

# Mathematical Reasoning with Connections

**Mathematical Reasoning with Connections (MRWC)** was developed by a group of faculty members from Cal Poly Pomona, California State University (CSU) Long Beach, and CSU San Bernardino. The MRWC curriculum is designed to reinforce topics and skills developed in the Integrated Math or Algebra/Geometry sequences but reorganizes the traditional pathway of topics to facilitate deep conceptual understanding. Course developers see this as a course that can work for students regardless of whether they plan to enter a STEM or non-STEM field in college. Students explore multiple representations and underlying structures to connect concepts in algebra, geometry, functions, and trigonometry. The curriculum is organized around three broad themes.

## Who Enrolls in MRWC?

The MRWC course has a fairly large footprint in the schools in which it is offered, serving almost 15% of all seniors in those high schools. The students enrolled in MRWC are representative of seniors in the schools offering the course.

## Topics of Study

### Reasoning with Numbers

- Integers
- Rational Numbers
- Irrational Numbers
- Real Numbers
- Complex Numbers

### Reasoning with Functions

- Relationships
- Features of Functions
- Representations of Functions
- Families of Functions
- Applications of Functions

### Reasoning with Equivalencies

- Structural Equivalencies
- Expressions
- Statements
- Equivalencies in other contexts



**2,756**

12th graders enrolled in MRWC in 2018–19 (by 2019–20, nearly 10,000 students in 26 districts were enrolled)



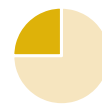
**67%**

of enrollees identified as Latinx (compared to 62% of seniors in the cohort)



**64%**

of enrollees were designated as socioeconomically disadvantaged (compared to 62% of seniors in the cohort)



**25%**

of 12th graders enrolled in MRWC *Met or Exceeded Standards* on math SBAC (compared to 30% of seniors in the cohort)



**86%**

of 12th graders enrolled in MRWC took Algebra 2/ Integrated Math III the previous year

To better understand who the students are who enroll in MRWC, it is helpful to understand the distribution of 12th graders across the different math courses. The figures that follow provide information on characteristics of twelfth grade math enrollment for all students in schools offering MRWC.

**Table 1. 12th Grade Math Enrollment in Schools Offering MRWC**

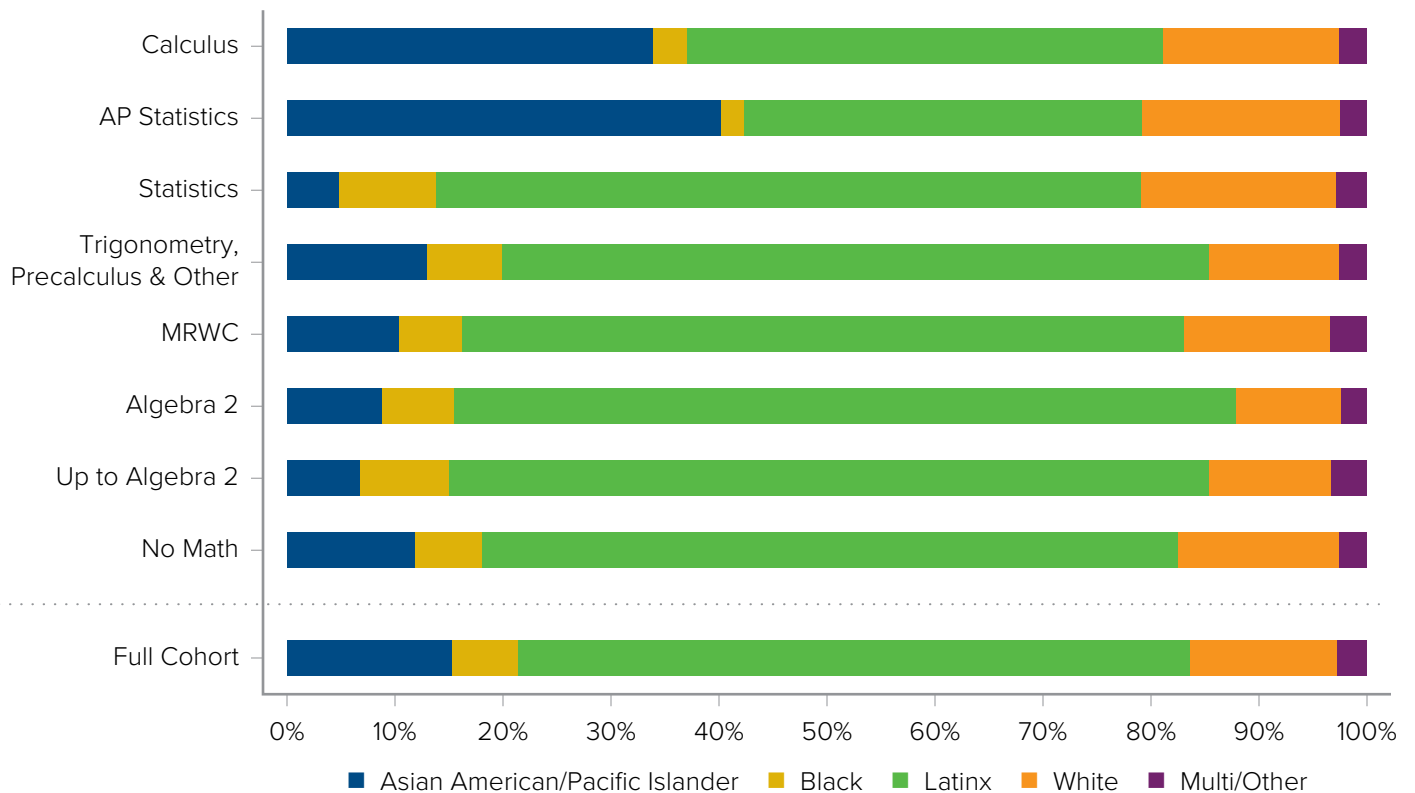
| Math Course Category              | Percent of 12th Graders Enrolled |               |
|-----------------------------------|----------------------------------|---------------|
|                                   | 2017–18                          | 2018–19       |
| Advanced Math Courses             |                                  |               |
| Calculus                          | 13                               | 10            |
| AP Statistics                     | 9                                | 9             |
| Statistics                        | 4                                | 4             |
| Trigonometry, Precalculus & Other | 19                               | 24            |
| <b>MRWC</b>                       | <b>10.3</b>                      | <b>15</b>     |
| Algebra 2                         | 13                               | 12            |
| Up to Algebra 2                   | 11                               | 12            |
| No Math                           | 26                               | 20            |
| <b>Total 12th Graders</b>         | <b>11,077</b>                    | <b>18,996</b> |

**DATA**

Statistics calculated from student-level and course-level data in the California Longitudinal Pupil Achievement Data System (CALPADS). Figures 1 through 3 include 12th graders in the 2018–19 academic year derived from participation in the 11th grade Smarter Balanced Assessments (SBAC) in 2017–18. Statistics may vary from other reports due to sample differences and data limitations.

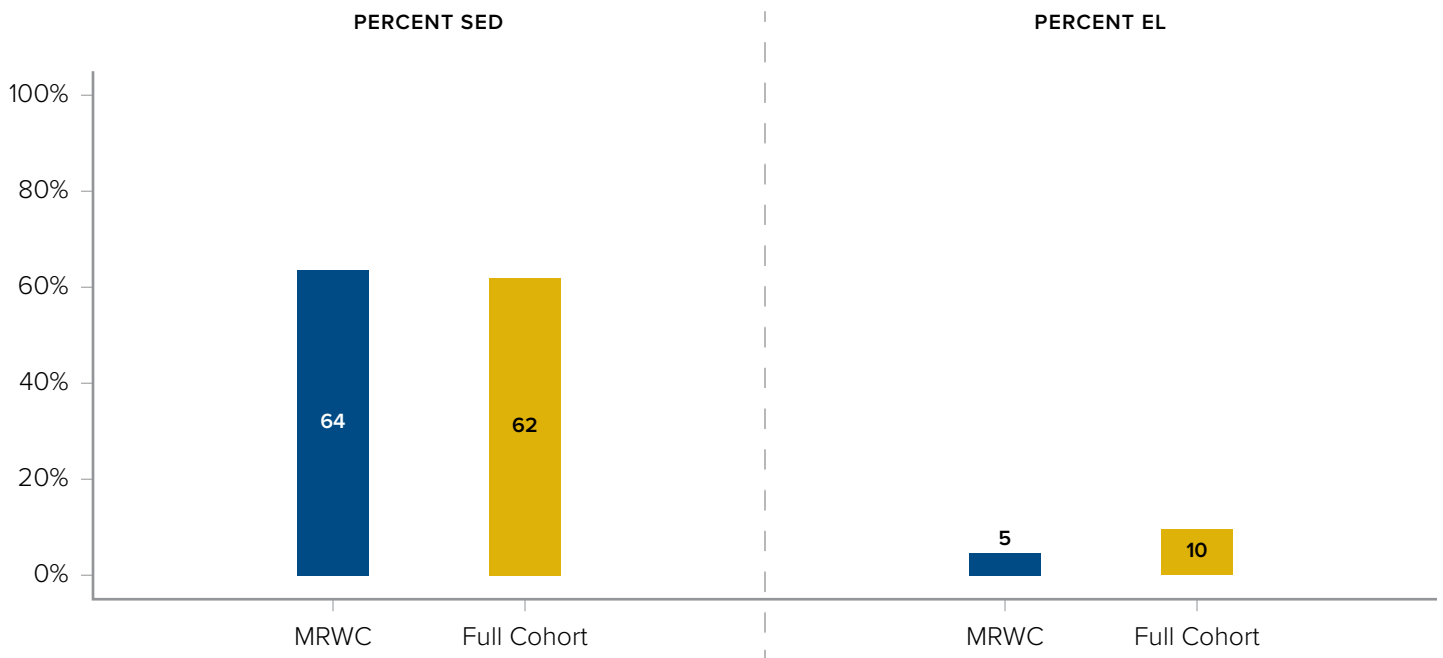
Note: Percentages do not add to 100% because some students enroll in more than one math course.

**Figure 1. Racial/Ethnic Composition of 12th Grade Math Courses in Schools Offering MRWC**



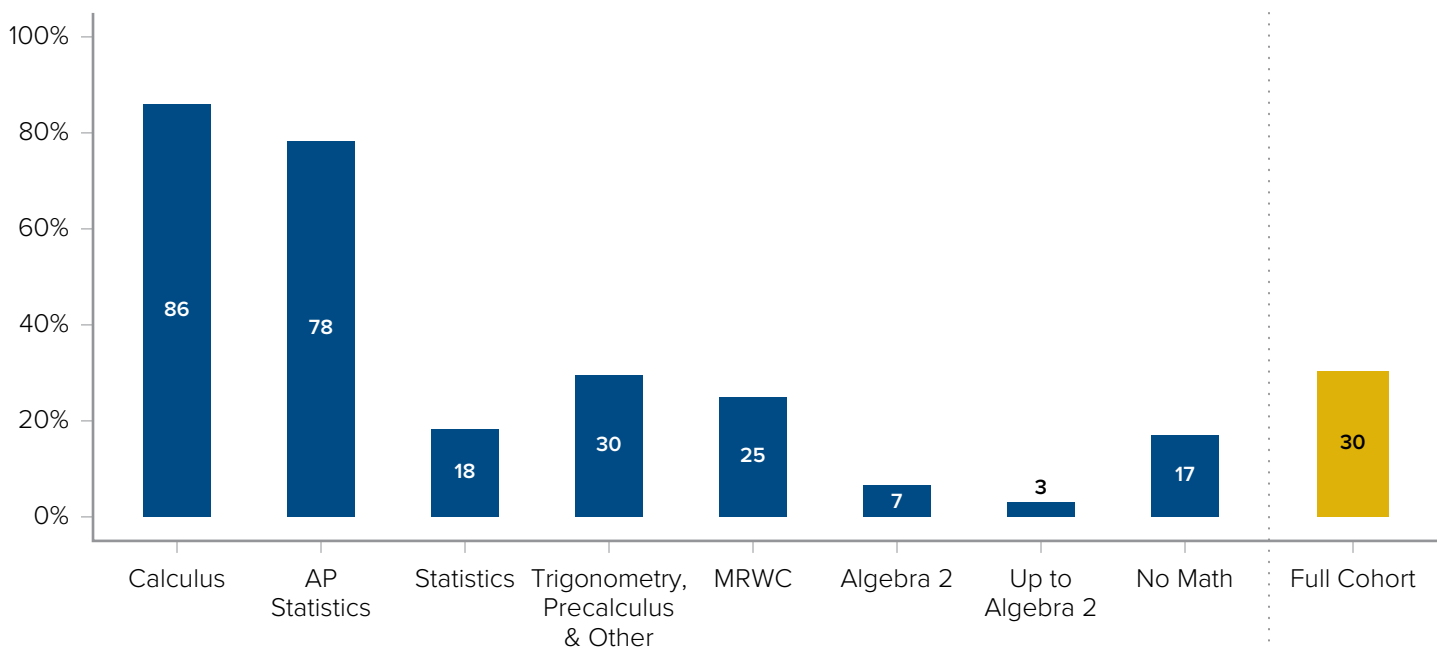
Note: Multi/Other includes students of Native American ancestry, students who identify with multiple racial/ethnic groups, and those for whom race/ethnicity information is missing.

**Figure 2. Percent of SED and EL Students in 12th Grade MRWC Courses Compared to Full Cohort in Schools Offering MRWC**



Notes: SED = Socioeconomically disadvantaged. EL = English Learner. SED status is defined by the California Department of Education as students who either qualify for the free or reduced-price school lunch program or do not have a parent who graduated from high school. For our analysis, we use the student-level SED and EL identifiers in the 11th grade SBAC data.

**Figure 3. Percent of Students Meeting or Exceeding 11th Grade Standards on SBAC Math by 12th Grade Math Courses Enrollment in Schools Offering MRWC**



Note: Students included in this figure achieved *Met Standard* (level 3) or *Exceeded Standard* (level 4) on the 11th grade math SBAC and were enrolled in high school courses the following year.

## What Do Teachers Say about MRWC?

Teachers interviewed as part of this broader study were positive about the MRWC course and see an important role for courses like this in the high school curriculum. Several teachers noted that they see this as an alternative to pre-calculus, and that the course integrates what students have already learned in mathematics much better than other courses:

“

**In a perfect world, I would say we don't need a pre-calculus course anymore... Because I think the concepts that you learn in MRWC really connect all you've done in Integrated 1, 2 and 3, or Algebra 1, 2 [much] more so than any other class.**

(MRWC Teacher)

”

In addition to the integration of concepts, MRWC teachers noted that the different pedagogical approach, allowing students to share their thinking and focus not necessarily on getting the right answer but rather how and why to approach a problem, helps to build confidence and interest in students that they have not previously experienced:

“

**I think the beauty about MRWC is it gives them this math confidence that they didn't have, and I'm a believer that if you have the confidence sometimes you can solve things and do things that you weren't able to do before.**

(MRWC Teacher)

”

“

**A lot of [the students] said that they never knew math could be this interesting or they never thought of themselves as a math person – at the beginning they were reluctant to share their thinking because they didn't want to be wrong, but lot of the class focus is not just on right and wrong but also, how did you approach the problem [or] connect it to a previous problem?**

(MRWC Teacher)

”

For more information on teachers' experiences with MRWC, see our [full report on teacher perspectives](#).

## What Is the Impact of MRWC for Students?

### Analysis of MRWC and similar courses reveals a consistent positive story for students enrolled in advanced innovation math (AIM) curricula.

Leveraging high school course-taking data along with a rich set of student- and school-level characteristics linked to postsecondary enrollment data allowed for a causal analysis of the impact of enrollment in six AIM courses on key high school and postsecondary outcomes, including grades in 12th grade math courses, UC/CSU eligibility (completion of A–G course requirements), and college enrollment. Methods included advanced matching techniques to compare students enrolling in an AIM course to those who enroll in other (or no) math courses, controlling for a variety of factors that likely influence both math course placement and our outcomes of interest (e.g., prior student achievement in math as measured by test scores, previous math courses, demographic characteristics). Analyses for each AIM course were conducted respectively, and cannot be directly compared given unique course content, schooling environment, and the number of students and schools served. However, all courses demonstrate a positive impact for various postsecondary outcomes.

Results of these analyses indicate that AIM courses provide an additional math pathway that supports students' readiness for and, in some cases, increases in college enrollment. Specifically, AIM courses increase the likelihood that a student will meet the course requirements for UC/CSU eligibility by 3 to 10 percentage points. In some cases, AIM course enrollment improves grades in 12th grade math courses and increases the likelihood of college enrollment. Even when strong evidence of a positive impact on grades is absent, results are still promising. In fact, we may expect that rigorous curricula can engage and challenge students, which could result in a shift in grades, while increasing college preparation. Nevertheless, we are cautious about interpreting changes in grades given the many factors (i.e., teachers, peers, homework time, motivation) that influence grades and the observed effects of the AIM courses are small in magnitude. Moreover, there is limited potential for 12th grade math course performance to change college enrollment trajectories given fall due dates of four-year college applications.

### Overall, early evidence of MRWC and similar courses is clearly promising: AIM courses contribute positively to student outcomes, offering students alternatives to traditional calculus pathways and increasing four-year college eligibility.

For more information on the development and implementation of MRWC and the other AIM courses, see our [full report](#).

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#### AUTHORS AND ACKNOWLEDGEMENTS

Information sheet prepared by Sherrie Reed, Kathy Bracco, Cassandra Merritt, and Michal Kurlaender as part of a broader project examining college and career readiness course-taking patterns in California public high schools.

Research was supported by the College Futures Foundation, through grants to Education Insights Center (EdInsights) at Sacramento State University and the California Education Lab at the University of California Davis, and by the Institute of Education Sciences, U.S. Department of Education, through Grant R305E150006 to the Regents of the University of California. Statistics calculated from data available to the research team through a research partnership and data sharing agreement with the California Department of Education (Michal Kurlaender, PI). The authors are grateful to colleagues from EdInsights for their engagement with the advanced innovative math course partnership leaders and their support of the research, and to Maureen Carew, Andrea Venezia, and Pamela Burdman for their expertise, advisement and review of research protocols and products.

For more information on these courses or the statistics included in this report, contact Sherrie Reed at [sreed@ucdavis.edu](mailto:sreed@ucdavis.edu).