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# Reforming Math Pathways at California's Community Colleges

## Technical Appendices

CONTENTS



Marisol Cuellar Mejia, Bonnie Brooks, Olga Rodriguez, Hans Johnson

Supported with funding from the Bill and Melinda Gates Foundation, the College Futures Foundation, and the Sutton Family Fund

# Appendix A. Data and Methods

## Data

Our analysis utilizes both quantitative and qualitative data to evaluate the overall effect of statistics pathways and compressed math pathways on various indicators of student success. Our quantitative approach utilizes student-level longitudinal data from the California Community College Chancellor's Office Management Information System (COMIS). Students in the dataset are enrolled across the 113 community colleges that comprise the California Community College system, and includes information on student demographics, course-taking behavior, course elements (e.g. title of course, basic skills status, minimum/maximum number of credits, etc.), and student outcomes (grades, credits earned, etc.). Table 1 lists the variables from the COMIS data that we use in our analyses.

Data was also collected from official college documents, such as college websites and course catalogs. We collected information on developmental math courses and levels offered; assessment and placement policies that determine course placement; curriculum descriptions; prerequisites; and credit status of courses (degree/non-degree applicability).

To inform our quantitative results, we collected information from interviews with faculty and staff from California community colleges. We selected interviewees from colleges that (1) demonstrated student throughput to be significantly better than the traditional math pathway and (2) were representative of each alternative math pathway we studied: statistics pathways (Statway, CAP, college-designed) and compression (upper and lower levels), with particular attention to scale. Out of 22 people we contacted, 15 were interviewed from 8 California community colleges: 11 math faculty, 2 researchers, and 2 administrators. We spoke with each interviewee for about one hour over the phone. Interviewees were asked a variety of questions pertaining to their background, how students enroll in and learn about alternative math pathways, student experiences in alternative math pathways, aspects of the alternative pathway course (e.g. use of instructional technology, curriculum), professional development, and funding and scaling reformed math pathways. Open-ended questions were used to facilitate the collection of information based on questions that do not restrict the participants' opinions (Creswell and Plano Clark, 2011).

The data collection and data analysis were carried out simultaneously to avoid the collection of repetitive and unfocused data (Merriam 1998). Particularly, after each interview was conducted, researchers debriefed, reviewed detailed data notes and audio recordings and kept notes to capture reflections, emerging themes, and points that needed to be pursued further. This process of review and reflection informed all subsequent interviews. In this manner, data collected from each interview was continuously compared and informed each other until data collection was complete. The data was also organized and coded on a secure spreadsheet. This approach was used to come up with a number of patterns and themes.

The main research questions guiding this research project are:

- What are the effects of enrolling in redesigned developmental math courses on student academic outcomes, compared to enrolling in the traditional developmental math sequence? How do these new approaches contribute to narrowing achievement gaps by gender, race, and other student demographics?
- What do faculty, staff and administrators involved with developmental math interventions identify as the key factors promoting improved student outcomes?

## Empirical Strategy for Estimating the Overall Effect of Reformed Math Pathways on Student Course Success

To estimate how statistics pathways and compression math pathways affect student course success, we restrict our sample to (1) students with valid social security numbers and birthdays, (2) first-time students aged 15–64 at time of entry into the California community college system who (3) took an English or math course in their community college career, and (4) were only enrolled in either statistics pathways, compression, or in the traditional math sequence. We exclude students who hold bachelor's or associate degrees at time of entry; students enrolled in only summer or winter terms; dual enrollment students; and students enrolled in another type of redesigned math pathway (outlined in the table on page 6). After implementing these restrictions, our sample of interest includes 169,363 first-time students in the CCC system for the 2013–14 academic year. Table A1 details a breakdown of the sample by intervention type. Our unit of observation is a student enrolled in a course at a given college in a given term.

Our treatment and control groups are as specified: students that take either a statistics pathway or compressed course are selected into the treatment group. For statistics pathways and upper-level compression, the control group is any student that enrolled in an elementary algebra course; for lower-level compression, the control group is any student that enrolled in an arithmetic course.

**TABLE A1**

Analytical sample breakdown by intervention type

| | Statistics Pathway | Compressed Elementary and Intermediate Algebra | Compressed Arithmetic and Pre-algebra |
|---|---|---|---|
| Full Sample | 71,365 | 74,020 | 23,978 |
| Treatment | 1,884 | 1,125 | 6,127 |
| Control | 69,481 | 72,895 | 17,851 |

NOTES: In the timeframe of our analytical sample, five college offer both types of compression, with a total of 46 students taking both types of compression.

Our study focuses on four key outcomes: completion of developmental math, enrollment in transfer-level math, completion of transfer-level math, and credits earned. Completion is measured in two ways: as conditional on enrollment or as the share of students within a cohort that successfully completes a transfer-level statistics or math course within a given timeframe. The latter is referred to as throughput. For statistics pathways, we distinguish between transfer-level math and transfer-level statistics when evaluating enrollment and completion outcomes, as some statistics pathways also allow students to take other transfer-level math courses outside of statistics.[1] Compression pathways allow students to take any transfer-level math, including statistics, so we do not make this distinction. Credits earned is measured in three ways: total units earned, total transferable units earned, and total units earned as a share of units attempted.

Tables A4 through A6 detail summary statistics of students' characteristics in both the statistics pathway and compression groups, as well as their comparison groups. Treatment and control groups across all three interventions are fairly similar, with some exceptions. For statistics pathways, there were slightly more females and Latinos present (58% vs. 53% in the traditional pathway; 55% vs. 49% in the traditional pathway, respectively). There were also a high number of BOGW/Pell Grant recipients at 75%, although the traditional pathway had more at about 80%. There were significantly higher percentages of full-time students and students

[1] In our sample, six colleges offer statistics pathways that allow students to take other transfer-level math courses, such as Math for Liberal Arts Students.

with limited English proficiency in statistics pathway pathways as well (46% vs. 37% in the traditional pathway; 25% vs. 7% in the traditional pathway, respectively).

Compression at the upper level mirrored the same trends in student characteristics as statistics pathways, although more students were BOGW/Pell Grant recipients than in statistics pathways, at 82%. For compression at the lowest level, some of these trends are either more pronounced or significantly less in comparison to upper-level compression and statistics pathway. For instance, Latinos comprise 66% of students, a difference of more than 10 percentage points with the other two pathways. In addition, there are not as many full-time students and students with limited English proficiency who enroll in compression at the lowest level as compared to the other two types of math reforms. Full-time students comprise 23% of students, with 46% and 42% for statistics pathway and upper-level compression, respectively; students with limited English proficiency comprise only 5% of students, with 25% and 27% for statistics pathway and upper-level compression, respectively. While there are a few differences between treatment and control groups, student characteristics are similar on the whole, which allows us to fairly compare these groups in our analyses.

We utilize various regression techniques to estimate the effect of statistics pathways and compression math pathways on students' course success, primarily probit and ordinary least squares (OLS) fixed-effects regressions. Our regression models take on the following form:

$$Y_{ijgt} = \gamma_t + \alpha_j + \beta_g + \delta Z_i + \gamma W_{igt} + e_{ijgt} \quad (1)$$
$$P(Y_{ijgt}) = \Phi(\gamma_t + \alpha_j + \beta_g + \delta Z_i + \gamma W_{igt} + e_{ijgt}) \quad (2)$$

where *i* indexes students, *j* course, *g* colleges, and *t* terms. Equation 1 was used to evaluate continuous outcomes, while equation 2 was used to evaluate dichotomous outcomes. In both equations, our outcome variables ($Y_{igct}$) include dichotomous variables (1) completion of the developmental math sequence, (2) enrollment in transfer-level math, (3) completion of transfer-level math, and continuous variables (4) total units earned, (5) total transferable units earned, and (6) total units earned as a share of total units attempted, for the *i*th student attending college *g* enrolling in course *j* during term *t*. Included are term ($\gamma_t$), and college ($\beta_g$) fixed effects that will control for unobserved term and college specific policies and programs. For statistics pathways, transfer-level statistics courses are also offered outside of the math department, so we include department ($\alpha_j$ ) fixed-effects to control for the department within which transfer-level statistics is offered (equation 2).[2] Our treatment variable ($W_{igt}$) is 1 if the student is enrolled in a statistics pathway course or compressed course, and 0 otherwise. The model controls for a vector of time invariant student attributes $Z_i$ (i.e., age at enrollment, gender, race, ever a Pell grant recipient, prior educational attainment; for others see Table A2). Finally, the model contains individual-specific errors ($e_{ijgt}$). Our parameter of interest is $\gamma$, the effect of enrolling in a statistics pathway or compressed course on student outcomes.

However, this model may generate biased estimates of $\gamma$ . The most notable arises due to omitted variable bias. Even when we control for a number of student characteristics, it is very difficult to measure other characteristics such as motivation or student ability upon college entry. Because these measures are likely correlated with enrollment in developmental education and success in college, even when students have similar observed characteristics, the inability to control for motivation and prior ability could lead to biased estimates. In addition, selection bias may arise due to differential enrollment patterns in developmental education, and statistics pathway in particular. For instance, if the most motivated students are more likely to enroll in required developmental

[2] About 34% of transfer-level statistics courses were offered outside of the math department within the time frame of our study.

courses while the least motivated are more likely to delay or never enroll in developmental coursework, we can observe upward bias.

## Robustness Checks

To test the structural validity of our regression results, we modify our regression specification with a number of variables that may be confounded with the effect of statistics and compressed pathways on student success. We run separate models that account for differences in regression estimates that may be due to term, student, and college characteristics (see tables 3, 4, and 5). The statistical significance of our results is virtually unchanged across each model specification. We also separate models that include interaction terms to evaluate the effect of statistics and compressed pathways by student attributes (race, gender, low income status) and by college. The college-interacted model is especially noteworthy, as it assures our results are not solely driven by a single college.

## Comparing our Estimates to Those in the Existing Literature

Our results for both statistics pathways and compressed math pathways are consistent with evidence found by prior studies. Research using multivariate regression and student background controls for a group of colleges participating in the California Acceleration Project (CAP) provides promising evidence of statistics pathways (Hayward and Willett, 2014). The study examined the impact of developmental math curricular redesign at nine pilot colleges that had implemented accelerated statistics pathways feeding into college level statistics courses, as opposed to the standard algebra based curriculum that feeds into pre-calculus, with the intent to reduce the time students spend in developmental math and make the skills students learn more relevant to non-STEM majors. The analysis drew from the data of 653 statistics pathway students and 23,607 traditional math students enrolled at 9 colleges during the 2011–12 academic year and tracked outcomes for two years. The study found that the odds of completing college level math for statistics pathway students were 4.5 times higher than for students in the traditional math sequence. Additionally the study found that the accelerated statistics pathway approach helped narrow achievement gaps for minority students. The research is the most promising evidence of developmental math reform available in the state of California, and this has led to a surge in colleges adopting this reform.

There is also national evidence of the success of statistics pathways that are part of Statway, an effort led by The Carnegie Foundation for the Advancement of Teaching (Sowers and Yamada, 2015; Yamada and Bryk, 2016). Statway allows students to complete transfer-level statistics stretched over two terms with developmental math embedded and is intended to better align developmental course content with students' programs of study, targeting students not intending to pursue a STEM major. Using a matching strategy and multilevel models, a recent study of over 1500 Statway students at 17 colleges across five states (California, Connecticut, Florida, Texas and Washington) from fall 2011 to spring 2012 found that Statway students were more likely to successfully complete college math than matched comparison students, by an odds of success of 5.31 for the first cohort and 7.4 for the second cohort. Statway students also earned slightly more college credits than their matched comparison, but the difference was less than one unit (5.57 vs. 4.08, respectively). The research also finds that students of all races/ethnicities and gender had improvements in these two outcomes. In addition, early findings from a randomized controlled trial study of the Dana Center Mathematics Pathways program, which similarly offers a two-course developmental math pathway that emphasizes statistics and quantitative reasoning skills, suggest positive effects on short-term outcomes such as completion of the developmental math sequence. This is promising evidence of the development function of statistics pathways on short-term outcomes.

Although the amount of rigorous research focused on the effect of compression on student outcomes is limited, the evidence does align with our findings. A study by Edgecombe, Jaggars, Baker, and Bailey 2013) utilized

regression analyses to evaluate the impact of participation in the FastStart math program at the Community College of Denver on student outcomes similar to those we use. The FastStart math program compresses developmental math at the upper and lower levels, and also provides a variety of student support services, most notably case management, career exploration, and educational planning services, designed to target the challenges students face as a result of testing into developmental education. The study found that FastStart students complete the developmental math sequence, enroll in transfer-level math, and pass transfer-level math at higher rates than those that enrolled in regular arithmetic or elementary algebra courses. FastStart students have a slightly higher likelihood of completing developmental math with a C or better as traditional developmental math students (83% and 80%, respectively). Furthermore, even though FastStart students were more likely to enroll in transfer-level math by 8 percentage points, performance in transfer-level math with a C or better was also similar between FastStart students and traditional students, at 82% and 81% respectively. These results suggest that although FastStart students progress more rapidly through the developmental math sequence, they have a similar level of preparedness to students in the traditional sequence.

## Caveats

While our analysis employs rigorous statistical analysis and includes a substantial number of controls, there are considerations to account for with regard to the data we use and our methods. Our data does not contain information pertaining to student assessment scores, placement recommendation, or high school GPA, all of which would most accurately control for student academic record prior to enrolling in developmental math. We use student's first course in the developmental math sequence as a proxy variable.

Our sample of interest is the 2014 student cohort, and we track student outcomes for this cohort over three academic years. While the sample sizes we do include in our study are sufficient to draw conclusions from our regression analyses, our analysis will benefit from having larger sample sizes of students enrolled in alternative math pathways. One reason for having smaller-than-desired sample sizes is due to the recent implementation of these reformed math pathways. In addition, three years is still a relatively short amount of time to evaluate the effect of alternative math pathways on longer-term outcomes such as transfer and degree completion. Time will generate larger sample sizes and allow for a more thorough evaluation of longer-term outcomes.

Our analysis focuses on enrollment in alternative math pathways in relation to student outcomes. However, other types of reforms were also implemented within our timeframe of interest that may also contribute to our results, most notably assessment and placement reforms such as multiple measures and reforms pertaining to cut scores used to place students. Including college fixed-effects in our model aims to account for these other reforms implemented at the college level, outside of alternative math pathways.

# Appendix B. Tables

**TABLE B1**

Variable Definitions

| Variable | Description |
|---|---|
| **Student outcomes** | |
| Developmental Math Sequence Completer | This variable is 1 if a student successfully completed developmental math requirements |
| Transfer Math Student | This variable is 1 if a student enrolled in a transfer-level math course |
| Transfer Statistics Student | This variable is 1 if a student enrolled in a transfer-level statistics course |
| Transfer Math Completion | This variable is 1 if a student successfully completed a transfer-level math course, conditional on the student enrolling in the course |
| Transfer Statistics Completion | This variable is 1 if a student successfully completed a transfer-level statistics course, conditional on the student enrolling in the course |
| Transfer Math Throughput | This variable is 1 if a student successfully completed a transfer-level math course within a given timeframe |
| Transfer Statistics Throughput | This variable is 1 if a student successfully completed a transfer-level statistics course within a given timeframe |
| Proportion | Total units earned as a share of total units attempted |
| Total Units Transferable | Total number of transferable units earned in a student's community college career |
| Total Units | Total units earned |
| Any Long-Term Success | This variable is 1 if a student successfully transferred to a 4-year institution or earned a short-term certificate (<6 to 30 units), long-term certificate (30 to 60+ units), or associate's degree |
| **Student demographic attributes** | |
| Gender | Categorical variables for female and unknown sex, with male as the reference category |
| Race/ethnicity | Categorical variables for Latino, African American, Asian, other race (includes two or more races, Native American), and unknown race. White is the reference category. |
| Citizenship status | Categorical variable for non-citizen (permanent resident, temporary resident, refugee/asylee, F-1 or M-1 student visa, other status) and unknown citizenship. US citizen is the reference category. |
| Traditional College-age Student | Categorical variable for a student is age 24 years or younger at first term of enrollment |
| **Student academic preparedness proxies** | |
| Highest level of education at first term | Categorical variable for not a high school graduate, adult education, GED or equivalent, graduate from a foreign high school, and unknown education. High school graduate is the reference category |
| Disability status | This variable is 1 if a student was ever reported with at least one primary disability (SD01) |
| Limited English Proficiency (LEP) status | This variable is 1 if a student was ever enrolled in a course with a TOP Code equal to 493084, 49085, 49086, 493087, or 493100 (English as a Second Language – Writing, Reading, Speaking/Listening, Integrated; Vocational English as a Second Language, respectively) or if the student was identified as ever needing English as a second language services during the matriculation process (SM03) |
| Full-Time Enrollment status | This variable is 1 if the student attempted 12 or more units in a term (SX03) |
| Extended Opportunity Programs and Services (EOPS) recipient | This variable is 1 if a student every received support from EOPS |
| Enrolled in more than one college | This variable is 1 if the student was enrolled in more than one community college during his or her academic career |
| Starting level in the developmental math sequence | Categorical variable for two levels, three levels, and four levels below a transfer-level course |
| Prior dual enrollment | This variable is 1 if the student was previously enrolled as a special admit student (i.e., simultaneously enrolled in K-12) |

| Variable | Description |
|---|---|
| Developmental English student | This variable is 1 if a student ever enrolled in at least one developmental English or ESL course |
| Prior non success | This variable is 1 if a student attempted to complete a course more than once |
| **Student socioeconomic proxies** | |
| Board of Governors Enrollment Waiver (BOGW)/Pell recipient | This variable is 1 if a student ever received a Board of Governor's waiver or Pell grant (SF21) |

NOTES: The CCCCO MIS data element dictionary provides a more detailed description of each variable used in our study (CCCCO undated)

**TABLE B2**

Regression estimates of the effect of statistics pathway on student outcomes

| | No controls | Student Characteristics | Student Characteristics, Term Fixed Effects | Student Characteristics, Term and College Fixed Effects |
|---|---|---|---|---|
| Student Completion of the Developmental Math Sequence | | | | |
| Estimated coefficient | 0.849 (0.156)*** | 0.947 (0.131)*** | 1.094 (0.137)*** | 0.975 (0.083)*** |
| Marginal effect | 0.323 (0.058)*** | 0.332 (0.045)*** | 0.374 (0.046)*** | 0.321 (0.027)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,342 |
| Enrollment in a Transfer-level Statistics Math Course | | | | |
| Estimated coefficient | 1.139 (0.095)*** | 1.136 (0.131)*** | 1.356 (0.138)*** | 1.307 (0.083)*** |
| Marginal effect | 0.286 (0.023)*** | 0.253 (0.029)*** | 0.294 (0.030)*** | 0.254 (0.019)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 69,804 |
| Completion of a Transfer-level Statistics Course (Conditional on Enrollment) | | | | |
| Estimated coefficient | 0.060 (0.120) | 0.102 (0.136) | 0.171 (0.142) | 0.071 (0.098) |
| Marginal effect | 0.020 (0.039) | 0.033 (0.043) | 0.054 (0.045) | 0.022 (0.030) |
| Number of observations | 12,422 | 12,417 | 12,417 | 12,415 |
| Completion of a Transfer-level Statistics Course (Throughput) | | | | |
| Estimated coefficient | 0.984 (0.117)*** | 0.983 (0.145)*** | 1.180 (0.152)*** | 1.073 (0.084)*** |
| Marginal effect | 0.202 (0.024)*** | 0.179 (0.027)*** | 0.210 (0.028)*** | 0.171 (0.015)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,315 |
| Enrollment in Any Transfer-level Math Course | | | | |
| Estimated coefficient | 0.974 (0.103)*** | 0.952 (0.138)*** | 1.184 (0.148)*** | 1.205 (0.087)*** |
| Marginal effect | 0.290 (0.030)*** | 0.253 (0.036)*** | 0.303 (0.038)*** | 0.289 (0.022)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 69,831 |
| Completion of Any Transfer-level Math Course (Conditional on Enrollment) | | | | |
| Estimated coefficient | 0.062 (0.108) | 0.076 (0.131) | 0.154 (0.134) | 0.062 (0.099) |
| Marginal effect | 0.020 (0.035) | 0.024 (0.041) | 0.049 (0.042) | 0.019 (0.031) |
| Number of observations | 16,302 | 16,294 | 16,294 | 16,291 |
| Completion of Any Transfer-level Math Course (Throughput) | | | | |
| Estimated coefficient | 0.831 (0.120)*** | 0.804 (0.148)*** | 1.014 (0.158)*** | 0.966 (0.086)*** |
| Marginal effect | 0.206 (0.030)*** | 0.178 (0.033)*** | 0.217 (0.034)*** | 0.192 (0.018)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,342 |

| | No controls | Student Characteristics | Student Characteristics, Term Fixed Effects | Student Characteristics, Term and College Fixed Effects |
|---|---|---|---|---|
| Earned a certificate/associate's degree or transferred to a 4-year institution | | | | |
| Estimated coefficient | 0.527<br>(0.116)*** | 0.526<br>(0.087)*** | 0.569<br>(0.085)*** | 0.478<br>(0.062)*** |
| Marginal effect | 0.113<br>(0.025)*** | 0.102<br>(0.017)*** | 0.111<br>(0.017)*** | 0.091<br>(0.012)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,342 |
| Total units earned as share of units attempted | | | | |
| Estimated coefficient | 8.235<br>2.766)*** | 5.512<br>(1.968)*** | 5.033<br>(1.855)*** | 3.264<br>(1.170)*** |
| Number of observations | 70,674 | 70,653 | 70,653 | 70,653 |
| Total units earned | | | | |
| Estimated coefficient | 10.513<br>(3.058)*** | 8.094<br>2.720)*** | 8.254<br>2.523)*** | 4.865<br>(1.038)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,344 |
| Total transferable units earned | | | | |
| Estimated coefficient | 11.432<br>(3.055)*** | 8.210<br>(3.226)** | 8.240<br>(3.066)*** | 6.038<br>(0.984)*** |
| Number of observations | 71,365 | 71,344 | 71,344 | 71,344 |

SOURCES: Each column represents a separate regression. Standard errors are clustered at the course level to account for within-course error correlation. All models include dummy variables for gender, race/ethnicity, nativity status, traditional college-age student, Board of Governor's Enrollment Waiver/Pell recipient, highest level of education at first term, disability status, full-time enrollment status, Extended Opportunity Programs and Services recipient, ever enrolled in developmental English or ESL, prior non-success of completing a course, prior dual enrollment, ever enrolled in more than one college, and starting level in the developmental math sequence. Regression results individually by short-term certificate, long-term certificate, associate's degree, and transfer to a 4-year institution are available but omitted from this study. Please contact the authors if interested in results.

**TABLE B3**

Regression estimates of the effect of compression (elementary and intermediate algebra) on student outcomes

| | No controls | Student Characteristics | Student Characteristics, Term Fixed Effects | Student Characteristics, Term and College Fixed Effects |
|---|---|---|---|---|
| Student Completion of the Developmental Math Sequence | | | | |
| Estimated coefficient | 0.412<br>(0.267) | 0.578<br>(0.240)** | 0.707<br>(0.253)*** | 0.726<br>(0.225)*** |
| Marginal effect | 0.157<br>(0.102) | 0.203<br>(0.084)** | 0.242<br>(0.086)*** | 0.244<br>(0.076)*** |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |
| Enrollment in a Transfer-level Math Course | | | | |
| Estimated coefficient | 0.397<br>(0.177)** | 0.486<br>(0.192)** | 0.675<br>(0.207)*** | 0.683<br>(0.174)*** |
| Marginal effect | 0.113<br>(0.050)** | 0.124<br>(0.049)** | 0.166<br>(0.051)*** | 0.164<br>(0.042)*** |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |
| Completion of a Transfer-level Math Course (Conditional on Enrollment) | | | | |
| Estimated coefficient | -0.234<br>(0.051)*** | -0.179<br>(0.062)*** | -0.133<br>(0.058)** | -0.180<br>(0.072)** |
| Marginal effect | -0.079<br>(0.017)*** | -0.059<br>(0.020)*** | -0.043<br>(0.019)** | -0.058<br>(0.023)** |
| Number of observations | 15,239 | 15,231 | 15,231 | 15,229 |
| Completion of a Transfer-level Math Course (Throughput) | | | | |
| Estimated coefficient | 0.251<br>(0.140)* | 0.324<br>(0.156)** | 0.483<br>(0.165)*** | 0.469<br>(0.141)*** |
| Marginal effect | 0.058<br>(0.032)* | 0.067<br>(0.032)** | 0.097<br>(0.033)*** | 0.092<br>(0.028)*** |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |
| Earned a certificate/associate's degree or transferred to a 4-year institution | | | | |
| Estimated coefficient | 0.125<br>(0.086) | 0.072<br>(0.079) | 0.103<br>(0.076) | 0.075<br>(0.067) |
| Marginal effect | 0.026<br>(0.018) | 0.014<br>(0.015) | 0.019<br>(0.014) | 0.014<br>(0.013) |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |
| Total units earned as share of units attempted | | | | |
| Estimated coefficient | 3.672<br>(3.760) | 0.474<br>(3.133) | 0.264<br>2.976) | 1.702<br>2.518) |
| Number of observations | 73,321 | 73,299 | 73,299 | 73,299 |
| Total units earned | | | | |
| Estimated coefficient | 5.991<br>(3.587)* | 1.655<br>2.759) | 2.153<br>2.573) | 3.847<br>2.180)* |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |
| Total transferable units earned | | | | |
| Estimated coefficient | 7.118<br>2.854)** | 4.464<br>(1.980)** | 4.789<br>(1.819)*** | 5.574<br>(1.660)*** |
| Number of observations | 74,020 | 73,998 | 73,998 | 73,998 |

SOURCES: Each column represents a separate regression. Standard errors are clustered at the course level to account for within-course error correlation. All models include dummy variables for gender, race/ethnicity, nativity status, traditional college-age student, Board of Governor's Enrollment Waiver/Pell recipient, highest level of education at first term, disability status, full-time enrollment status, Extended Opportunity Programs and Services recipient, ever enrolled in developmental English or ESL, prior non-success of completing a course, prior dual enrollment, ever enrolled in more than one college, and starting level in the developmental math sequence. Regression results individually by short-term certificate, long-term certificate, associate's degree, and transfer to a 4-year institution are available but omitted from this study. Please contact the authors if interested in results.

**TABLE B4**

Regression estimates of the effect of compression (arithmetic and pre-algebra) on student outcomes

| | No controls | Student Characteristics | Student Characteristics, Term Fixed Effects | Student Characteristics, Term and College Fixed Effects |
|---|---|---|---|---|
| Student Completion of the Developmental Math Sequence | | | | |
| Estimated coefficient | 0.276 (0.064)*** | 0.321 (0.064)*** | 0.346 (0.063)*** | 0.626 (0.100)*** |
| Marginal effect | 0.056 (0.013)*** | 0.059 (0.012)*** | 0.062 (0.011)*** | 0.110 (0.018)*** |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,929 |
| Enrollment in a Transfer-level Math Course | | | | |
| Estimated coefficient | 0.227 (0.073)*** | 0.261 (0.076)*** | 0.293 (0.075)*** | 0.486 (0.070)*** |
| Marginal effect | 0.026 (0.009)*** | 0.026 (0.008)*** | 0.029 (0.008)*** | 0.046 (0.007)*** |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,833 |
| Completion of a Transfer-level Math Course (Conditional on Enrollment) | | | | |
| Estimated coefficient | -0.093 (0.072) | -0.072 (0.073) | -0.049 (0.078) | -0.109 (0.124) |
| Marginal effect | -0.033 (0.025) | -0.025 (0.025) | -0.017 (0.027) | -0.036 (0.041) |
| Number of observations | 1,369 | 1,368 | 1,368 | 1,345 |
| Completion of a Transfer-level Math Course (Throughput) | | | | |
| Estimated coefficient | 0.187 (0.074)** | 0.214 (0.078)*** | 0.248 (0.076)*** | 0.429 (0.070)*** |
| Marginal effect | 0.016 (0.007)** | 0.016 (0.006)*** | 0.018 (0.006)*** | 0.031 (0.005)*** |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,806 |
| Earned a certificate/associate's degree or transferred to a 4-year institution | | | | |
| Estimated coefficient | 0.131 (0.057)** | 0.178 (0.074)** | 0.167 (0.073)** | 0.046 (0.085) |
| Marginal effect | 0.017 (0.008)** | 0.022 (0.009)** | 0.020 (0.009)** | 0.005 (0.010) |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,789 |
| Total units earned as share of units attempted | | | | |
| Estimated coefficient | 1.759 (1.331) | 2.640 (1.259)** | 1.707 (1.173) | 3.378 (1.846)* |
| Number of observations | 23,135 | 23,127 | 23,127 | 23,127 |
| Total units earned | | | | |
| Estimated coefficient | 3.551 (1.240)*** | 3.920 (1.154)*** | 3.105 (1.086)*** | 6.429 (1.570)*** |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,970 |
| Total transferable units earned | | | | |
| Estimated coefficient | 3.477 (1.059)*** | 3.353 (0.994)*** | 2.725 (0.932)*** | 3.476 (1.047)*** |
| Number of observations | 23,978 | 23,970 | 23,970 | 23,970 |

SOURCES: Each column represents a separate regression. Standard errors are clustered at the course level to account for within-course error correlation. All models include dummy variables for gender, race/ethnicity, nativity status, traditional college-age student, Board of Governor's Enrollment Waiver/Pell recipient, highest level of education at first term, disability status, full-time enrollment status, Extended Opportunity Programs and Services recipient, ever enrolled in developmental English or ESL, prior non-success of completing a course, prior dual enrollment, ever enrolled in more than one college, and starting level in the developmental math sequence. Regression results individually by short-term certificate, long-term certificate, associate's degree, and transfer to a 4-year institution are available but omitted from this study. Please contact the authors if interested in results.

## TABLE B5

Student characteristics (Statistics pathway)

| | Our Relevant Sample | | Students Enrolled in Statistics pathway | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Total | **71,365** | **100** | **1,884** | **100** | **69,481** | **100** |
| **Age at First Term** | | | | | | |
| 15-19 | 52,961 | 74 | 1,509 | 80 | 51,452 | 74 |
| 20-24 | 11,099 | 16 | 224 | 12 | 10,875 | 16 |
| 25-29 | 3,484 | 5 | 68 | 4 | 3,416 | 5 |
| 30-34 | 1,469 | 2 | 26 | 1 | 1,443 | 2 |
| 35-39 | 798 | 1 | 17 | 1 | 781 | 1 |
| 40-44 | 554 | 1 | 11 | 1 | 543 | 1 |
| 45-49 | 438 | 1 | 11 | 1 | 427 | 1 |
| 50-54 | 312 | 0 | 10 | 1 | 302 | 0 |
| 55-59 | 185 | 0 | * | * | 178 | 0 |
| 60-64 | 65 | 0 | * | * | 64 | 0 |
| **Gender** | | | | | | |
| Female | 37,716 | 53 | 1,090 | 58 | 36,626 | 53 |
| Male | 33,270 | 47 | 785 | 42 | 32,485 | 47 |
| Unknown | 379 | 1 | * | * | 370 | 1 |
| **Race/ethnicity** | | | | | | |
| White | 17,474 | 24 | 490 | 26 | 16,984 | 24 |
| Latino | 39,172 | 55 | 918 | 49 | 38,254 | 55 |
| Asian | 5,512 | 8 | 157 | 8 | 5,355 | 8 |
| African American | 4,632 | 6 | 176 | 9 | 4,456 | 6 |
| Other Race | 711 | 1 | 33 | 2 | 678 | 1 |
| Two or more races | 3,175 | 4 | 102 | 5 | 3,073 | 4 |
| Unknown race | 689 | 1 | * | * | 681 | 1 |
| **Citizenship status** | | | | | | |
| U.S. citizen | 64,885 | 91 | 1,747 | 93 | 63,138 | 91 |
| Non-citizen | 5,727 | 8 | 135 | 7 | 5,592 | 8 |
| Unknown | 753 | 1 | * | * | 751 | 1 |
| **Highest level of education** | | | | | | |
| Not a graduate or no longer enrolled in high school | 936 | 1 | 34 | 2 | 902 | 1 |
| Currently enrolled in adult school | 195 | 0 | * | * | 191 | 0 |
| High school diploma | 61,758 | 87 | 1,642 | 87 | 60,116 | 87 |
| Passed GED or received a HS Certificate of Achievement | 3,536 | 5 | 68 | 4 | 3,468 | 5 |

| | Our Relevant Sample | | Students Enrolled in Statistics pathway | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| California HS Proficiency Certificate | 825 | 1 | 21 | 1 | 804 | 1 |
| Foreign Secondary School Diploma/Certificate of Graduation | 1,564 | 2 | 30 | 2 | 1,534 | 2 |
| Unknown | 2,551 | 4 | 85 | 5 | 2,466 | 4 |
| **Previous dual enrollment** | | | | | | |
| 0 | 66,011 | 92 | 1,694 | 90 | 64,317 | 93 |
| 1 | 5,354 | 8 | 190 | 10 | 5,164 | 7 |
| **BOGW or Pell Grant recipient (anytime during his/her college career)** | | | | | | |
| 0 | 14,625 | 20 | 478 | 25 | 14,147 | 20 |
| 1 | 56,740 | 80 | 1,406 | 75 | 55,334 | 80 |
| **Starting level in developmental math sequence** | | | | | | |
| One level below transfer | 1,391 | 2 | 1,391 | 74 | 0 | 0 |
| Two levels below transfer | 48,582 | 68 | * | * | 48,581 | 70 |
| Three levels below transfer | 16,104 | 23 | 259 | 14 | 15,845 | 23 |
| Four levels below transfer | 5,288 | 7 | 233 | 12 | 5,055 | 7 |
| **Ever enrolled in developmental English** | | | | | | |
| 0 | 25,142 | 35 | 610 | 32 | 24,532 | 35 |
| 1 | 46,223 | 65 | 1,274 | 68 | 44,949 | 65 |
| **Full-time student** | | | | | | |
| 0 | 44,816 | 63 | 1,013 | 54 | 43,803 | 63 |
| 1 | 26,549 | 37 | 871 | 46 | 25,678 | 37 |
| **EOPS participant** | | | | | | |
| 0 | 62,284 | 87 | 1,653 | 88 | 60,631 | 87 |
| 1 | 9,081 | 13 | 231 | 12 | 8,850 | 13 |
| **Student with limited English proficiency** | | | | | | |
| 0 | 68,953 | 94 | 1,857 | 95 | 67,096 | 93 |
| 1 | 2,412 | 6 | 27 | 5 | 2,385 | 7 |
| **Student with disabilities** | | | | | | |
| 0 | 66,446 | 93 | 1,738 | 92 | 64,708 | 93 |
| 1 | 4,919 | 7 | 146 | 8 | 4,773 | 7 |
| **Student educational goal at first term of enrollment** | | | | | | |
| Obtain an associate degree and transfer to a baccalaureate granting institution | 31,862 | 45 | 985 | 52 | 30,877 | 44 |

| | Our Relevant Sample | | Students Enrolled in Statistics pathway | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Transfer to a baccalaureate granting institution without an associate degree | 7,063 | 10 | 275 | 15 | 6,788 | 10 |
| Obtain a two-year associate degree without transfer | 6,398 | 9 | 113 | 6 | 6,285 | 9 |
| Earn a career technical certificate without transfer | 878 | 1 | 19 | 1 | 859 | 1 |
| Other | 3,024 | 4 | 50 | 3 | 2,974 | 4 |
| Undecided on goal | 13,350 | 19 | 240 | 13 | 13,110 | 19 |
| 4-year college student taking courses to meet 4-year college requirements | 1,638 | 2 | 74 | 4 | 1,564 | 2 |
| No information | 7,152 | 10 | 128 | 7 | 7,024 | 10 |

NOTES: (1) Includes students with known birth dates and valid Social Security Numbers. (2) Includes students ages 15 to 64 at the start of the fall semester of 2013, tracked through the spring semester of 2016. First-term enrollment is defined as the first time a student appears in the CCCCO MIS enrollment file as a non-special admit student (Education Status SB11 not = 10000). (3) Includes students who have taken at least one developmental math or English course. (4) Includes students who took statistics pathway, compressed elementary and intermediate algebra, or compressed arithmetic and pre-algebra. (5) Includes students who took traditional arithmetic and traditional elementary algebra. We exclude cells with n<10.

## TABLE B6

Student characteristics (Compressed Elementary and Intermediate Algebra)

| | Our Relevant Sample | | Students Enrolled in Compressed Elementary and Intermediate Algebra | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Total | **74,020** | **100** | **1,125** | **100** | **72,895** | **100** |
| **Age at First Term** | | | | | | |
| 15-19 | 54,682 | 74 | 842 | 75 | 53,840 | 74 |
| 20-24 | 11,580 | 16 | 168 | 15 | 11,412 | 16 |
| 25-29 | 3,684 | 5 | 63 | 6 | 3,621 | 5 |
| 30-34 | 1,579 | 2 | 27 | 2 | 1,552 | 2 |
| 35-39 | 851 | 1 | * | * | 842 | 1 |
| 40-44 | 582 | 1 | * | * | 580 | 1 |
| 45-49 | 465 | 1 | * | * | 461 | 1 |
| 50-54 | 330 | 0 | * | * | 321 | 0 |
| 55-59 | 196 | 0 | * | * | 196 | 0 |
| 60-64 | 71 | 0 | * | * | 70 | 0 |
| **Gender** | | | | | | |
| Female | 39,456 | 53 | 665 | 59 | 38,791 | 53 |
| Male | 34,183 | 46 | 457 | 41 | 33,726 | 46 |
| Unknown | 381 | 1 | * | * | 378 | 1 |
| **Race/ethnicity** | | | | | | |
| White | 17,709 | 24 | 200 | 18 | 17,509 | 24 |
| Latino | 41,228 | 56 | 635 | 56 | 40,593 | 56 |
| Asian | 5,612 | 8 | 108 | 10 | 5,504 | 8 |
| African American | 4,843 | 7 | 117 | 10 | 4,726 | 6 |
| Other Race | 702 | 1 | * | * | 696 | 1 |
| Two or more races | 3,212 | 4 | 48 | 4 | 3,164 | 4 |
| Unknown race | 714 | 1 | 11 | 1 | 703 | 1 |
| **Citizenship status** | | | | | | |
| U.S. citizen | 67,204 | 91 | 1,002 | 89 | 66,202 | 91 |
| Non-citizen | 6,021 | 8 | 123 | 10 | 6,693 | 8 |
| Unknown | 795 | 1 | * | * | 792 | 1 |
| **Highest level of education** | | | | | | |
| Not a graduate or no longer enrolled in high school | 953 | 1 | 11 | 1 | 942 | 1 |
| Currently enrolled in adult school | 205 | 0 | * | * | 21 | 0 |
| High school diploma | 63,973 | 86 | 956 | 85 | 63,017 | 86 |
| Passed GED or received a HS Certificate of Achievement | 3,701 | 5 | 61 | 5 | 3,640 | 5 |

| | Our Relevant Sample | | Students Enrolled in Compressed Elementary and Intermediate Algebra | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| California HS Proficiency Certificate | 844 | 1 | 12 | 1 | 832 | 1 |
| Foreign Secondary School Diploma/Certificate of Graduation | 1,690 | 2 | 31 | 3 | 1,659 | 2 |
| Unknown | 2,654 | 4 | 50 | 4 | 2,604 | 4 |
| **Previous dual enrollment** | | | | | | |
| 0 | 68,598 | 93 | 1,053 | 94 | 67,545 | 93 |
| 1 | 5,422 | 7 | 72 | 6 | 5,350 | 7 |
| **BOGW or Pell Grant recipient (anytime during his/her college career)** | | | | | | |
| 0 | 14,805 | 20 | 199 | 18 | 14,606 | 20 |
| 1 | 59,215 | 80 | 926 | 82 | 58,289 | 80 |
| **Starting level in developmental math sequence** | | | | | | |
| One level below transfer | 658 | 0 | 658 | 0 | 0 | 0 |
| Two levels below transfer | 484,464 | 0 | 0 | 0 | 48,464 | 0 |
| Three levels below transfer | 19,086 | 26 | 308 | 100 | 18,778 | 0 |
| Four levels below transfer | 5,812 | 74 | 159 | 0 | 5,653 | 100 |
| **Ever enrolled in developmental English** | | | | | | |
| 0 | 25,542 | 35 | 362 | 32 | 25,180 | 35 |
| 1 | 48,478 | 65 | 763 | 68 | 47,715 | 65 |
| **Full-time student** | | | | | | |
| 0 | 46,862 | 63 | 655 | 58 | 46,207 | 63 |
| 1 | 27,158 | 37 | 470 | 42 | 26,688 | 37 |
| **EOPS participant** | | | | | | |
| 0 | 64,387 | 87 | 963 | 86 | 63,424 | 87 |
| 1 | 9,633 | 13 | 162 | 14 | 9,471 | 13 |
| **Student with limited English proficiency** | | | | | | |
| 0 | 71,394 | 96 | 1,098 | 98 | 70,296 | 96 |
| 1 | 2,626 | 4 | 27 | 2 | 2,599 | 4 |
| **Student with disabilities** | | | | | | |
| 0 | 68,847 | 93 | 1,049 | 93 | 67,798 | 93 |
| 1 | 5,151 | 7 | 76 | 7 | 5,075 | 7 |
| **Student educational goal at first term of enrollment** | | | | | | |
| Obtain an associate degree and transfer to a baccalaureate granting institution | 33,514 | 45 | 561 | 50 | 32,953 | 45 |

| | Our Relevant Sample | | Students Enrolled in Compressed Elementary and Intermediate Algebra | | Students Enrolled in Traditional Elementary Algebra | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Transfer to a baccalaureate granting institution without an associate degree | 7,287 | 10 | 146 | 13 | 7,141 | 10 |
| Obtain a two-year associate degree without transfer | 6,796 | 9 | 71 | 6 | 6,725 | 9 |
| Earn a career technical certificate without transfer | 907 | 1 | * | * | 900 | 1 |
| Other | 3,118 | 4 | 39 | 3 | 3,079 | 4 |
| Undecided on goal | 13,534 | 18 | 211 | 19 | 13,323 | 18 |
| 4-year college student taking courses to meet 4-year college requirements | 1,707 | 2 | 22 | 2 | 1,685 | 2 |
| No information | 7,157 | 10 | 68 | 6 | 7,089 | 10 |

NOTES: (1) Includes students with known birth dates and valid Social Security Numbers. (2) Includes students ages 15 to 64 at the start of the fall semester of 2013, tracked through the spring semester of 2016. First-term enrollment is defined as the first time a student appears in the CCCCO MIS enrollment file as a non-special admit student (Education Status SB11 not = 10000). (3) Includes students who have taken at least one developmental math or English course. (4) Includes students who took statistics pathway, compressed elementary and intermediate algebra, or compressed arithmetic and pre-algebra. (5) Includes students who took traditional arithmetic and traditional elementary algebra. We exclude cells with n<10.

## TABLE B7

Student characteristics (compressed arithmetic and pre-algebra)

| | Our Relevant Sample | | Students Enrolled in Compressed Arithmetic and Prealgebra | | Students Enrolled in Traditional Arithmetic | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Total | **23,978** | **100** | **6,127** | **100** | **17,851** | **100** |
| **Age at First Term** | | | | | | |
| 15-19 | 15,076 | 63 | 4,186 | 68 | 10,890 | 61 |
| 20-24 | 4,603 | 19 | 1,114 | 18 | 3,489 | 20 |
| 25-29 | 1,546 | 6 | 331 | 5 | 1,215 | 7 |
| 30-34 | 816 | 3 | 180 | 3 | 636 | 4 |
| 35-39 | 500 | 2 | 101 | 2 | 399 | 2 |
| 40-44 | 410 | 2 | 60 | 1 | 350 | 2 |
| 45-49 | 376 | 2 | 66 | 1 | 310 | 2 |
| 50-54 | 318 | 1 | 34 | 1 | 284 | 2 |
| 55-59 | 243 | 1 | 38 | 1 | 205 | 1 |
| 60-64 | 90 | 0 | 17 | 0 | 73 | 0 |
| **Gender** | | | | | | |
| Female | 14,207 | 59 | 3,630 | 59 | 10,577 | 59 |
| Male | 9,644 | 40 | 2,483 | 41 | 7,161 | 40 |
| Unknown | 127 | 1 | 14 | 0 | 113 | 1 |
| **Race/ethnicity** | | | | | | |
| White | 4,095 | 17 | 955 | 16 | 3,140 | 18 |
| Latino | 14,267 | 60 | 4,039 | 66 | 10,228 | 57 |
| Asian | 1,305 | 5 | 229 | 4 | 1,076 | 6 |
| African American | 3,016 | 13 | 639 | 10 | 2,377 | 13 |
| Other Race | 223 | 0 | 32 | 0 | 191 | 2 |
| Two or more races | 845 | 4 | 194 | 3 | 651 | 4 |
| Unknown race | 227 | 1 | 39 | 1 | 188 | 1 |
| **Citizenship status** | | | | | | |
| U.S. citizen | 21,496 | 90 | 5,541 | 90 | 15,955 | 89 |
| Non-citizen | 2,219 | 9 | 506 | 9 | 1,720 | 9 |
| Unknown | 263 | 1 | 80 | 1 | 183 | 1 |
| **Highest level of education** | | | | | | |
| Not a graduate or no longer enrolled in high school | 644 | 3 | 123 | 2 | 521 | 3 |
| Currently enrolled in adult school | 108 | 0 | 24 | 0 | 84 | 0 |
| High school diploma | 19,246 | 80 | 5,108 | 83 | 14,138 | 79 |
| Passed GED or received a HS Certificate of Achievement | 1,780 | 7 | 374 | 6 | 1,406 | 8 |

| | Our Relevant Sample | | Students Enrolled in Compressed Arithmetic and Prealgebra | | Students Enrolled in Traditional Arithmetic | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| California HS Proficiency Certificate | 299 | 1 | 46 | 1 | 253 | 1 |
| Foreign Secondary School Diploma/Certificate of Graduation | 755 | 3 | 181 | 3 | 574 | 3 |
| Unknown | 1,146 | 5 | 271 | 4 | 875 | 5 |
| **Previous dual enrollment** | | | | | | |
| 0 | 22,664 | 95 | 5,785 | 94 | 16,879 | 95 |
| 1 | 1,314 | 5 | 342 | 6 | 972 | 5 |
| **BOGW or Pell Grant recipient (anytime during his/her college career)** | | | | | | |
| 0 | 3,230 | 13 | 868 | 14 | 2,362 | 13 |
| 1 | 20,748 | 87 | 5,259 | 86 | 15,489 | 87 |
| **Starting level in developmental math sequence** | | | | | | |
| One level below transfer | 0 | 0 | 0 | 0 | 0 | 0 |
| Two levels below transfer | 0 | 0 | 0 | 0 | 0 | 0 |
| Three levels below transfer | 6,118 | 26 | 6,127 | 100 | 0 | 0 |
| Four levels below transfer | 17,860 | 74 | 0 | 0 | 17,860 | 100 |
| **Ever enrolled in developmental English** | | | | | | |
| 0 | 5,670 | 24 | 1,505 | 25 | 4,165 | 23 |
| 1 | 18,308 | 76 | 4,622 | 75 | 13,686 | 77 |
| **Full-time student** | | | | | | |
| 0 | 18,100 | 75 | 4,693 | 77 | 13,407 | 75 |
| 1 | 5,878 | 25 | 1,434 | 23 | 4,444 | 25 |
| **EOPS participant** | | | | | | |
| 0 | 20,029 | 84 | 5,265 | 86 | 14,764 | 83 |
| 1 | 3,949 | 16 | 862 | 14 | 3,087 | 17 |
| **Student with limited English proficiency** | | | | | | |
| 0 | 22,420 | 94 | 5,795 | 95 | 16,625 | 93 |
| 1 | 1,558 | 6 | 332 | 5 | 1,226 | 7 |
| **Student with disabilities** | | | | | | |
| 0 | 20,656 | 86 | 5,500 | 90 | 15,156 | 85 |
| 1 | 3,314 | 14 | 625 | 10 | 2,689 | 15 |
| **Student educational goal at first term of enrollment** | | | | | | |
| Obtain an associate degree and transfer to a baccalaureate granting institution | 10,372 | 43 | 3,266 | 53 | 7,106 | 40 |

| | Our Relevant Sample | | Students Enrolled in Compressed Arithmetic and Prealgebra | | Students Enrolled in Traditional Arithmetic | |
|---|---|---|---|---|---|---|
| | **Student Count** | **%** | **Student Count** | **%** | **Student Count** | **%** |
| Transfer to a baccalaureate granting institution without an associate degree | 1,718 | 7 | 566 | 9 | 1,152 | 6 |
| Obtain a two-year associate degree without transfer | 3,050 | 13 | 767 | 13 | 2,283 | 13 |
| Earn a career technical certificate without transfer | 421 | 2 | 80 | 1 | 341 | 2 |
| Other | 1,246 | 5 | 208 | 3 | 1,038 | 6 |
| Undecided on goal | 3,013 | 13 | 438 | 7 | 2,575 | 14 |
| 4-year college student taking courses to meet 4-year college requirements | 615 | 2 | 217 | 4 | 398 | 2 |
| No information | 3,543 | 15 | 585 | 10 | 2,958 | 17 |

NOTES: (1) Includes students with known birth dates and valid Social Security Numbers. (2) Includes students ages 15 to 64 at the start of the fall semester of 2013, tracked through the spring semester of 2016. First-term enrollment is defined as the first time a student appears in the CCCCO MIS enrollment file as a non-special admit student (Education Status SB11 not = 10000). (3) Includes students who have taken at least one developmental math or English course. (4) Includes students who took statistics pathway, compressed elementary and intermediate algebra, or compressed arithmetic and prealgebra. (5) Includes students who took traditional arithmetic and traditional elementary algebra. We exclude cells with n<10.

## TABLE B8

Estimated effect of statistics pathway on student success by gender, race/ethnicity, and financial status

| | Estimates | | | |
|---|---|---|---|---|
| | **Completed the Developmental Math Sequence** | **Enrollment in a Transfer-level Statistics Course** | **Completion of a Transfer-level Statistics Course (conditional on enrollment)** | **Completion of a Transfer-level Statistics Course (Throughput)** |
| Statistics pathway | 0.341<br>(0.031)*** | 0.266<br>(0.020)*** | -0.003<br>(0.031) | 0.176<br>(0.015)*** |
| Statistics pathway x female | -0.092<br>(0.062) | -0.084<br>(0.057) | 0.120<br>(0.075) | -0.038<br>(0.056) |
| Statistics pathway x unknown gender | -0.351<br>(0.318) | -0.542<br>(0.344) | 0.115<br>(0.325) | -0.409<br>(0.279) |
| Statistics pathway | 0.370<br>(0.039)*** | 0.255<br>(0.022)*** | 0.107<br>(0.047)** | 0.190<br>(0.021)*** |
| Statistics pathway x Latino | -0.211<br>(0.076)*** | 0.032<br>(0.133) | -0.345<br>(0.125)*** | -0.135<br>(0.139) |
| Statistics pathway x Asian | -0.360<br>(0.163)** | -0.070<br>(0.158) | -0.323<br>(0.135)** | -0.196<br>(0.132) |
| Statistics pathway x African American | -0.242<br>(0.115)** | -0.181<br>(0.177) | -0.440<br>(0.198)** | -0.345<br>(0.163)** |
| Statistics pathway x other race | 0.235<br>(0.185) | 0.178<br>(0.152) | -0.207<br>(0.203) | 0.050<br>(0.168) |
| Statistics pathway x unknown race | -- | -0.304<br>(0.488) | -0.030<br>(0.597) | -0.291<br>(0.399) |
| Statistics pathway | 0.369<br>(0.035)*** | 0.264<br>(0.020)*** | 0.026<br>(0.031) | 0.178<br>(0.015)*** |
| Statistics pathway x BOGW/Pell recipient | -0.175<br>(0.097)* | -0.061<br>(0.069) | -0.014<br>(0.096) | -0.050<br>(0.071) |

NOTES: Each box (3) represents a different regression. The Statistics pathway coefficient denotes the estimated gap between statistics pathway students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between statistics pathway and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group is the sum of the coefficients of statistics pathway and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.
*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

## TABLE B9

Estimated effect of statistics pathway on student success by gender, race/ethnicity, and financial status, cont.

| Estimates | | | | |
|---|---|---|---|---|
| | **Enrollment in a Transfer-level Math Course** | **Completion of a Transfer-level Math Course (conditional on enrollment)** | **Completion of a Transfer-level Math Course (Throughput)** | **Earned a certificate/associate's degree or transferred** |
| Statistics pathway | 1.237<br>(0.099)*** | 0.959<br>(0.076)*** | -0.039<br>(0.101) | 0.442<br>(0.068)*** |
| Statistics pathway x female | -0.044<br>(0.064) | 0.014<br>(0.053) | 0.147<br>(0.080)* | 0.061<br>(0.055) |
| Statistics pathway x unknown gender | -0.514<br>(0.354) | -0.318<br>(0.273) | 0.282<br>(0.294) | -- |
| Statistics pathway | 1.239<br>(0.094)*** | 1.126<br>(0.109)*** | 0.359<br>(0.138)*** | 0.510<br>(0.082)*** |
| Statistics pathway x Latino | -0.013<br>(0.119) | -0.195<br>(0.133) | -0.373<br>(0.121)*** | 0.019<br>(0.057) |
| Statistics pathway x Asian | -0.127<br>(0.160) | -0.278<br>(0.131)** | -0.372<br>(0.133)*** | 0.042<br>(0.096) |
| Statistics pathway x African American | -0.203<br>(0.167) | -0.391<br>(0.149)*** | -0.490<br>(0.191)** | -0.376<br>(0.134)*** |
| Statistics pathway x other race | 0.134<br>(0.152) | 0.047<br>(0.167) | -0.107<br>(0.192) | -0.161<br>(0.143) |
| Statistics pathway x unknown race | -0.303<br>(0.510) | -0.319<br>(0.406) | -0.083<br>(0.596) | 0.079<br>(0.433) |
| Statistics pathway | 1.287<br>(0.090)*** | 1.035<br>(0.090)*** | 0.106<br>(0.091) | 0.548<br>(0.077)*** |
| Statistics pathway x BOGW/Pell recipient | -0.100<br>(0.066) | -0.085<br>(0.068) | -0.053<br>(0.086) | -0.088<br>(0.054) |

NOTES: Each box (3) represents a different regression. The Statistics pathway coefficient denotes the estimated gap between statistics pathway students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between statistics pathway and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group is the sum of the coefficients of statistics pathway and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.
*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

**TABLE B10**

Estimated effect of statistics pathway on student success by gender, race/ethnicity, and financial status, cont.

| Estimates | | | |
|---|---|---|---|
| | **Total Units Completed** | **Total Transfer Units Completed** | **Total Units Completed As Share of Units Attempted** |
| Statistics pathway | 5.829<br>(1.243)*** | 6.259<br>(1.122)*** | 4.062<br>(1.165)*** |
| Statistics pathway x female | -1.419<br>(1.013) | -0.264<br>(0.824) | -1.084<br>(1.007) |
| Statistics pathway x unknown gender | -5.858<br>(5.559) | -7.551<br>(6.054) | -14.067<br>(4.535)*** |
| Statistics pathway | 6.379<br>(1.217)*** | 7.748<br>(1.262)*** | 5.304<br>(1.551)*** |
| Statistics pathway x Latino | -1.353<br>(1.278) | -1.632<br>(1.160) | -2.246<br>(1.315)* |
| Statistics pathway x Asian | -5.934<br>2.366)** | -4.962<br>(1.910)** | -5.790<br>2.427)** |
| Statistics pathway x African American | -4.807<br>2.340)** | -5.428<br>(1.968)*** | -5.467<br>2.006)*** |
| Statistics pathway x other race | 3.064<br>(1.805)* | 2.408<br>(1.609) | 1.870<br>2.313) |
| Statistics pathway x unknown race | 3.009<br>(7.839) | -3.687<br>(5.333) | 9.714<br>(7.956) |
| Statistics pathway | 4.456<br>(1.338)*** | 5.564<br>(1.241)*** | 3.157<br>(1.658)* |
| Statistics pathway x BOGW/Pell recipient | 0.498<br>(1.334) | 0.578<br>(1.283) | 0.130<br>(1.606) |

NOTES: Each box (3) represents a different regression. The Statistics pathway coefficient denotes the estimated gap between statistics pathway students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between statistics pathway and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group is the sum of the coefficients of statistics pathway and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.

*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

**TABLE B11**

Estimated effect of compressed elementary/intermediate algebra on student success by gender, race/ethnicity, and financial status

| Estimates | | | | |
|---|---|---|---|---|
| | **Completed the Developmental Math Sequence** | **Enrollment in a Transfer-level Math Course** | **Completion of a Transfer-level Math Course (conditional on enrollment)** | **Completion of a Transfer-level Math Course (Throughput)** |
| Compressed Elem/Interm Algebra | 0.651<br>(0.194)*** | 0.592<br>(0.145)*** | -0.243<br>(0.089)*** | 0.380<br>(0.125)*** |
| Compressed Elem/Interm Algebra x female | 0.117<br>(0.096) | 0.147<br>(0.097) | 0.093<br>(0.119) | 0.141<br>(0.095) |
| Compressed Elem/Interm Algebra x unknown gender | -- | -- | -- | -- |
| Compressed Elem/Interm Algebra | 0.576<br>(0.249)** | 0.677<br>(0.140)*** | -0.503<br>(0.125)*** | 0.315<br>(0.116)*** |
| Compressed Elem/Interm Algebra x Latino | 0.276<br>(0.246) | 0.044<br>(0.191) | 0.361<br>(0.098)*** | 0.206<br>(0.177) |
| Compressed Elem/Interm Algebra x Asian | 0.057<br>(0.207) | 0.006<br>(0.148) | 0.335<br>(0.152)** | 0.180<br>(0.143) |
| Compressed Elem/Interm Algebra x African American | -0.176<br>(0.269) | -0.180<br>(0.220) | 0.503<br>(0.269)* | 0.073<br>(0.259) |
| Compressed Elem/Interm Algebra x other race | 0.052<br>(0.156) | -0.091<br>(0.194) | 0.498<br>(0.363) | 0.112<br>(0.165) |
| Compressed Elem/Interm Algebra x unknown race | -0.219<br>(0.298) | -0.077<br>(0.473) | 0.790<br>(0.506) | 0.192<br>(0.311) |
| Compressed Elem/Interm Algebra | 0.779<br>(0.216)*** | 0.685<br>(0.203)*** | 0.004<br>(0.135) | 0.544<br>(0.176)*** |
| Compressed Elem/Interm Algebra x BOGW/Pell recipient | -0.063<br>(0.100) | -0.003<br>(0.153) | -0.209<br>(0.110)* | -0.086<br>(0.126) |

NOTES: Each box (3) represents a different regression. The Compressed Elementary/Intermediate Algebra coefficient denotes the estimated gap between compressed elementary/intermediate algebra students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between compressed elementary/intermediate algebra and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group sums the coefficients of compressed elementary/intermediate algebra and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.

*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

**TABLE B12**

Estimated effect of compressed elementary/intermediate algebra on student success by gender, race/ethnicity, and financial status, cont.

| | Estimates | | | |
|---|---|---|---|---|
| | Earned a certificate/associate's degree or transferred | Total Units Completed | Total Transfer Units Completed | Total Units Completed As Share of Units Attempted |
| Compressed Elem/Interm Algebra | 0.131<br>(0.075)* | 3.078<br>2.387) | 4.582<br>(1.946)** | 0.021<br>2.523) |
| Compressed Elem/Interm Algebra x female | -0.100<br>(0.103) | 1.197<br>(1.944) | 1.430<br>(1.871) | 2.628<br>(1.268)** |
| Compressed Elem/Interm Algebra x unknown gender | 0.674<br>(1.030) | 7.345<br>2.369)*** | 5.758<br>(1.890)*** | 14.275<br>(12.522) |
| Compressed Elem/Interm Algebra | 0.024<br>(0.138) | 4.010<br>(1.418)*** | 5.630<br>(1.235)*** | 0.946<br>(1.619) |
| Compressed Elem/Interm Algebra x Latino | 0.089<br>(0.160) | 0.824<br>2.587) | 0.189<br>2.107) | 1.808<br>2.855) |
| Compressed Elem/Interm Algebra x Asian | 0.039<br>(0.255) | -1.561<br>(3.467) | 0.008<br>(3.593) | 0.997<br>(1.954) |
| Compressed Elem/Interm Algebra x African American | 0.113<br>(0.156) | -5.347<br>(3.890) | -4.815<br>(3.507) | -6.055<br>(3.869) |
| Compressed Elem/Interm Algebra x other race | -0.260<br>(0.331) | 1.215<br>2.532) | 0.177<br>2.713) | 4.430<br>2.549)* |
| Compressed Elem/Interm Algebra x unknown race | -0.089<br>(0.554) | -0.559<br>(4.094) | 0.677<br>(3.712) | 0.335<br>(7.159) |
| Compressed Elem/Interm Algebra | 0.009<br>(0.131) | 4.697<br>2.231)** | 5.947<br>(1.637)*** | 0.329<br>2.767) |
| Compressed Elem/Interm Algebra x BOGW/Pell recipient | 0.082<br>(0.143) | -0.994<br>(1.738) | -0.807<br>(1.374) | 1.603<br>(1.843) |

NOTES: Each box (3) represents a different regression. The Compressed Elementary/Intermediate Algebra coefficient denotes the estimated gap between compressed elementary/intermediate algebra students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between compressed elementary/intermediate algebra and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group sums the coefficients of compressed elementary/intermediate algebra and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.

*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

**TABLE B13**

Estimated effect of compressed arithmetic/prealgebra on student course success by gender, race/ethnicity, and financial status

| | Estimates | | | |
|---|---|---|---|---|
| | **Completed the Developmental Math Sequence** | **Enrollment in a Transfer-level Math Course** | **Completion of a Transfer-level Math Course (conditional on enrollment)** | **Completion of a Transfer-level Math Course (Throughput)** |
| Compressed Arithm/Prealgebra | 0.622<br>(0.099)*** | 0.592<br>(0.145)*** | -0.243<br>(0.089)*** | 0.391<br>(0.078)*** |
| Compressed Arithm/Prealgebra x female | 0.008<br>(0.038) | 0.027<br>(0.056) | 0.036<br>(0.180) | 0.061<br>(0.057) |
| Compressed Arithm/Prealgebra x unknown gender | -- | -- | -- | -- |
| Compressed Arithm/Prealgebra | 0.722<br>(0.106)*** | 0.677<br>(0.140)*** | -0.503<br>(0.125)*** | 0.603<br>(0.093)*** |
| Compressed Arithm/Prealgebra x Latino | -0.112<br>(0.076) | -0.131<br>(0.075)* | -0.172<br>(0.252) | -0.202<br>(0.087)** |
| Compressed Arithm/Prealgebra x Asian | -0.002<br>(0.160) | -0.044<br>(0.121) | -0.126<br>(0.273) | -0.103<br>(0.106) |
| Compressed Arithm/Prealgebra x African American | -0.120<br>(0.155) | -0.212<br>(0.141) | -0.139<br>(0.448) | -0.301<br>(0.145)** |
| Compressed Arithm/Prealgebra x other race | -0.268<br>(0.123)** | -0.329<br>(0.178)* | -0.710<br>(0.447) | -0.563<br>(0.233)** |
| Compressed Arithm/Prealgebra x unknown race | -0.361<br>(0.205)* | 0.173<br>(0.264) | -0.188<br>(0.918) | 0.146<br>(0.356) |
| Compressed Arithm/Prealgebra | 0.637<br>(0.121)*** | 0.685<br>(0.203)*** | 0.004<br>(0.135) | 0.498<br>(0.102)*** |
| Compressed Arithm/Prealgebra x BOGW/Pell recipient | -0.012<br>(0.081) | -0.059<br>(0.088) | -0.132<br>(0.214) | -0.080<br>(0.088) |

NOTES: Each box (3) represents a different regression. The Compressed Arithm/Prealgebra coefficient denotes the estimated gap between compressed arithmetic/prealgebra students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between compressed arithmetic/prealgebra and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group sums the coefficients of compressed arithmetic/prealgebra and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.
*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

**TABLE B14**

Estimated effect of compressed arithmetic/prealgebra on student course success by gender, race/ethnicity, and financial status, cont.

| | Estimates | | | |
|---|---|---|---|---|
| | **Earned a certificate/associate's degree or transferred** | **Total Units Completed** | **Total Transfer Units Completed** | **Total Units Completed As Share of Units Attempted** |
| Compressed Arithm/Prealgebra | -0.013<br>(0.095) | 5.752<br>(1.537)*** | 2.910<br>(1.049)*** | 2.547<br>(1.940) |
| Compressed Arithm/Prealgebra x female | 0.103<br>(0.053)* | 1.181<br>(0.856) | 0.987<br>(0.700) | 1.445<br>(1.093) |
| Compressed Arithm/Prealgebra x unknown gender | -- | -- | -- | -- |
| Compressed Arithm/Prealgebra | 0.181<br>(0.140) | 7.364<br>(1.582)*** | 4.397<br>(1.149)*** | 4.357<br>2.227)* |
| Compressed Arithm/Prealgebra x Latino | -0.158<br>(0.102) | -0.823<br>(0.991) | -1.019<br>(0.875) | -0.886<br>(1.315) |
| Compressed Arithm/Prealgebra x Asian | -0.017<br>(0.124) | -3.537<br>(1.371)** | -1.217<br>(1.151) | -4.174<br>2.534) |
| Compressed Arithm/Prealgebra x African American | -0.164<br>(0.133) | -1.443<br>2.033) | -1.197<br>(1.609) | -0.638<br>2.352) |
| Compressed Arithm/Prealgebra x other race | -0.024<br>(0.120) | -2.913<br>(1.554)* | -1.592<br>(1.215) | -2.876<br>2.121) |
| Compressed Arithm/Prealgebra x unknown race | 0.204<br>(0.315) | -1.814<br>(4.629) | 0.161<br>(3.162) | -7.287<br>(6.318) |
| Compressed Arithm/Prealgebra | 0.025<br>(0.124) | 6.541<br>(1.937)*** | 3.340<br>(1.400)** | 2.219<br>2.300) |
| Compressed Arithm/Prealgebra x BOGW/Pell recipient | 0.024<br>(0.088) | -0.127<br>(1.120) | 0.154<br>(0.915) | 1.307<br>(1.354) |

NOTES: Each box (3) represents a different regression. The Compressed Arithm/Prealgebra coefficient denotes the estimated gap between compressed arithmetic/prealgebra students and traditional developmental math students in relation to each outcome variable, but only for the reference group of each category of student characteristic. For gender, the reference group is male; for race/ethnicity, the reference group is white; for financial status, the reference group is non-BOGW/Pell recipient. The interaction term between compressed arithmetic/prealgebra and each student attribute denotes the difference in the gap between the reference group and the comparison group. The coefficient for the comparison group sums the coefficients of compressed arithmetic/prealgebra and the interaction term. Standard errors are clustered at the student level, denoted in parentheses. Each regression includes term and college fixed effects.
*** Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

# Appendix C. Developmental Math Reforms

Below we briefly summarize the various approaches to developmental math reform in California's Community Colleges (CCC). In addition, Figure 1 provides a count of the math pathways offered in CCC. To determine which non-traditional math pathways are offered, we draw on prior research and an exhaustive scan of 2016–17 college catalogs and institutional websites (Cuellar Mejia et al. 2016). To determine whether CCCs were planning assessment and placement reforms we draw on a 2016 PPIC survey of assessment and placement policies (Rodriguez, et al., 2016).

- **Statistics pathways.** This approach, also known as curriculum redesign, aims to offer an alternative developmental math course (e.g. pre-statistics) that better aligns with the skills students need to know for transfer-level statistics[3], the transfer-math course most students take. In addition to better aligning with the statistics course, this approach can reduce the amount of time students spend in developmental math and eliminate exit points by reducing the number of courses in the sequence from four levels to at most two. The statistics pathway began to be offered as early as 2009 and has grown significantly over the last few years. Indeed, between 2013 and 2016, statistics pathways experienced the biggest gain going from 24 colleges to 45 colleges over this timeframe.
- **Compression.** This approach shortens the traditional developmental sequence by combining two levels of the traditional developmental math sequence into a single course. This approach can reduce the amount of time students spend in developmental math and eliminate exit points by reducing the number of courses in the sequence from four levels to two or three, depending on whether the full sequence is compressed or only half of the sequence is compressed, respectively. Compression aims to streamline content, for example, by reducing the amount of time spent on review and eliminating redundancies. We find that in 2016, 45 community colleges offered at least one compressed course; 28 colleges offered arithmetic and pre-algebra compressed into a single course, while 21 colleges combined elementary and intermediate algebra into a single course and 5 colleges offered both types of compression. Compression also grew significantly between 2013 and 2016, going from 27 to 45 colleges within this timeframe.
- **Contextualization.** Contextualization provide students with an alternative curricular option that is more aligned with their program of study. Examples of these types of courses include, intermediate algebra for business and intermediate algebra for healthcare. While this approach does not necessarily reduce the length of the developmental math sequence, the ability to focus learning on math concepts and skills needed to succeed in subsequent coursework for a given program of study is considered to be a strength of this approach. We find that the number of colleges offering multiple pathways declined slightly between 2013-14 and 2016-17, going from 46 to 44.
- **Modularization.** Under this approach, the math curriculum is divided into modules that represent discrete math learning outcomes or competencies. Modularization allows students to focus their learning on the skills that were assessed as needing further development—in such a way, students can skip content/modules where they have shown proficiency and thus accelerating progress through developmental math. Modularization is often done using computer mediated instruction. Our scan of courses found that between 2013 and 2016 the number of colleges offering some kind of modularized instruction increased from 15 to 17.
- **Co-requisite:** This approach allows developmental math students to simultaneously enroll in a transfer-level math course, such as Pre-Calculus or Statistics alongside with a support course. The support course can take on the form of a companion developmental math course, lab time, supplemental instruction and the like. This approach is new to California, only 5 community colleges had began offering co-requisites in fall 2016.

[3] The majority of statistics pathway students fulfil their transfer-level math requirement with transfer-level statistics, either general (offered in the math department) or specialized (offered in psychology, political science, etc.). Additionally, statistics pathway courses at some colleges (6) also lead to other non-STEM transfer-level math courses such as Liberal Arts Math.

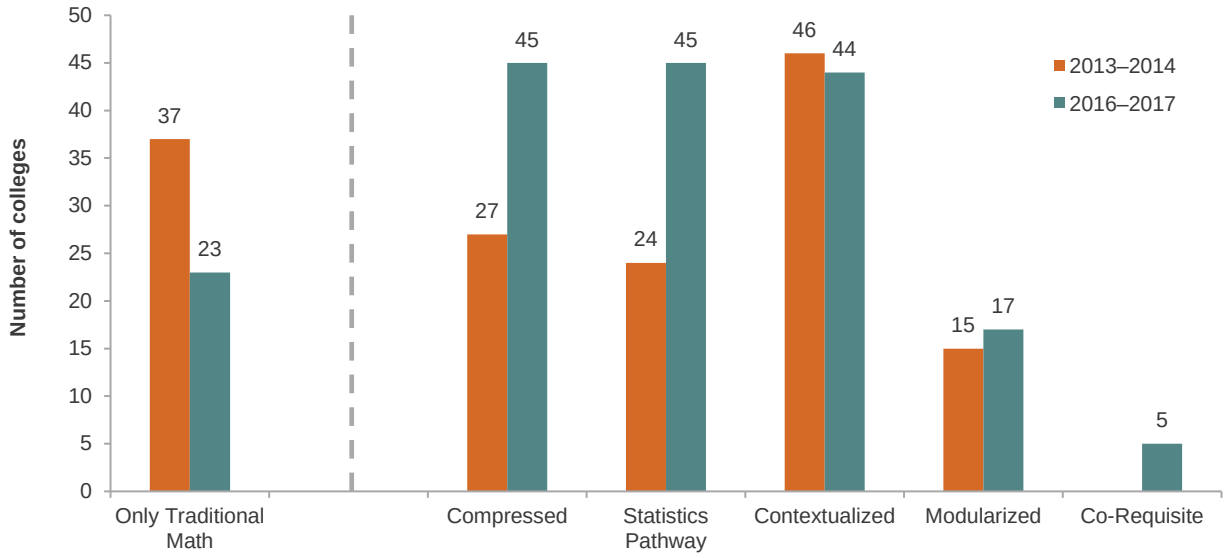
- **Placement Reform.** Placement reform aims to broaden access to transfer-level courses and make access more equitable by adjusting cut scores, using robust multiple measures, and requiring algebra-based testing and developmental education only for access to courses that require substantial algebra. Our research finds that the majority (91%) of colleges across the state are planning for placement reform, often as part of their involvement with the Common Assessment Initiative and the Multiple Measures Assessment Project.

It is important to note that even though an increasing number of colleges across the state have begun to reform developmental math, our scan revealed that 20 percent (23) of colleges were not implementing any curricular reform. Furthermore, even within colleges that have implemented reforms, many have not implemented at scale and continue to offer most sections using the traditional developmental math approach. Therefore, it is not surprising that we find that the overwhelming majority of students are not touched by the curricular reforms—less than 10 percent of all developmental math enrollment was in one of the alternative course formats.

While this report focuses on statistics and compressed math pathways, future PPIC research will examine the role of the other curricular and placement reforms.

**FIGURE C1**

Compressed and statistics pathway courses are the most prevalent developmental math reforms




SOURCE: Authors' 2016-2017 estimates based on an exhaustive scan of CCC catalogs and websites for courses offered in 2016–17.

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Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111
T: 415.291.4400
F: 415.291.4401
**PPIC.ORG**

PPIC Sacramento Center
Senator Office Building
1121 L Street, Suite 801
Sacramento, CA 95814
T: 916.440.1120
F: 916.440.1121