit—their academic journey. By restructuring placement and preparatory pathways to be more supportive and less punitive, campuses are working to build a stronger, more inclusive foundation for STEM success.

Early results from these pilots are promising, but further analysis is needed to understand their long-term impact on persistence, degree completion, and student confidence. As this work evolves, it is worth asking how long such changes will be seen as compensatory—and when they will become the new standard for equitable instruction.

Bridging learning disruption

Many students entering UC Davis's general chemistry sequence after the pandemic had taken high school chemistry via remote instruction—often with limited support, hands-on experience, or structured accountability. For students from under-resourced schools, this disruption compounded existing challenges.

To help support these students, UC Davis launched CHE 98, a small-group co-course taken alongside general chemistry. The course blends collaborative learning, practice exams, and peer support—all designed to help students build confidence and succeed in college-level chemistry.

And it works:

Students in CHE 98—most of whom were first-generation and low-income—were more than twice as likely to earn a C or higher in general chemistry compared to a matched control group.

Source: Kumari et al., 2025

While many campuses are rethinking placement and preparation, other innovations have focused on expanding course access. UC Santa Cruz offers a fully online, four-course calculus sequence (Math 19A/B and 23A/B), developed with UC system support and approved for major credit ("articulated") at all nine undergraduate-serving campuses.

The format emphasizes flexibility and scalability, featuring short, high-quality video lectures; algorithmically generated, auto-graded assessments (which reduce grading variability and provide individualized problem sets); year-round availability, including summer; and online instructional support and office hours.

While demand for the courses has grown since the early pandemic period, systemwide coordination remains limited. Expanded use—particularly during summer—could help more students stay on track in STEM pathways and complete critical coursework on time. *(See sidebar: Leveraging online infrastructure.)*

Read more about the development of online education at UC in the UC Online 2023-24 Annual Report.

Leveraging online infrastructure

UC Santa Cruz's fully online calculus sequence is approved for major credit at all nine undergraduate-serving campuses and has been available through cross-campus enrollment for more than a decade.

Systemwide access

Available to all UC students through UC Online, the infrastructure is in place—but use across the system remains uneven. This may reflect limited awareness but might also point to broader dynamics: campuses may prioritize their own curricula, and advising practices will vary.

A promising approach

Since its launch in 2012-13, the sequence has served tens of thousands of students, with consistently strong pass rates and student satisfaction. Analysis of pre-pandemic course outcomes (UCSC-internal) showed comparable or stronger performance in the online format—but also indicated that students who opted in tended to have stronger prior math preparation.

Looking ahead

Today, with greater familiarity and comfort with online learning, students may be more open to this option—but deeper, systemwide analysis is needed to understand how to leverage this shared structure for broader impact.

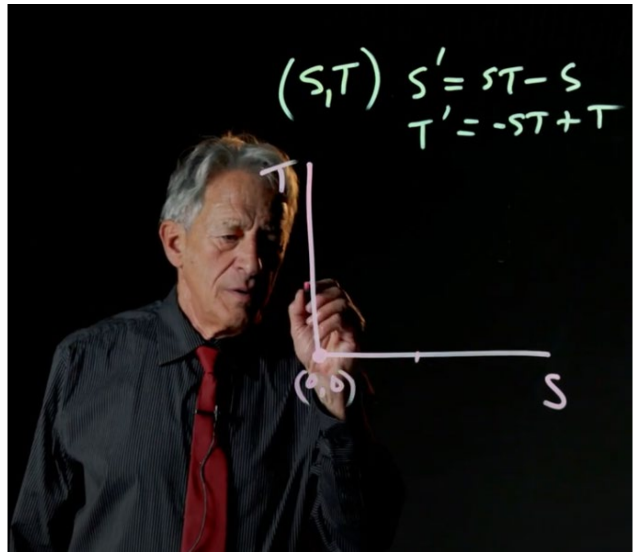
Making STEM relevant: curricular redesign rooted in application

Across the UC system and nationally, a growing number of departments are redesigning foundational STEM courses to connect more directly to a variety of disciplines and career paths. While calculus and general chemistry have long served as universal gatekeepers to STEM degrees, these courses are increasingly being reshaped to align with the ways different disciplines use quantitative and scientific reasoning in practice.

Rather than treating all students as though they are preparing for the same future, instructors across UC are tailoring content, pedagogy, and assessments to better reflect the needs of majors in life sciences, social sciences, and other applied fields. These efforts aim to increase relevance and engagement, support deeper learning, and ultimately foster greater equity in who succeeds and persists in STEM.

At UCLA, the life sciences department offers a course that provides an alternative to the standard calculus sequence. Rather than focusing on abstract concepts and symbolic manipulation, *Mathematics for Life Sciences* emphasizes dynamical systems and a 'modeling first' approach to calculus. Students explore mathematical models of real-world systems—like predator-prey dynamics or hormone regulation—making the material more intuitive and directly relevant to students' intended fields.

The UCLA model has been tested, refined, and even replicated elsewhere, including at UC Santa Cruz, with UC San Diego and UC Santa Barbara now exploring a similar approach.



Watch a video lecture from UCLA's Life Science 30 course (Mathematics for Life Sciences) on modeling shark and tuna populations. The lesson is delivered by Prof. Alan Garfinkel, shown above.

What the research says

UCLA's *Mathematics for Life Sciences* (LS30) course takes a modeling-first approach, using biological systems to introduce students to core concepts in calculus, dynamics, and feedback.

A multi-year study found:

- 80% of students reported increased confidence in math.
- Grade disparities between first-generation students and their peers were smaller in LS30 than in traditional calculus.
- LS30 students earned higher grades in subsequent chemistry and physics courses than peers who took traditional calculus.

Source: Garfinkel et al., 2022

UC Davis has similarly reimagined its calculus offerings with a focus on the social sciences. Supported by a grant from the California Education Learning Lab, the department developed a new course centered on modeling and data analysis. *(See sidebar: Calculus for data-driven applications.)*

Chemistry departments are also redesigning their courses to better serve students with diverse academic goals. At UC Berkeley, for example, the department has implemented two interventions: a preparatory course for non-majors and a co-requisite support course for chemistry majors. The preparatory course helps students build the conceptual foundation needed to succeed in general chemistry. The co-course supports majors through additional instructional time and active learning strategies.

These curricular innovations are more than pedagogical adjustments; they represent a rethinking of who foundational courses are for—and how they can be designed to meet students where they are. They respond directly to calls for more inclusive, evidence-based, and future-oriented models of undergraduate STEM education.

These reforms are promising, but they come with real challenges. Developing new content, revising assessments, and retraining faculty require significant time and effort—often supported by grant funding or the commitment of a small group of faculty champions. Without stronger infrastructure for cross-campus collaboration and broader adoption, sustaining and scaling these changes remains difficult. Still, these are exactly the kinds of transformative moves national experts have long called for.

By connecting learning to students' academic identities and career goals, UC is helping ensure that the first steps into STEM are both meaningful and equitable—for all students.

Calculus for data-driven applications

At UC Davis, faculty redesigned a calculus sequence for social science majors to better meet the demands of a data-driven world. The new course, Math 19, replaced the traditional Math 16 sequence with a curriculum integrating calculus, probability, and discrete math, grounded in real-world modeling and interdisciplinary applications.

Weekly computer labs reinforced core concepts while introducing students to programming, social science datasets, and applied modeling. The redesign aimed to improve workforce preparation and reduce equity gaps in math outcomes.

Supporting materials, including open-access lab modules, are available via LibreText. More information about these and other resources is offered in Appendix 5.

Rethinking how students learn: pedagogy in practice

Introductory STEM courses often enroll hundreds of students, making them some of the largest at any UC campus—and among the most difficult to redesign using inclusive, evidence-based teaching practices.

Large lectures can make it difficult to personalize instruction, foster interaction, or respond to students' individual learning needs. And on the quarter system, where the pace is fast and stakes are high, a single absence or low midterm grade can have lasting consequences.

Despite these challenges, UC campuses are making important strides toward rethinking how teaching and learning happen in these foundational courses. Many departments are adopting pedagogical approaches that prioritize mastery, build in flexibility, and reflect current research on how students best engage with complex material.

Faculty seeking to implement inclusive, evidence-based teaching practices face unique challenges in high-enrollment courses. The use of learning assistants—specially trained peer educators—offers a model for fostering interaction and responding to student needs.

At UC Riverside, the chemistry department has adopted a mastery-based grading model in its general chemistry sequence. Instead of relying on a few high-stakes exams, the course uses regular assessments and opportunities for revision. Students can retake unit exams tied to specific learning outcomes, allowing them to learn from mistakes and demonstrate growth. Paired with interactive tools, this approach reflects a broader shift toward more transparent, growth-oriented course structures. *(See sidebar: The impact of grading changes.)*

UC Irvine has focused its efforts on active learning in chemistry, restructuring large courses to make space for interaction and collaborative problem-solving. One innovation is a co-course that reinforces the math foundations needed for success in general chemistry.

The co-course is designed to reinforce key concepts in real time, helping students apply what they're learning in ways that feel immediate and relevant. Determining which students would benefit from this kind of support has become more difficult in recent years—particularly with the move to test-optional admissions, which removed a once-standard, if flawed, signal of STEM readiness.

At UCLA, a new "enhanced" chemistry course incorporates multiple layers of support, including an additional hour of discussion time led by peer instructors and a blended in-class approach using Process-Oriented Guided Inquiry Learning (POGIL) and Peer-Led Team Learning (PLTL).

These methods emphasize small-group work, peer explanation, and guided discovery, which are strategies shown to increase engagement and deepen understanding. The UCLA initiative was driven by internal data showing disparities in chemistry course outcomes, and its implementation was made possible by strategic investments in faculty capacity, including a professor of teaching hire and funding to support course redesign.

As campuses work to redesign high-enrollment courses, pedagogy is not just about content delivery—it's also about how students perceive themselves as learners. A growing body of practice centers STEM identity development as integral to student success, particularly for those from backgrounds historically excluded from science and math (Jiang & Wei, 2025).

At UC Merced, faculty in introductory chemistry and math report that many students arrive unsure whether they belong in STEM. To address this, instructors design courses that build not only skills, but STEM identity. In chemistry, students engage in collaborative work and structured reflection to help them process feedback and build confidence. Instructors note that this is especially important for students who might interpret critique as a sign they don't belong.

In a similar vein, math faculty at Merced center reasoning and group discussion over rote memorization. They encourage students to explain their thinking aloud and challenge their peers—even their instructors. These moments help learners build agency and self-trust, reinforcing the idea that doing STEM means thinking critically, asking questions, and seeing yourself as someone who belongs.

What unites these campus efforts is a shared emphasis on how learning happens—not just what is taught. These redesigned courses challenge longstanding assumptions about grading, pacing, and instructional structure. They prompt important questions: Are large lecture sizes a function of pedagogical strategy, or simply of available room capacity? Are grading policies designed to reflect student mastery, or to manage instructional constraints?

Transforming teaching at scale is not a one-time investment. It requires sustained coordination—from redesigning materials and assessments to training learning assistants and learning from student feedback.

The impact of grading changes

A recent study of UC Riverside's general chemistry sequence found that pairing mastery-based grading with interactive courseware significantly improved student outcomes. Students from historically underserved groups—including those who are first-generation college students, from minoritized racial and ethnic groups, or receiving financial aid—saw gains of over 11 percentage points on a common final exam compared to students in a traditional, high-stakes grading model. Students also reported reduced anxiety and greater confidence navigating the course.

Source: Hartman & Eichler, 2024

Learning together: peer instruction and out-of-class supports

As campuses work to make classroom instruction more equitable, they are also investing in what happens outside the classroom. Peer learning, cohort programs, and co-curricular support are increasingly recognized as critical components of a student-centered approach to undergraduate STEM education. These strategies not only reinforce academic skills—they also foster community, demystify the hidden curriculum of college, and support identity development as scientists, mathematicians, and problem-solvers.

Peer instruction plays a dual role in this work. On one hand, it supports evidence-based teaching practices such as active learning and small-group problem-solving. On the other, it offers students near-peer role models who help normalize struggle and model successful academic behaviors. Research suggests that these kinds of interactions can enhance students' sense of belonging and self-efficacy, especially for students whose backgrounds or experiences are not shared with faculty or graduate student instructors.

At UC Merced, the convergence of multiple grants enabled a system of peer support that spans departments. With funding from the National Science Foundation, California Education Learning Lab, and Howard Hughes Medical Institute, the campus introduced peer instructors across biology, physical sciences, and math. This cross-departmental coordination built capacity while creating a more consistent and visible culture of peer-led learning.

In chemistry, UC Merced faculty used NSF grant funds to create short videos of peer instructors introducing lab techniques. These videos humanize the material and help students prepare more confidently for lab sessions. Although the full series wasn't completed due to the end of grant funding, the videos remain in use—highlighting both the project's impact and the challenge of sustaining innovation without ongoing support. See Appendix 3 for a review of similar grants to UC campuses.

What is a Learning Assistant?

Learning Assistants (LAs) are trained undergraduates who support classmates during lectures, labs, or discussions by guiding collaborative thinking and problem-solving.

Rooted in a near-peer learning model, their role focuses on helping students engage actively with course material—rather than grading or delivering content.

LAs work closely with faculty to plan activities and share insights from the classroom, and first-time LAs complete training on evidence-based teaching practices.

The model supports deeper student learning, cultivates undergraduate leadership, and helps create more inclusive, interactive classrooms.

Read more: Barrasso & Spilios, 2021

To deepen peer-based support, some campuses have gone further, building cohort models that connect students not just to peer tutors, but to each other. UC San Diego created a physical sciences cohort program that enrolls students in common math, chemistry, and physics courses over their first two years.

These academic communities are supported by dedicated advising and mentoring structures, helping students navigate both course content and the college experience. The model recognizes that students majoring in physical sciences are often distributed across campus and that providing coordinated support can help them feel less isolated and more grounded in their studies

In a similar approach, UC Santa Barbara created its MAXimizing Students' Potential (MAX) Program following a campuswide study of students' movement through majors. The program begins with an online summer course on STEM concepts and navigation skills, taught by UCSB STEM faculty. Undergraduate learning assistants (ULAs) support students in small groups during the summer and continue working with them into the fall quarter.

At UC Berkeley, the College of Chemistry Scholars Program (COCSP) offers peer mentoring, social support, and academic enrichment. Funded by donors and linked to the broader Berkeley Scholars Consortium, the program reflects a whole-student approach to success. By fostering belonging and normalizing help-seeking, COCSP and similar initiatives aim to close equity gaps not just through scaffolding, but through cultural transformation.

Taken together, these programs address more than content mastery. They create community, reveal the unwritten rules of academic culture, and offer students tangible support as they build their identities in STEM. Yet they are also resource intensive. Peer-led models require robust training, supervision, and often compensation. Cohort programs require coordinated scheduling and sustained advising.

As campuses look to scale what works, the question becomes how to institutionalize these models in ways that are both sustainable and equitable, ensuring that all students, not just those in special programs, benefit from the power of learning together.

UC Merced lab demonstration videos, like this one featuring student Amy Kisner, help students arrive more confident and prepared by showing lab techniques modeled by fellow students.

More in this series:
youtube.com/@UCMercedChemistry

3 LEVERS FOR CHANGE

The efforts described in this report—course redesigns, placement reforms, peer-led programs—do not emerge in isolation. They are made possible by institutional structures that support collaboration, experimentation, and reflection. Workgroups, teaching-focused faculty, and centers for teaching and learning each play a critical role in making innovation feasible—and in translating good ideas into lasting change.

“We are an institution of higher education, so having colleagues whose expertise is in education in the broader sense, understanding how people learn … it's really important for the mission of a university, and [professors of teaching] can significantly contribute to this.”

—University administrator, quoted in Harlow et al., 2022

Collaborative problem-solving: the role of workgroups

Workgroups are often the seedbeds of reform. When structured thoughtfully, they bring together faculty, staff, and sometimes students to explore a shared challenge and recommend solutions. But they also face common hurdles: defining the problem clearly, maintaining momentum beyond the initial charge, and securing the resources needed to act on their findings.

At UC Berkeley, a math taskforce was formed in response to low pass rates in calculus. Designated the “math preparedness” group, the taskforce focused its inquiry on the transition from high school to college and explored placement, support strategies, and instructional design. A survey of students revealed that more than half disagreed with the statement: “The approach to teaching and learning in [this course] is/was very similar to the upper-level math classes I took in high school or community college.” This insight helped shift the conversation toward better alignment between students’ prior experiences and college expectations.

UC Santa Barbara offers a different model. As part of a broader self-study for reaccreditation, the campus launched an exploratory initiative that examined student pathways and outcomes across four case study departments, including chemistry—and biology, a major that requires students to complete all three introductory chemistry courses. Using a locally developed framework centered on “effectors of opportunity,” the effort took a deep dive into student experiences and outcomes. The data not only informed departmental reforms but also sparked a broader institutional push to make data tools and success metrics more accessible across campus.

At UC Davis, faculty collaboration around gateway course reform has also extended beyond campus. The campus participated in the HHMI Driving Change Learning Community[1]—an initiative focused on equity and inclusion in STEM that brought together teams from UC Davis, UC Irvine, and UCLA, among others. Through regular convenings and shared inquiry, the program supported cross-campus dialogue about institutional strategies for reform.

Participants described the experience as deeply valuable, particularly in connecting faculty working toward similar goals who might otherwise remain siloed. While each campus shaped its own approach, the community fostered alignment and reinforced the power of cross-campus collaboration—not only for scaling what works, but for cultivating the leadership culture needed for sustained change.

Leaders in learning: the role of professors of teaching

Workgroups can be powerful catalysts for reform, but sustained change also depends on who does the work—and how that work is supported and valued. At many UC campuses, professors of teaching play a central role in undergraduate education innovation. These faculty carry higher teaching loads than their colleagues and often lead curriculum design, mentoring, and assessment efforts. As scholars, they contribute to both disciplinary research and discipline-based education research, bridging educational theory and instructional practice.

At UC Santa Cruz, for example, a professor of teaching led a full-sequence redesign of the introductory chemistry pathway. The new curriculum emphasized clearly defined learning outcomes and included robust assessment—not just of grades, but of student understanding. It also enabled co-enrollment in an aligned math course for students who would benefit. This change was part of a broader strategy to improve instruction and advance the campus's goals as a minority-serving research institution.

Building influence

Professors of teaching at UC have established a cross-campus network to build community, collaborate on education research, and advocate for the role. With NSF support, they have studied their collective impact, and the findings point to a growing influence on undergraduate STEM instruction.

- Professors of teaching are more likely to use active learning strategies in their courses.
- They frequently serve as instructional influencers, shaping how colleagues approach teaching and course design.
- They are deeply engaged in advancing equity, diversity, and inclusion—both in their classrooms and through department-level reform.

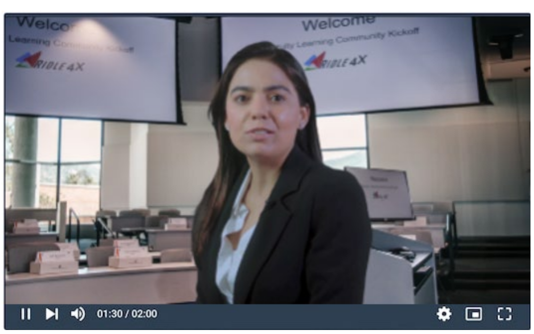
Sources: Dennin et al., 2022; Denaro et al., 2022; Wilton et al., 2024; Harlow et al., 2020
tpn.ucop.edu/research-on-t3ps/

---

[1] HHMI has rebranded its equity-focused initiatives "Success in Science". For clarity, when referencing past awards, this report uses the name associated with the initiative at the time of the award.

Across UC, professors of teaching are helping shift campus culture by modeling active learning, collaboration, and equity-minded instruction. Many have led externally funded education research, and their growing presence spurred the creation of the UC STEM Tenure-Track Teaching Professor Network, which fosters mentorship and visibility for the role. As more campuses nationwide adopt this teaching-focused model, UC offers a promising example of how it can drive institutional change.

Still, challenges remain. Professors of teaching are typically hired for disciplinary expertise and may be expected to conduct education research without formal support. If their role is narrowly focused—such as staffing high-enrollment courses—it can limit broader impact. But with intentional support, these faculty can strengthen teaching ecosystems, catalyze department-wide change, and help UC lead in undergraduate STEM education.



Watch as UC Riverside faculty reflect on the impact of learning communities. Learning specialist Swati Ramani introduces the RIDLE program.
teaching.ucr.edu/ridle

Equipping educators: UC teaching and learning centers

Supporting this ecosystem of change are the centers for teaching and learning (CTLs) that exist on every UC campus. These centers offer professional development and pedagogical training, as well as course design support, and they often serve as a hub for educational innovation. Their reach extends beyond faculty: many also support graduate students and postdocs who are preparing for teaching roles. Many also house or collaborate with student-facing programs for undergraduates—such as tutoring centers, academic coaching, and Supplemental Instruction—that reinforce inclusive, evidence-based learning beyond the classroom. *(See sidebar: Peer-led success at UC San Diego.)*

At UC Riverside, the RIDLE (Rethinking Instructional Design for Learning Engagement) project has created faculty learning communities that support course redesign and evidence-based pedagogy. Over sixty faculty have participated to date, creating a network of instructors committed to transforming teaching in their departments. Similar initiatives exist at UC Santa Cruz (Project REAL) and other campuses, helping faculty learn from one another and build momentum for change.

UCLA is home to two centers that support faculty and future faculty in advancing evidence-based instruction: the campuswide Teaching and Learning Center (TLC) and the Center for Education Innovation and Learning in the Sciences (CEILS), which focuses on life and physical sciences. CEILS provides faculty development, assessment services, and collaborative support for efforts like the life sciences calculus course and redesigned chemistry sequence described earlier.

Together, CEILS and TLC run CIRTL@UCLA, a local program of the national Center for the Integration of Research, Teaching, and Learning (CIRTL) network. CIRTL@UCLA prepares graduate students and postdoctoral scholars with training in evidence-based teaching, research skill development, career preparation, and change leadership.

At UC Irvine, educational innovation is supported not just by its CTL, but by synergies across campus units—including the School of Education and a cohort of teaching professors conducting discipline-based education research. Support from a project scientist within the Division of Teaching Excellence and Innovation (DTEI) has enabled faculty to pursue more rigorous evaluations of their interventions and has elevated the role of research in everyday instructional decisions.

For example, the introduction of a chemistry co-course at UC Irvine, described on page 13, was evaluated by a research team that included professors of teaching from UC Irvine and UC San Diego, together with the DTEI project scientist. Analyzing course grades (for a common final exam and overall), retention in the chemistry sequence, and student perceptions, the team confirmed the effectiveness of the new co-course (Denaro et al., 2021) and supported the departmental decision to retire the preparatory course that preceded it.

Peer-Led Success at UC San Diego's Teaching + Learning Commons

At UC San Diego, the Academic Achievement Hub—part of the Teaching + Learning Commons—hosts a robust Supplemental Instruction (SI) program that supports students in foundational STEM courses, including introductory math and chemistry. Designed for courses that are both high-enrollment and historically challenging, SI provides structured, peer-led sessions that emphasize collaboration, community, and academic confidence.

SI Leaders are trained undergraduate students who have successfully completed the course they are supporting. Rather than re-lecturing content, they facilitate weekly small-group sessions that help students engage with material actively and learn from one another. The program is designed to be inclusive and low-barrier, with no registration required and both in-person and virtual options available.

Program evaluation over five years shows that regular participation in SI is linked to stronger academic performance—participating students earn, on average, a half-letter grade higher than non-participants (UCSD-internal analysis). Perhaps just as important, students report greater confidence, improved study habits, and a stronger sense of belonging in STEM.

Grant funding: catalyzing innovation, challenging sustainability

Across the University of California, many of the most ambitious and equity-minded changes to undergraduate STEM education have been made possible through grant funding. Grants provide the resources, flexibility, and incentive structures that allow faculty and departments to experiment, redesign, and assess new approaches. From course development and instructional materials to peer mentoring and faculty training, grant-funded initiatives have launched dozens of efforts aimed at improving student outcomes in math and chemistry.

But reliance on external funding introduces a tension: while grants can spark innovation, they often leave behind the question of how to sustain and scale successful efforts once the funding ends.

At UC Merced, for example, a trio of grants enabled faculty to embed peer instruction across the STEM curriculum and build infrastructure for mentor training and curricular redesign. This effort helped shift department culture toward more consistent use of active learning, as described on page 15. But like many grant-funded innovations, it now faces a familiar challenge: how to sustain peer mentor roles, ongoing training, and the instructional practices they enable without continued funding.

UC Santa Cruz similarly used a set of Hispanic-Serving Institution (HSI) grants to redesign entry-level math courses. These efforts worked in tandem with an earlier HHMI grant, with both funding streams reinforcing each other. (For more detail see pages 41-42.) While the HHMI funds were focused on active learning in the sciences, the HSI grants extended those approaches into math—supporting project-based learning, cross-disciplinary curriculum design, and collaboration with advising for proactive student outreach. Even with strong alignment and impact, the question of sustainability persists: how to maintain redesigned courses, faculty development, and student supports once grants end?

These examples are not unique. Across the UC system, grant funding has launched many of the initiatives highlighted in this report—from placement reforms to course redesigns to cross-campus collaboration. A review of such awards is provided in Appendix 3. But grant timelines are finite and often tied to a small group of champions. When those faculty move on—or when funding runs out—campuses risk losing momentum or reverting to older models that are easier to sustain but less effective for students.

Yet this work often leaves a lasting legacy. Many grant-funded projects generate instructional materials, lab modules, assessment tools, and research findings that can benefit others across the system. Examples of these shareable resources are listed in Appendix 5.

Lessons from UCSC

Experiences from grant-supported work at UC Santa Cruz highlight strategies that can strengthen equity-focused innovation:

Work across the curriculum. Department-level change is essential, but cross-department collaboration expands the potential for shared solutions and broader cultural shifts.

Build teaching teams. Strengthening collaboration among faculty, student instructors, and instructional support staff fosters more inclusive and consistent learning environments.

Develop future educators. Course redesign efforts offer powerful opportunities to train graduate students and post-docs, many of whom will go on to serve as faculty at other institutions—taking their UC experience with them.

Balance academic freedom with collective goals. In gateway courses especially, building shared trust around content and pedagogy can support cultural change and collective student success.

These approaches are examples-in-action of the types of change called for by national bodies like the Association for Undergraduate Education at Research Universities (UERU) and the National Academies of Sciences, Engineering, and Medicine (NASEM).

Learn more about the UERU "Blueprint" for undergraduate education and the NASEM consensus report.

The challenge—and the opportunity—is for UC to capture, curate, and share resources systemwide, turning isolated innovation into collective progress.

Changing how students experience introductory STEM courses requires more than new content or placement policies. It depends on reimagining pedagogy, building out-of-class supports, and investing in the structures and people who make innovation possible. Peer instructors, teaching faculty, workgroups, and centers for teaching and learning are the backbone of this work. Grant funding has often been a spark—but sustaining and scaling what works will require deeper institutional commitment. When UC invests not just in instruction, but in the ecosystem that surrounds it, the result is a more equitable, resilient, and student-centered path through STEM.

From insight to action

The remainder of this report is designed to help convert insight into action. It begins with a set of recommendations, grounded in the findings from Sections 1–3, followed by appendices that offer models, references, and tools to support campus-level and systemwide progress.

4 RECOMMENDATIONS FOR SUSTAINING AND SCALING EQUITY IN STEM FOUNDATIONS

The recommendations below are informed by and aligned with the National Academies' 2025 report Transforming Undergraduate STEM Education: Supporting Equitable and Effective Teaching, which outlines a broad national framework for change. While the National Academies establish powerful principles, these UC-specific recommendations are necessary to translate that framework into action within our unique institutional and systemwide context—where budget constraints and instructional structures require tailored solutions. Where possible, we reference existing UC reports, tools, or networks that can support implementation and local adaptation.

Driving equity in STEM education means creating the conditions for all students to be able to learn—regardless of their background, preparation, or access to outside resources. Equity requires designing for variability: recognizing that students arrive with different strengths, constraints, and needs, and building structures that support meaningful learning for everyone. An equitable foundation in STEM benefits not only students who have historically been marginalized, but the university as a whole—and helps ensure California has the diverse, skilled workforce it needs to meet its future challenges.

1. Protect what works: prioritize and sustain promising work already underway
2. Explore shared stewardship of instructional resources
3. Design peer educator roles as career-connected learning experiences
4. Support department-level coordination for scalable redesign
5. Advance department-level equity assessment and use of data
6. Connect intervention assessment with available data and expertise
7. Elevate faculty leadership in effective, equity-oriented instruction
8. Align equity goals in STEM with UC's broader mission and partnerships

1. Protect what works: prioritize and sustain promising work already underway

What it means: UC should focus on protecting proven instructional and support models. This includes sustaining the infrastructure—teaching centers, course redesigns, faculty networks, and peer learning structures—that has already demonstrated impact.

Who: Campus academic leadership, UCOP Academic Affairs, Senate committees.

Why it matters: Faculty and staff are already stretched thin. Strategic continuity—not constant expansion—is an act of care, for both educational quality and the people doing the work.

---

2. Explore shared stewardship of instructional resources

What it means: UC should assess how materials like course labs and videos, peer educator training guides, and placement exams can be curated and shared across campuses. The current report includes a partial landscape scan as Appendix 5, which can serve as a foundation. UC libraries may be natural partners in building this infrastructure, and existing platforms like UC Online could inform or help support cross-campus sharing—especially for scalable course content and instructional tools.

Who: Instructional faculty, libraries, CTLs, UC Online leadership, and campus innovators.

How: Rather than duplicating efforts, focus on surfacing and connecting existing hubs and networks—starting with those identified in Appendix 4. Expanding access to shared resources can help scale what works across campuses and strengthen systemwide infrastructure.

3. Design peer educator roles as career-connected learning experiences

What it means: Peer educators facilitate learning, and they are also learners themselves. Connect these roles to career preparation and the development of competencies like leadership and communication. Access to these roles should be considered an equity issue in its own right, with attention to who participates, how they're supported, and what they gain.

Who: Campus teaching centers, advising offices, academic departments.

How: Use credit-bearing structures, academic internships, or paid roles (where possible). Align with advising and career services to communicate value and document outcomes. A scan of emerging campus models could inform systemwide guidance on what makes peer educator roles most impactful—for both student learning and job readiness.

---

4. Support department-level coordination for scalable redesign

What it means: Instead of relying heavily on individual instructors, campuses should support departments in planning coordinated approaches to pedagogy and curriculum redesign. Faculty should not be expected to undertake this work in isolation; they need coordinated support and shared responsibility.

Who: Department chairs, CTLs, instructional design teams.

How: Leverage existing structures like department-based curriculum committees, and align institutional levers—such as program review processes and departmental planning—with equity-focused instructional goals.

5. Advance department-level equity assessment and use of data

What it means: Departments should integrate equity questions into routine processes like curriculum review and program planning. This implements a core principle from the National Academies guidance, which calls for departments to take collective responsibility for course outcomes. The UC-wide review of existing equity data tools—summarized in the report UC 2030: Equity is Excellence—can serve as a reference point for campuses exploring local implementation.

Who: Departments, with support from IR offices and teaching centers.

How: Provide templates and tools for analyzing and visualizing equity data. Encourage departments to embed these metrics in program review and assessment of student learning outcomes.

6. Connect pilot assessment with available data and expertise

What it means: Assessment of specific course or program redesigns requires expertise—and data. These findings should not only inform local improvement but be shared broadly to support collective learning across departments and campuses. IR offices can help fill data gaps, but faculty and staff conducting interventions need to guide what gets measured. What's needed is more cross-talk among evaluators, IR staff, and campus assessment offices.

Who: Departmental faculty and staff, IR offices, assessment offices, CTLs.

How: Support campus conversations that connect assessment strategy with data access. Normalize small-scale evaluations as part of shared learning and iterative design.

7. Elevate faculty leadership in effective, equity-oriented instruction

What it means: Faculty excellence should be defined and rewarded based on what truly supports student learning—structure, relevance, active pedagogy, and belonging through rigor. This aligns with national calls for holistic, evidence-based evaluations tied to course design and outcomes. Recent studies of the Teaching Professor role in the UC system highlight misalignments in how teaching is valued—underscoring the need for a more consistent, institutionwide understanding.

Who: Department chairs, Academic Senate Committees on Academic Personnel, UCOP Academic Personnel.

How: Expand support for documentation (e.g., teaching portfolios), chair education, and peer evaluation standards that reflect the full range of instructional impact.

8. Align equity goals in STEM with UC's broader mission and partnerships

What it means: STEM equity is central to UC's mission—advancing 2030 goals, fulfilling MSI commitments, and preparing California's workforce. These efforts are strongest when aligned with statewide priorities and coordinated across systems. UC can continue to strengthen partnerships with CSU and CCC through shared grant efforts, faculty cross-talk, and system-level collaboration.

Who: UCOP leaders, Academic Senate, campus planning offices.

How: Use mission-driven messaging, intersegmental convenings, and aligned grants to connect STEM equity with statewide impact. These partnerships are essential to fulfilling UC's public role.

5 LOOKING AHEAD

The University of California has long been a driver of scientific discovery, technological advancement, and social mobility. As this report illustrates, UC is also a site of critical reflection and innovation in how science and math are taught—and to whom. Across the system, faculty, departments, and campus leaders are rethinking how students enter STEM, how they are supported in foundational courses, and how curricula can better reflect both disciplinary relevance and inclusive pedagogy.

From restructured placement pathways and preparatory coursework to redesigned calculus and chemistry sequences, the University is taking tangible steps to remove barriers and build stronger foundations for student success. Innovations in teaching, peer support, and faculty collaboration are showing early signs of impact—closing equity gaps, improving pass rates, and strengthening students' sense of belonging in STEM. These efforts are often grounded in rigorous research and supported by institutional assets: teaching faculty, centers for teaching and learning, cross-campus networks, and strategic grant funding.

But the work is far from finished. Equity in access must be matched by equity in outcomes. And while many of the efforts highlighted in this report have been championed by small teams or sustained by short-term resources, broader and more durable change will require system-level support. The opportunity ahead is not only to deepen what is working, but to connect it—across campuses, disciplines, and institutional silos.

UC has the potential to lead nationally in creating a more inclusive and effective model for undergraduate STEM education—one grounded in evidence, informed by equity, and designed with students at the center. Realizing that potential will depend not only on continued innovation, but on the structures and commitments that allow such innovation to thrive.

UNIVERSITY
OF
CALIFORNIA

6 APPENDICES

Appendix 1. Innovations by campus

UC Berkeley

Preparatory chemistry

Preparation for General Chemistry enhances student readiness through active learning, problem-solving, and study skills—building confidence and a strong foundation for success in general chemistry.

Support for general chemistry

Chem 49 supports first-year students enrolled in Chem 4A by building study skills, reinforcing key concepts, and connecting students with the College of Chemistry community.

Solid Foundations project

UC Berkeley's math department, with support from the Eustace-Kwan Family Foundation, launched its Solid Foundations initiative to strengthen math learning through interactive learning, peer support, and course redesign.

Calculus co-course

Originally an online summer program, Precalculus Essentials is now Foundations of Lower Division Mathematics—a course taken alongside calculus as an alternative to precalculus.

Adjunct calculus course

The Berkeley Student Learning Center offers a one-unit adjunct course for calculus students focused on learning strategies and metacognitive skills in a peer-supported, low-stakes environment.

Courses

CHEM 32	Preparation for general chemistry *NEW*
CHEM 1A	General chemistry
CHEM 4A	General chemistry and quantitative analysis
CHEM 49	Supplementary work in lower division chemistry *CO-COURSE*
MATH 3	Precalculus
MATH 51	Calculus
MATH 1	Foundations of lower division mathematics *NEW CO-COURSE*
MATH 10A	Methods of mathematics: calculus, statistics, and combinatorics (life sciences)
MATH 16A	Analytic geometry and calculus (business / social sciences)
MATH 98	Adjunct course (supervised group study) *CO-COURSE*

UC Davis

Preparatory chemistry

The newly launched Preparation for General Chemistry course, offered in summer and fall, equips students with a strong foundation before entering general chemistry. Offered in person and online, the course is designed for students across multiple majors and integrates real-world applications, case studies, and connections to broader global events.

Chemistry for physical sciences and engineering

CHE 4 is a new general chemistry course designed specifically for students majoring in physical sciences and engineering. With those students now served by their own course, the chemistry department is revising CHE 2 (General Chemistry) to better meet the needs of life sciences and other majors. The redesign, which includes new laboratory assignments, will allow CHE 2 to incorporate more relevant context and examples, aligning instruction with students' academic pathways and career interests.

Co-course support for General Chemistry

CHE 98 is a small-group co-course designed for students who could benefit from additional support in General Chemistry. In its first iteration, many of the enrollees were first-generation college students or from low-income backgrounds. The course blends collaborative problem-solving, metacognitive strategies, and community-building, and has been demonstrated to boost confidence, engagement, and academic success.

Source: Kumari et al., 2025

Calculus labs

With support from a grant from the California Education Learning Lab, faculty redesigned Calculus for Data-Driven Applications to include a series of interactive, two-hour weekly lab sessions. The labs feature mini data projects, enabling students to deepen their understanding through hands-on analysis.

Inclusive learning environments

The HHMI Driving Change Learning Community includes UC Davis, UCLA, UC Irvine, and more than 30 other institutions, working together to eliminate barriers to STEM inclusion. This initiative fosters the development of inclusive learning environments through collaboration across research universities.

Courses

CHE 001/001V	Preparation for general chemistry *NEW*
CHE 002A	General chemistry
CHE 98	Directed group study *NEW CO-COURSE*
CHE 004A	General chemistry for the physical sciences & engineering *NEW*
MAT 000B	Elementary algebra
MAT 000C	Trigonometry
MAT 000D	Intermediate algebra
MAT 012	Precalculus
MAT 021A	Calculus
MAT 017A	Calculus for biology & medicine
MAT 019A	Calculus for data-driven applications *REDESIGNED*

UC Irvine

Preparatory chemistry redesign

UC Irvine faculty created a co-course called General Chemistry Plus (CHEM 1X) which runs concurrently with standard General Chemistry (CHEM 1A). The plus course includes more instruction focused on mathematics foundations and does away with a preparatory course that formerly preceded the first course in the general chemistry sequence. An extension of this model is planned for courses that follow in the sequence.

Chemistry: collaborative innovation

Chemistry faculty in the professor of teaching series have been pivotal in redesigning courses to better leverage evidence-based approaches to learning. With support from the Division of Teaching Excellence and Innovation, faculty test and tweak their designs to find what works best for UC Irvine students.

Calculus redesign

UC Irvine is launching a major calculus redesign beginning Winter 2026, inspired by a review of systemwide efforts. Changes include flipped classrooms, learning assistants, Gates-funded courseware (Learnvia), and a new companion course for targeted precalculus support.

Math: active learning with learning assistants

UC Irvine's online precalculus course has been supplemented with an hour of required in-person active learning. Led by learning assistants, the sessions foster collaboration and deepen engagement with the material. This initiative enhances the learning experience in a supportive, interactive environment.

AAU STEM Education Network

With a grant from AAU, plus matching funds, UC Irvine expanded supports for faculty learning communities, course redesign, and training for graduate students and peer mentors.

Inclusive learning environments

The HHMI Driving Change Learning Community includes UC Davis, UCLA, UC Irvine, and more than 30 other institutions, working together to eliminate barriers to STEM inclusion. This initiative fosters the development of inclusive learning environments through collaborative efforts across research universities.

Courses

CHEM 1A	General chemistry
CHEM 1X	General chemistry plus *NEW CO-COURSE*
MATH 1A	Precalculus (workload credit)
MATH 2A	Single variable calculus

UCLA

Enhanced general chemistry for life scientists

An "enhanced" version of General Chemistry for Life Scientists incorporates a two-hour discussion session that leverages the POGIL (process-oriented guided inquiry learning) framework. This method encourages teamwork and interactive learning, and the course is supported by undergraduate learning assistants.

Precalculus redesign

With support from the Curtis Center, UCLA Mathematics launched a redesigned Precalculus (MATH 1) course in 2024. The course features weekly "investigations," which can take the form of a physical experiment, and which are designed to increase student agency in learning.

Calculus laboratory

UCLA has launched an enriched calculus course, Differential and Integral Calculus Laboratory (MATH 31 AL), that includes an extra hour of "laboratory" study with support from learning assistants. The course offers an avenue for more students to move directly into the study of calculus without completing precalculus.

Mathematics for life scientists

Initially developed with funding from NSF, Mathematics for Life Scientists provides an alternative to traditional calculus for life sciences majors. The course incorporates discipline-specific problem sets and examples and is supplemented with over 50 faculty-created videos. The new curriculum reduces course outcome disparities and boosts student engagement.

Source: O'Leary et al., 2021

Inclusive learning environments

The HHMI Driving Change Learning Community includes UC Davis, UCLA, UC Irvine, and more than 30 other institutions, working together to eliminate barriers to STEM inclusion. This initiative fosters the development of inclusive learning environments through collaborative efforts across research universities.

Courses

CHEM 17	Chemical principles
CHEM 14A	General chemistry for life scientists
CHEM 14AE	General chemistry for life scientists – Enhanced *NEW*
CHEM 20A(H)	Chemical structure (chemistry and engineering majors)
LIFESCI 30A	Mathematics for life scientists
MATH 1	Precalculus *REDESIGNED*
MATH 3A	Calculus for life sciences students
MATH 31A	Differential and integral calculus
MATH 31AL	Differential and integral calculus laboratory *NEW*

UC Merced

Embedded learning assistants

In a multi-year pilot, UC Merced embedded peer learning assistants in introductory STEM courses supported by an Inclusive Excellence award from the Howard Hughes Medical Institute. This collaborative initiative enhances student learning across math, chemistry, and biology.

Chemistry lab demonstrations

Through a collaboration between chemistry majors and communications majors and with funding from NSF, UC Merced students created videos of students demonstrating laboratory techniques. Students can view these in advance of the lab. This increases their familiarity with the technique, reduces anxiety about entering the lab, and models student mastery.

Chemistry tutoring center

The Chem Center is a part of the STEM Tutoring Hub. Any UC Merced student can visit the center for support provided by graduate students, trained undergraduate students, and instructors.

Calculus for science and engineering

With funding from the California Education Learning Lab, mathematics faculty at UC Merced redesigned Calculus for Science and Engineering (MATH 21). In a collaboration with CSU Fresno, faculty introduced more active learning into the course to engage students in application-focused collaborative problem solving.

External funding

At UC Merced, three major grants (NSF, California Education Learning Lab, HHMI) supported peer instruction in chemistry, math, and biology. Faculty built training infrastructure and redesigned curricula around active learning, fostering cross-departmental collaboration and a broader culture shift in STEM teaching and support.

Courses

CHEM 001	Preparatory chemistry
CHEM 002	General chemistry I
MATH 005	Preparatory calculus
MATH 008	Foundations of quantitative reasoning (alternative to calculus sequence for social sciences and humanities)
MATH 011	Calculus I (2 semester sequence)
MATH 021	Calculus I for physical sciences and engineering *REDESIGNED* (4 semester sequence)

UC Riverside

Mastery grading model for chemistry

With NSF funding, UC Riverside enhanced General Chemistry (CHEM 1) by implementing a mastery grading model that promotes deeper learning. This approach shifts the focus from high-stakes exams to a transparent, skills-based progression. Interactive software further supports students in mastering key concepts and achieving their learning goals. The approach allows students to develop and demonstrate their understanding over time and has been shown to reduce disparities across student groups.

Source: Hartman & Eichler, 2024

Math fundamentals

UC Riverside has strengthened its calculus pathway by transforming a non-credit-bearing workshop into College Mathematics Fundamentals and Problem Solving (MATH 003), now a workload credit-bearing course. Enhanced placement practices and an added laboratory hour in Introduction to College Mathematics for Business and the Social Sciences (MATH 004) ensure students receive the foundational support needed to excel in their mathematics coursework.

Precalculus corequisite course

UC Riverside's two-quarter precalculus sequence (MATH 6A-6B) builds strong mathematical foundations for calculus. The newly introduced corequisite course (MATH 6LA) offers additional support, enabling students to engage more deeply with precalculus while progressing through the curriculum with their peers.

Principles of calculus

Principles of Calculus (MATH 005) at UC Riverside uses evidence-based pedagogy to deepen students' understanding through concept mastery and spatial learning. Supported by a California Education Learning Lab grant, the course integrates micro-tutorial videos, interactive worksheets, and an open-source e-textbook, providing students with varied, engaging resources to enhance their learning experience.

Courses

CHEM 001W	Preparation for general chemistry
CHEM 001A	General chemistry *REDESIGNED*
CHEM 002A	General chemistry for chemistry majors
MATH 003	College mathematics fundamentals and problem solving (workload credit) *NEW*
MATH 004	Introduction to college mathematics for business and the social sciences *LAB HOUR ADDED*
MATH 005A	The principles of calculus 1
MATH 006A-B	Precalculus: an introduction to functions 1 & 2
MATH 06LA	Precalculus study group: an introduction to functions 1 *NEW CO-COURSE*
MATH 005B	The principles of calculus 2
MATH 007A	Calculus for life sciences
MATH 009A	First-year calculus
MATH 022	Calculus for business

UC San Diego

Cohort learning in physical sciences

UC San Diego's School of Physical Sciences Cohort Program fosters a supportive STEM community. Students take chemistry, math, and physics together while engaging in research and peer mentoring throughout their first two years, strengthening their academic foundation and connections.

Preparatory chemistry

Chemical Thinking (CHEM 4) is a one-quarter course designed to prepare students for General Chemistry. The course has no prerequisites, though students are encouraged to co-enroll in either precalculus or calculus, enabling them to progress to General Chemistry sooner while mastering critical math concepts.

Individualized learning

Introduction to College Math (Math 2) at UC San Diego offers support for students building a foundation in math before entering precalculus. The course uses pass/fail grading, adaptive software, and individualized learning plans, with additional support from the ASC@Math learning center.

Pathways to Calculus

Foundations of Precalculus (MATH 3B) is a new course designed to give more students an entry point to the calculus sequence. Introducing functions and their properties, the course prepares students to either continue to precalculus or enter calculus directly.

Math testing and placement

UC San Diego's Math Testing and Placement (MTP) program helps place students in appropriate math courses based on multiple factors, such as high school experience, AP scores, and diagnostic assessments. UC San Diego is one of several UC campuses that uses an assessment developed by the CSU/UC Mathematics Diagnostic Testing Project (MDTP).

Courses

CHEM 04	Chemical thinking *NEW*
CHEM 06A(H)	General chemistry I Honors general chemistry I
MATH 2	Introduction to college mathematics (workload credit)
MATH 3B	Foundations of precalculus *NEW*
MATH 3C	Precalculus
MATH 4C	Precalculus for science and engineering
MATH 10A	Calculus I
MATH 20A	Calculus for science and engineering

UC Santa Barbara

Chemistry curriculum

UC Santa Barbara introduced a new general chemistry course for chemistry and chemical sciences majors (CHEM 3A) and has redesigned its Introductory Chemistry course (CHEM 25) to better serve students who would benefit from a review of chemistry fundamentals. Students can self-place using an online assessment tool to determine their readiness for the course.

Calculus with algebra and trigonometry

UC Santa Barbara does not offer precalculus, offering instead an enhanced calculus course that integrates algebra and trigonometry concepts (MATH 2A). This approach helps students progress through the calculus sequence more quickly. Many engineering students benefit from the pathway, and the engineering department has supported the course with instructional assistants.

Support for STEM faculty

The Center for Innovative Teaching, Research, and Learning at UC Santa Barbara promotes evidence-based pedagogy and supports faculty development. The Center collaborates with faculty to redesign courses and improve student retention, including efforts to assess the impact of recent curriculum changes in chemistry.

Learning Assistants

UC Santa Barbara leverages Undergraduate Learning Assistants (ULAs) and Undergraduate Peer Mentors (UPMs) in introductory STEM courses in two ways: to help facilitate active learning during course sections, and to hold supplementary "student hours" outside of class.

MAXimizing Students' Potential

UCSB's MAX Program supports incoming students with a summer STEM prep course and continued peer support from undergraduate learning assistants. Early participants earned higher chemistry grades than matched peers.

Source: UCSB internal analysis

Data tools

A comprehensive data project at UC Santa Barbara tracks course pass rates and student persistence. This data-driven approach has informed curricular reforms, enhancing student success and shaping future course development. The chemistry department was an early partner in the development of the tools.

Courses

CHEM 25	Introductory chemistry *REDESIGNED*
CHEM 1A	General chemistry
CHEM 3A	General chemistry for chemistry and chemical engineering majors *NEW*
MATH 2A	Calculus with algebra and trigonometry
MATH 3A	Calculus with applications, first course
MATH 34A	Calculus for social and life sciences

UC Santa Cruz

Active learning

UC Santa Cruz began improving STEM courses with active learning strategies, using HHMI grant funding more than a decade ago. Post-docs redesigned introductory courses, incorporating evidence-based pedagogies. This early start gave the campus an advantage in restructuring curricula ahead of pandemic disruptions.

Embedded learning advisors

UC Santa Cruz's Academic Excellence Program (ACE) embeds professional learning advisers in introductory math and chemistry courses. Career professionals with disciplinary expertise, advisers collaborate with student employees to enhance student engagement and problem-solving.

Chemistry learning alignment

UC Santa Cruz's chemistry department overhauled its curriculum to improve alignment between math and chemistry courses. With the appointment of a professor of teaching to oversee the process, the department reduced reliance on math prerequisites and improved integration of lecture and lab content.

Online Calculus

UCSC's fully online calculus sequence, which begins with MATH 19A and continues through 19B and 23A/B, is articulated for major credit across all nine UC undergraduate campuses—the first such systemwide articulation for a full STEM gateway series.

Equity-focused redesign in math

Designated a Hispanic Serving Institution (HSI) in 2014, UC Santa Cruz has secured multiple federal grants to improve courses, curricula, and co-curricular supports that promote student-centered learning. The math department used HSI grant funding to redesign three courses in its calculus pathway.

External funding

UC Santa Cruz used HSI grants to redesign entry-level math, building on earlier HHMI-funded work in the sciences. In addition to course redesigns, efforts included project-based learning, cross-disciplinary curricula, and teaching teams that partnered with advising to support students through proactive outreach and collaboration.

Courses

CHEM 3A	General chemistry *NEW*
MATH 2	College algebra for calculus *REDESIGNED*
MATH 3	Precalculus *REDESIGNED*
MATH 11A	Calculus with applications *REDESIGNED*
MATH 16A	Mathematics for life and environmental sciences *NEW*
MATH 19A	Calculus for science, engineering, and mathematics (online and in-person)

Appendix 2. Course summary

Chemistry courses

	Preparatory	General chemistry			
		Default	Chemistry/chemical engineering majors	Physical sciences	Life sciences
Berkeley	CHEM 32	CHEM 1A	CHEM 4A CHEM 49		
Davis	CHE 001/001V [2]	CHE 002A		CHE 004A	
Irvine		CHEM 1A CHEM 1X			
Los Angeles	CHEM 17	CHEM 20A(H)			CHEM 14A CHEM 14AE
Merced	CHEM 001	CHEM 002			
Riverside	CHEM 001W	CHEM 001A	CHEM 002A		
San Diego	CHEM 04	CHEM 06A(H)			
Santa Barbara	CHEM 25	CHEM 1A	CHEM 3A		
Santa Cruz		CHEM 3A			

[2] CHE 1 is in-person; CHE 1V is the remote version of the class.

Math courses

	Preparatory	Precalculus	Calculus			
			Default	Business / social sciences	Physical sciences	Life sciences
Berkeley		MATH 3	MATH 1 MATH 51 [3] MATH 98	MATH 16A		MATH 10A
Davis	MAT 000B* MAT 000C* MAT 000D*	MAT 012	MAT 021A	MAT 019A		MAT 017A
Irvine		MATH 1A*	MATH 2A			
Los Angeles		MATH 1	MATH 31A MATH 31AL			MATH 3A LIFE SCI 30A**
Merced		MATH 005 MATH 008	MATH 011		MATH 021	
Riverside	MATH 003*	MATH 004 MATH 005A MATH 006A-B MATH 06LA	MATH 005B MATH 009A	MATH 022		MATH 007A
San Diego	MATH 2* MATH 3B	MATH 3C MATH 4C	MATH 10A		MATH 20A	
Santa Barbara			MATH 2A MATH 3A			MATH 34A
Santa Cruz		MATH 2 MATH 3	MATH 11A		MATH 19A [4]	MATH 16A

* workload credit
** contains calculus plus other topics relevant to life sciences

---

[3] Effective Fall 2025, the UC Berkeley Department of Mathematics adopted new course numbering: Math 32 was renumbered Math 3; Math 1A was renumbered Math 51.

[4] UC Santa Cruz's MATH 19A is available systemwide via cross-campus enrollment through UC Online. It is articulated for major credit at all nine undergraduate-serving campuses. Equivalents include: Davis MAT 021A, Irvine MATH 2A, Merced MATH 021, Riverside MATH 009A, San Diego MATH 20A, and Santa Barbara MATH 3A. At Berkeley, both MATH 19A and 19B are required for MATH 1/51 credit.

Appendix 3. Grant support

Association of American Universities (AAU) STEM Education Grants (2013–2017)

The Association of American Universities (AAU) supported UC campuses through a national initiative to strengthen undergraduate STEM instruction. In 2013 UC Davis served as one of eight flagship sites, with a project that focused on building a data-informed culture of teaching improvement and developing new analytics tools and visualizations to support instructional decision-making. These tools were used to inform curricular changes in introductory biology, chemistry, and math.

In 2017, UC Irvine and UCLA each received AAU STEM Network mini-grants. UCI's efforts focused on training graduate student instructors and learning assistants, building faculty learning communities, and applying analytics to improve outcomes. UCLA used its funding to convene cross-departmental workshops on inclusive pedagogy, curricular alignment, and student support structures that support student retention in STEM disciplines.

Together, these early grants laid foundational groundwork for broader changes across the UC system.

AAU STEM Education Grants

2017—UC Irvine
AAU STEM Network Mini-grant
Graduate instructor training, learning analytics, and faculty learning communities

2017—UCLA
AAU STEM Network Mini-grant
Cross-department workshops on inclusive pedagogy, advising, and curriculum coordination

2013—UC Davis
AAU STEM Project Site
Data infrastructure, evidence-based pedagogical innovation in STEM

Learn more about the AAU Undergraduate STEM Education Initiative. Explore project sites and review a five-year status report at aau.edu.

California Education Learning Lab Grants (2019–2024)

Since 2019, UC faculty have received support from the California Education Learning Lab (Learning Lab) to redesign entry-level STEM courses with a focus on improving outcomes and closing equity gaps. Through this state-funded initiative, UC projects have tackled persistent barriers in high-enrollment courses like calculus, chemistry, and engineering—often through cross-segment collaboration and shared course infrastructure. Many efforts have focused on redesigning learning environments to center student engagement, career relevance, and access to high-quality, low-cost materials.

One major area of innovation has been the transformation of introductory calculus. Projects across UC Davis, UC Irvine, UC Merced, UC Riverside, and UC Santa Cruz explored how to make calculus more inclusive and meaningful—especially for students pursuing degrees in engineering, biology, or the social sciences. These efforts emphasized conceptual understanding, active learning, and applications grounded in real-world data. Others focused on reducing structural barriers, such as device access, or reimagining course pacing and structure to support student persistence and confidence. At several campuses, faculty training, community-building, and inclusive pedagogy were central design principles from the start.

UC teams also led work in chemistry, engineering, and adaptive learning infrastructure. Some projects created hybrid general chemistry courses that combined active learning with adaptive courseware and analytics, while others investigated how simulations and feedback strategies shape student understanding in online environments. Engineering-focused efforts redesigned multiple entry-level courses to strengthen students' sense of identity and connection to the field, using collaborative learning, adaptive practice, and real-world context. Still others developed open-source platforms and curricular packages that lower costs while expanding access to personalized, just-in-time support. Together, these projects demonstrate how targeted public investment can catalyze both innovation and equity at scale.

UC-Led California Education Learning Lab Projects

2023–24 AI Grand Challenge

—Mission College, San José State, UC Berkeley
OATutor: Personalized, Open-Access STEM Tutoring
AI-powered, mastery-based tutoring system

2021–22 Seeding Strategies I

—UC Davis
Calculus for Data-Driven Applications
Contextualized calculus for social science majors

—UC Santa Cruz
Improving Calculus Learning Outcomes for Student Success in Engineering
Embedded learning support in engineering calculus

—CSU Monterey Bay, UC Santa Cruz, UCOP
C3: Convene, Connect, Collaborate
Community-building to support success in calculus

2020–21 Calculus Grand Challenge

—Bakersfield College, CSU Sacramento, UC Riverside
Access for Equity
Mobile-first, open-access online calculus course

—CSU Fresno, CSU Fullerton, UC Irvine
BioCalculus: Preparation, Engagement, Application
Inclusive bio-calculus pathway with prep, curriculum, and upper-division integration

—Saddleback College, UC Riverside, Yuba College
A New Mathematics Gateway
Principles-based precalculus and calculus

—UC Merced, CSU Fresno
Why, What, and How Calculus
Culturally responsive, concept-focused pedagogy

2019–20 Innovation

—Mt. San Antonio College, Shasta College, UC Davis, Cal State LA
AHA! Chemistry
Adaptive, hybrid general chemistry across segments

—UC Riverside
Supporting Student Learning from Simulations
Formative assessment in online chemistry environments

—UC Riverside, UC San Diego
Enhancing Student Success
Introductory engineering redesign with adaptive tools and identity development

Full project descriptions available at calearninglab.org

Howard Hughes Medical Institute (HHMI) Inclusive Excellence Grants (2014–2025)

The Howard Hughes Medical Institute (HHMI) awarded Inclusive Excellence grants to select UC campuses as part of a national effort to improve undergraduate biology education and advance systemic instructional change. While focused primarily on biology, this work often extended into chemistry and other foundational STEM courses—reflecting the interconnected nature of early STEM learning and broader shifts in teaching practice.

Three UC campuses—UC Merced, UC Santa Cruz, and UCLA—received Inclusive Excellence awards supporting curricular redesign, faculty development, and more inclusive STEM learning environments. UC Santa Cruz received grants in 2014 and 2022; UC Merced in 2018; and UCLA was one of six institutions nationally to receive a $2.5 million Driving Change award in 2023. In addition, UCLA, UC Davis, and UC Irvine participated in the Driving Change Learning Community, receiving $50,000 planning grants to support institutional capacity-building.

UC has also benefited from other HHMI initiatives—including the Gilliam Fellows, Freeman Hrabowski Scholars, and HHMI Investigators programs—which support inclusive excellence in research, teaching, and graduate training across the system.

The HHMI Inclusive Excellence program concluded in 2025, midway through its third national grant cycle, but the work it enabled at UC continues—woven into broader instructional reform efforts across disciplines.

HHMI Driving Change

2023—UCLA
HHMI Driving Change Award
Campuswide initiative to advance inclusive STEM instruction and institutional transformation
UCLA Newsroom, 2023

2021—UCLA, UC Davis, UC Irvine
HHMI Driving Change Learning Community
Planning grants to support institutional collaboration and capacity-building in inclusive STEM education
hhmi.org/programs/driving-change

HHMI Inclusive Excellence

2022—UC Santa Cruz
HHMI Inclusive Excellence 3 (IE3) Learning Community
Field-based biology course design and curriculum alignment
UC Santa Cruz News, 2022

2018—UC Merced
HHMI Inclusive Excellence Initiative
Inclusive biology curriculum redesign, faculty development, and learning communities
UC Merced News, 2018

2014—UC Santa Cruz
HHMI Science Education Award
Active learning reforms in introductory biology, chemistry, and physics
UC Santa Cruz News, 2014

U.S. Department of Education Developing Hispanic-Serving Institutions (DHSI) (2011–2023)

UC Santa Cruz has used a series of Title V grants from the U.S. Department of Education to redesign its undergraduate math sequence with a focus on access, persistence, and long-term student success. These efforts have centered on foundational courses that often shape students' STEM trajectories.

The MAPA grant (Maximizing Achievement through Preparedness and Advising) supported a redesigned version of Math 2, College Algebra for Calculus, pairing small-group instruction with integrated academic and advising support. The SEMILLA initiative extended this work into Math 3 (precalculus), incorporating culturally responsive pedagogy, early alert systems, and intensive academic support. Most recently, the GANAS Career Pathways grant focused on Math 11A/B, Calculus with Applications, redesigning the curriculum and layering in peer-led supplemental instruction and applied career pathways.

These math reforms are part of a larger institutional strategy to improve outcomes in gateway STEM courses. While the UCSC grants represent only a portion of the Title V and Title III support received across the UC system, they illustrate the deep and sustained role these programs have played in enabling course transformation and equity-focused instructional redesign.

Developing Hispanic-Serving Institutions (DHSI)

UC Santa Cruz

2020—*GANAS Career Pathways*
Curriculum redesign and supplemental instruction in Math 11A/B (calculus with applications)

2016—*Science Education & Mentorship in Latino Lives in Academia (SEMILLA)*
Pedagogical reform and student support in Math 3 (precalculus)

2015—*Maximizing Achievement through Preparedness and Advising (MAPA)*
Redesign of Math 2 (college algebra for calculus) with embedded advising and academic support

To learn more about UCSC's HSI initiatives, visit hsi.ucsc.edu/grants.

For an overview of HSI-related grant funding across UC, see the 2022 report to the UC Regents.

National Science Foundation Grants Supporting Intro STEM Reform

The National Science Foundation (NSF) is a major funder of UC STEM research—and a critical partner in enhancing undergraduate instruction. While UC receives substantial NSF support across many disciplines, several targeted programs have specifically advanced the system's goals around gateway course redesign, equity in instruction, and capacity-building in high-enrollment STEM sequences.

Through the Improving Undergraduate STEM Education (IUSE) and HSI Program tracks, UC campuses have piloted curricular redesigns, professional learning communities, and data-informed approaches to improving outcomes in chemistry, math, and related fields. UC Riverside and UC Merced have led projects focused on general chemistry and peer-led active learning. UCLA used S-STEM funding to implement and evaluate student-centered pedagogy in gateway courses. UC Davis, UC Irvine, and UC Santa Barbara have participated in a national STEM Equity Learning Community, part of the SEISMIC collaboration, supported by NSF grants to UC Davis and to the University of Michigan, Ann Arbor, to embed equity practices in institutional structures and STEM teaching culture.

These grants illustrate how federal investments in instructional reform can amplify UC's systemwide efforts to make introductory STEM more inclusive, effective, and equitable.

National Science Foundation – STEM Education Grants

HSI Program: Improving Undergraduate STEM Education

2024—UC Riverside
Growth mindset and assessment reform in General Chemistry (Grant No. 2421279)

2023—UC Merced
Green chemistry and peer-led learning in undergrad curriculum (Grant No. 1832538)

IUSE: Improving Undergraduate STEM Education: Directorate for STEM Education

2022–2024—UC Davis, UC Irvine, UC Santa Barbara*
STEM Equity Learning Communities (SEISMIC) Collaborative work on inclusive instructional practices (Grant No. 2215689 and 2215398 via University of Michigan)

S-STEM: Scholarships in Science, Technology, Engineering, and Mathematics Program

2014—UCLA
Student-centered pedagogy and teaching culture in STEM (Grant No. 1432804)

Grants listed above represent targeted NSF investments in UC's introductory STEM reform. UC receives over $25M annually in NSF education funding systemwide.

Source: UC Information Center

* UC Davis, UC Irvine, and UC Santa Barbara are all members of the Sloan Equity and Inclusion in STEM Introductory Courses (SEISMIC) STEM Equity Learning Community (SELC), which has been funded by two NSF grants.

UC Online

The Innovative Learning Technology Initiative (ILTI), launched in 2012–13 with support from the UC Office of the President, invested in the development of high-quality online courses that could be shared across campuses. Between 2013 and 2023, the initiative—now operating as UC Online—provided over $50 million in systemwide funding to support course design, instructional infrastructure, and cross-campus coordination. UC Online remains a foundational piece of UC's shared infrastructure for high-quality online education and student mobility.

One early outcome was the creation of UC Santa Cruz's fully online calculus sequence, now articulated for major credit at all nine undergraduate-serving UC campuses. The course is available systemwide and serves as a rare example of a STEM gateway series built to scale. UC Online also developed the Cross-Campus Enrollment System (CCES), which enabled growth in cross-campus online enrollment from under 100 students to nearly 4,800 by 2023–24.

uconline.edu

UC Online / ILTI – STEM course development

2012–13—UC Santa Cruz
MATH 19A/B Calculus for Science, Engineering, and Mathematics

2013–14—UC Riverside
MATH 23A Vector Calculus & MATH 23B Calculus IV

Grants listed above reflect early investments in online STEM gateway courses. For additional course listings, see the January 2024 UC Regents update on UC Online.

Appendix 4. Collaboratives

UC collaboratives

UC Teaching and Learning Centers

The UC Teaching and Learning Centers support instructors with research-based teaching practices, professional development, and innovative strategies to enhance student success.

UC STEM Faculty Learning Community

The UC STEM Faculty Learning Community, active 2016 to 2019, was formed to advance science teaching by sharing best practices, fostering collaboration, and supporting intercampus exchanges across UC campuses. The Community hosted annual meetings 2016 to 2019. Four HHMI-funded UC campuses sponsored the initiative: UC Berkeley, UC Riverside, UC Santa Barbara, and UC Santa Cruz.

UC Teaching Professor Network

The UC Tenure Track Teaching Professor Network (T3PN) supports UC professors of teaching through collaboration, mentorship, advocacy, and professional development in teaching, curriculum, and pedagogy. The network has hosted an annual meeting since 2022.

State and national collaboratives

AAU STEM Initiative

The AAU Undergraduate STEM Education Initiative promotes evidence-based, student-centered teaching to transform STEM department cultures and encourage active learning at AAU universities. UC Davis was a seed-funded project site selected to implement the initiative framework. All AAU institutions, including UC campuses, are members of the STEM Network.

CIRTL Network

The national CIRTL Network supports future faculty in developing evidence-based, inclusive teaching practices. UCLA is UC's only member campus and hosts CIRTL@UCLA, a local program that offers the CIRTL Certification Program, open to graduate students, postdocs, and early career faculty across all discipline

CSU/UC Mathematics Diagnostic Testing Project (MDTP)

MDTP provides free, Common Core-aligned diagnostic math assessments to California schools and supports UC campuses to enhance student readiness and curriculum improvement. Four UC campuses (UC Berkeley, UC Merced, UC Santa Barbara, and UC San Diego) use MDTP-developed instruments for mathematics placement.

HHMI Driving Change Learning Community

The HHMI Driving Change Learning Community brings together 38 institutions—including UC Davis, UC Irvine, and UCLA—to explore strategies for institutional change in STEM education.

Appendix 5. Shareable resources

Course materials

Calculus activities and quizzes	Why, What, How Calculus course materials emphasize conceptual understanding, problem-solving, active learning, collaboration, real-world applications, and culturally responsive instruction to enhance student success and STEM identity.	UC Merced, CSU Fresno
Calculus e-book	*Precalculus: An Investigation of Functions* *(2nd Ed)* is a free, open-access textbook covering functions and trigonometry with a focus on modeling, interpretation, and conceptual understanding, supported by extensive online and teaching resources.	UCLA
Calculus e-book	*Principles of Calculus* reimagines calculus instruction by teaching core mathematical concepts through guiding principles and spatial reasoning, aiming to deepen understanding and boost student engagement and retention.	UC Riverside, Saddleback College, and Yuba College
Calculus worksheets	Math 1A and Math 1B worksheet booklets support collaborative learning through qualitative and quantitative problems, aiming to build students' communication, group work, and problem-solving skills essential for STEM careers.	UC Berkeley
Chemistry simulations	Chemistry simulations hosted on PhET Interactive offer free, research-based math and science simulations that promote exploration and discovery, supported by teaching tips, community activities, and educator-submitted lessons.	UC Riverside, CSU Northridge

Online courses

Calculus mobile course shell	Mobile Access for Equity Calculus 1 is a free, mobile-first online course shell for introductory calculus, available on Canvas Commons. Designed to promote equity in access, the course features active learning strategies, faculty support materials, and open educational resources (OER). It has been piloted across multiple California colleges.	Bakersfield College, CSU Sacramento, UC Riverside
Chemistry curriculum	The OpenChem initiative offers free, reusable chemistry course materials covering an entire curriculum, supporting both self-learners and educators, with searchable video content, textbook links, and optional homework and lab guidance.	UC Irvine
UC Online course	Calculus for Science, Engineering, and Mathematics (Math 19A/Calculus 1) is a flexible, self-paced online course focused on differential calculus—covering limits, derivatives, and applications—supported by interactive tools, peer forums, and instructor-led discussions for STEM learners.	UC Santa Cruz

Videos

Calculus tutorials	Microtutorials in Mathematics provides free, supplemental online materials to help students overcome challenges in calculus, with videos and follow-up questions designed to support instructors and enable flipped classrooms.	UC Riverside
Calculus YouTube playlist	The Mobile Access for Student Equity student video series covers key calculus concepts like derivatives, optimization, and limits, offering creative, engaging explanations and alternative methods to support student understanding. Professional development videos in the series provide tips on mobile-friendly course design, using student feedback effectively, creating engaging welcome videos, and supporting student success with resources and meaningful feedback.	Bakersfield College, CSU Sacramento, UC Riverside
Chemistry lab demonstrations	UC Merced students created short videos demonstrating chemistry lab techniques, supported by NSF funding. The videos feature students—not faculty—modeling core procedures to help peers prepare for lab sessions and reduce anxiety through relatable, peer-led instruction.	UC Merced
Modeling calculus concepts in biology	The Modeling in Biology GitHub hosts online videos that explore calculus concepts through life science applications. The site is designed to support the textbook *Modeling Life: The Mathematics of Biological Systems*, authored by UCLA faculty. The videos are free to use and available to students and instructors alike.	UCLA

Other

Chemistry survey Instrument	The Attitude toward the Subject of Chemistry Inventory (ASCI) measures students' cognitive and affective attitudes toward chemistry, assessing their thoughts and feelings about the subject to gauge overall engagement.	UC Merced