Wheelhouse
The Center for Community College Leadership and Research

Research Brief
Volume 4, Number 3
December 2019

UCDAVIS SCHOOL OF EDUCATION

Starting Off on the Wrong Foot

Math Misalignment and STEM Outcomes in California Community Colleges

By Elizabeth Park, Federick Ngo and Tatiana Melguizo

ACROSS THE NATION and in California in particular, labor market demand for workers trained in the STEM fields—science, technology, engineering and math—is strong. California's workforce added 161,000 STEM jobs between 2009 and 2015, with significant growth expected in the future.[1] In addition to contributing to the vitality of the U.S. economy, STEM fields have substantial individual payoffs as well: the median wage of STEM workers in 2018 was $84,800, compared to $37,020 in non-STEM fields.[2]

Community colleges educate and train many low-income students and students of color who aspire to enter STEM fields. From 2010 to 2016 however, approximately 65% of first-time California community college enrollees—many of them aspiring to degrees and careers in STEM—started their college trajectory in developmental math courses for which they made no progress toward degree or transfer.[3]

In theory, students who have successfully completed high school math requirements should not need math remediation in community college. That so many did is a strong indication of misalignment between high school and community college expectations.

This brief examines *inter-sector math misalignment*, the mismatch between high school GPA and advanced math course-taking (two benchmarks of readiness in high school) and community college math placement (a key benchmark of readiness in college).[4] In particular, we focus on STEM-aspiring students to test the extent of the penalty of math misalignment for this population.

Background and Context

Prior to 2018, all California community colleges used some form of placement test to assess students' math level, though the specific matriculation policy varied by campus.[5] The overreliance on placement tests often resulted in erroneous placement into

TOPLINES

- The majority of STEM-aspiring students who earned a 3.4 GPA in high school (or earned a 2.6 GPA but took calculus) were placed below transfer-level math in community college.
- Students placed directly into transfer-level math, on average, completed 7 to 14 more transferable STEM units compared to those placed into lower-level math courses.
- Math is an integral subject in nearly all STEM disciplines and placing lower than expected into developmental math may sidetrack students who aspire to enter STEM fields.

DATA AND METHODS

This brief is based on a study that linked longitudinal transcript data obtained through partnerships with a large urban school district and a large urban community college district in the same metropolitan area in California.[9] We focused on high school graduates who enrolled in a local community college between 2009 to 2014 within three years of graduation. A variety of statistical models were used to estimate the relationship between math misalignment and multiple STEM outcomes and to determine whether the experience of math misalignment differentially affected students in STEM pathways, while controlling for a wide range of factors (such as academic achievement in high school) that could affect these outcomes.

developmental coursework for a significant proportion of community college students.[6] Studies estimated that as many as a quarter of math students were unnecessarily placed into lower-level courses and that misplacement hindered students' academic success.[7] As such, several states now mandate the use of multiple measures like high school records in determining students' college placement.[8]

In 2018, a change in California law (Assembly Bill 705 or AB 705) mandated that California community colleges use high school performance criteria instead of placement tests in making course placement decisions. It is important to note that the research reported here does not directly address the effects of AB 705 itself. Instead, it highlights the negative impacts of placing high-achieving students into math courses below transfer level that do not count toward degree. These results are particularly relevant as California community colleges adapt their practices to comply with AB 705.

Findings

Overall, more than half of the students experienced math misalignment in community college, whether or not they had expressed a desire to pursue STEM degrees. This misalignment had measurable consequences for student trajectories on their desired paths: STEM-aspiring students who experienced math misalignment completed fewer STEM units than STEM-aspiring students who were directly placed into transfer-level math.

Table 1 below shows the percentage of students placed into each level of community college math by the level of high school courses they completed. The first three rows show CCC math placement by high-school course-taking. The most common math placement among STEM-aspiring students who took algebra 2 in high school was pre-algebra in college (50%). But even among those students who took calculus in high school, just over half placed directly into transfer-level math. The fourth row shows that only 25% of students with a high school GPA greater than or equal to 3.0 were placed into transfer-level math. Finally, the fifth row shows math placement for students who met the multiple measure criteria most relevant to STEM-aspiring students according to AB 705—graduating from high school with at least a 3.4 HS GPA or having taken calculus.[13] Only 40% of students who met these criteria placed directly in transfer-level math.

Table 1. College Math Course Placement by HS Criteria among STEM-Aspiring Students

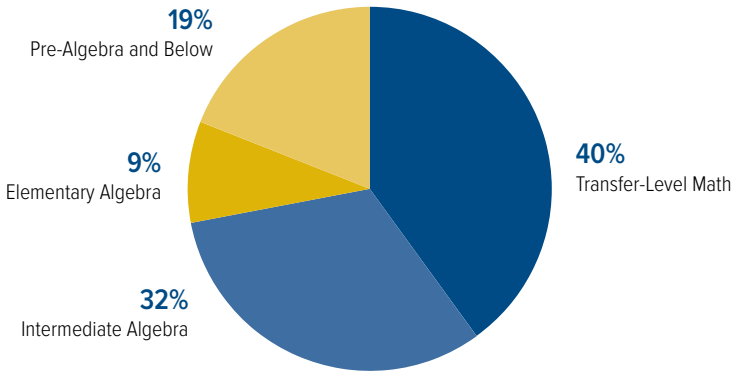
HIGH SCHOOL MATH EXPERIENCE	MATH PLACEMENT IN COLLEGE				
	Transfer-Level	Intermediate Algebra	Elementary Algebra	Pre-Algebra and Below	N
Highest HS Math = Algebra 2	3%	20%	27%	50%	3,697
Highest HS Math = Pre-Calculus	16%	34%	21%	29%	2,273
Highest HS Math = Calculus	51%	29%	7%	13%	611
HS GPA>=3.0	25%	31%	17%	27%	1,921
HS GPA>=3.4 or HS GPA>=2.6 + Calculus	40%	32%	9%	19%	1,010

Note: The shaded cells indicate the course placements that are misaligned based on students' high school transcript.

Figure 1 shows math placement for STEM-aspiring students, focusing on the multiple measures criteria most relevant to these students outlined in AB 705 (high school GPA ≥3.4 or HS GPA ≥2.6 and took Calculus). Only 40% of STEM-aspiring students were placed into transfer-level math. An additional 32% of students were only placed into intermediate algebra (equivalent to algebra 2). Over a quarter of students who met these criterion placed into elementary algebra, pre-algebra, or arithmetic.

Only 40% of STEM-aspiring students were placed into transfer-level math.

Figure 1. College Math Placement Among STEM-aspiring Students Who Earned a 3.4 High School GPA or Earned a 2.6 GPA *and* Took Calculus in High School



NOTE: All courses in the figure above are credit-bearing; however only intermediate algebra and above are considered degree-applicable. Transfer-level math is considered both degree-applicable and transferrable to the UC/CSU.

Figure 2 shows that math misaligment had signficant impacts on college performance and STEM transferable unit acccumulation for students who had either earned a 3.4 high school GPA, or had earned a 2.6 high school GPA and took calculus.

KEY TERMS

AB 705
Legislation enacted in 2018 that requires all California community colleges to use, instead of placement tests, at least one of three criteria to determine course placement: high school course taking, course grades, and/or grade point average (GPA).

STEM-aspiring Students
Students who stated intent to major in a STEM field, (including life science or physical science and engineering), on their college application.[10]

Math Misalignment
Students placed in a lower level of math than their high school transcript would suggest they are prepared for.[11] We examined three types of misalignment:

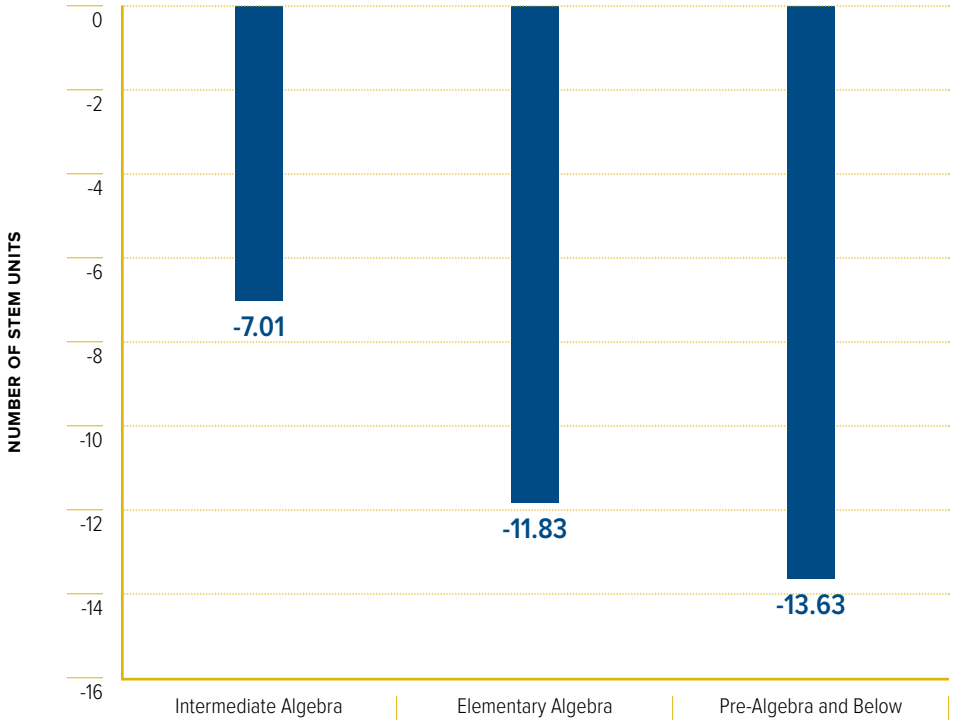
1. The mismatch between high school math course-taking (algebra 2, pre-calculus or calculus) and math placement in college.
2. The mismatch between overall high school GPA (greater or equal to 3.0) and math placement in college.
3. The mismatch between a combination of overall high school GPA and high school math grades and college math placement. This is for students who either earned at least a 3.4 high school GPA, or earned an overall high school GPA of 2.6 or higher *and* took calculus.

The second and third types of misalignment were derived from the rules developed for AB 705.[12] According to AB 705, students who intend to major in STEM must either have at least a 3.4 HS GPA or at least a 2.6 HS GPA and have enrolled in calculus in order to be directly placed in transfer-level math without additional math support.

Even among STEM-aspiring students with similar levels of high school achievement, the difference in placement had profound effects on overall STEM credit accumulation.

Students who were directly placed in transfer-level math completed seven more transferable STEM units (about two courses) compared to students who were placed into intermediate algebra, almost 12 units more than students in elementary algebra, and 13.6 more units than those placed into elementary algebra. Importantly, this relationship held after controlling for student background, academic achievement in high school (e.g., grades, standardized test scores), and feeder high school. That is, even among STEM-aspiring students with similar levels of high school achievement, the difference in placement had profound effects on overall STEM credit accumulation.

Figure 2. Transferable STEM Units Completed after Math Misalignment



Even among STEM-aspiring students who successfully completed calculus in high school, only about 50% were placed into transfer-level math in community college.

Why Does It Matter?

Inter-sector math misalignment is critical to understanding postsecondary STEM attainment among community college students. For one, math is integral to nearly all STEM disciplines. Secondly, students who placed lower than expected in community college math may lose important momentum and interest in STEM that they developed in high school.[14]

Before AB 705, the lack of a common definition of college readiness resulted in the placement of a large proportion of students in below-college-level math. Even among STEM-aspiring students who successfully completed calculus in high school, fewer than 50% were placed into transfer-level math in community college.

On average, students who experienced math misalignment completed 7 to 14 fewer transferable STEM units than those who did not. This has significant cost implications for

both students and institutions as seemingly college-ready students have to repeat course material they have already mastered, as demonstrated by their grades, in high school.

Finally, these findings suggest that math misalignment hindered many of the very students with the greatest STEM interest. This imposes significant costs in terms of STEM momentum as students received a negative signal regarding their academic preparation that may not have been justified.

What can colleges do?

As community colleges revamp their assessment and placement policies to comply with AB 705, efforts like these could help reduce misalignment:

- Establish a systematic data sharing agreement between high schools and community colleges to illuminate issues of misalignment from both sides.
- Encourage community college math faculty to collaborate with local high school teachers to create courses, so that the rigor of those courses is valued and the knowledge and skills students bring from high school is trusted.
- Expand dual enrollment partnerships with high schools as a low-cost way of allowing students to understand college course expectations and complete college courses while still in high school.
- For students whose high school records are difficult to evaluate, such as international students or students with older high school records, develop consistent standards across colleges to ensure that fewer students experience math misalignment.
- Use high school records to identify STEM potential, talent and aspiration, and encourage these students to pursue STEM.

Conclusion

Students who experienced math misalignment likely received one message about their academic preparation in high school and a very different message in college. This misalignment penalty is akin to "starting off on the wrong foot": STEM-aspiring students who experienced math misalignment face the burden of rectifying a bad start. Our results suggest that if math misalignment were reduced, STEM-aspiring students entering community colleges would likely complete more transferable STEM courses, and, potentially, increase their likelihood of STEM degree attainment and experience the labor market advantages such attainment provides.

These findings underscore the importance of aligning academic standards across high school and postsecondary institutions as a means of improving STEM participation and student success. The findings also suggest that the recent AB 705 policy emphasizing high school preparation in placement decisions may open more doors for underserved STEM-aspiring students in community colleges. But even with this directive, colleges vary significantly in their approaches to implementing the new policy.

The impact of this new state policy to address equity and historical opportunity gaps could be dampened absent strong collaboration between high school and college faculty, and strong college-level commitments to place the majority of STEM-aspiring students in college-level math with the supports necessary to help them achieve their career goals.

Our results suggest that if math misalignment were reduced, STEM-aspiring students entering community colleges would likely complete more transferable STEM courses, and, potentially, increase their likelihood of STEM degree attainment and experience the labor market advantages such attainment provides.

Elizabeth Park is a Postdoctoral Scholar at the Teaching and Learning Center and the Education Research Initiative at UC Irvine. Federick Ngo is an Assistant Professor at University of Nevada, Las Vegas. Tatiana Melguizo is an Associate Professor in the USC Rossier School of Education.

The research upon which this brief was based was supported through the generosity of the National Science Foundation (EAGER), the University of Southern California Russell Endowed Fellowship, and the Haynes Foundation. The opinions expressed are those of the authors and do not represent the views of the granting agencies. Wheelhouse and the authors are grateful to the College Futures Foundation for its support of this brief and its dissemination.

[1] Fayer, S., Lacey, A. & Watson, A. (2017). *STEM occupations: Past, present and future.* Washington, D.C.: Bureau of Labor Statistics.
[2] Bureau of Labor Statistics (2018). Employment in STEM occupations, 2018 and projected 2028. Retrieved from https://www.bls.gov/emp/tables/stem-employment.htm
[3] Mejia, M. C., Rodriguez, O., & Johnson, H. (2016). *Preparing students for success in California's community colleges.* San Francisco, CA: Public Policy Institute of California.
[4] Melguizo, T., & Ngo, F. (in press). Mis/Alignment between high school and community college standards. *Educational Researcher.*
[5] Melguizo, T., Kosiewicz, H., Prather, G., & Bos, H. (2014). How are community college students assessed and placed in developmental math? Grounding our understanding in reality. *Journal of Higher Education, 85*(5), 691–722; Rodriguez, O., Mejia, M., & Johnson, H. (2016). *Determining college readiness in California's community colleges: A survey of assessment and placement policies.* San Francisco, CA: Public Policy Institute of California.
[6] Bahr, P. R., Fagioli, L. P., Hetts, J., Hayward, C., Willett, T., Lamoree, D., Newell, M. A., Sorey, K., & Baker, R. B. (2019). Improving placement accuracy in California's community colleges using multiple measures of high school achievement. *Community College Review, 47*(2), 178-211. doi:10.1177/0091552119840705
[7] Ngo, F., Chi, W. E., & Park, E. (2018). Mathematics course placement using holistic measures: Possibilities for community college students. *Teachers College Record, 120*(3); Scott-Clayton, J., Crosta, P. M., & Belfield, C. R. (2014). Improving the targeting of treatment: Evidence from college remediation. *Educational Evaluation and Policy Analysis, 3*6(3), 371–393.
[8] Scott-Clayton, J. (2018). *Evidence-based reforms in college remediation are gaining steam – and so far living up to the hype.* Washington D.C.: The Brookings Institution.
[9] Park, E.S., Ngo, F., & Melguizo, T. (under review). The role of math misalignment in the community college STEM pathway.
[10] This encompasses a broader definition of STEM to include those who indicated majors like Engineering Technicians and Medical Assistants. As these students typically take a significant number of STEM courses, they were included in the definition.
[11] These analyses are based on high school course enrollment, but results are similar when restricted to those who received an A or B in their advanced math courses.
[12] Research and Planning Group (2018) *Multiple measures assessment project (MMAP) spring 2018 implementation survey results.*
[13] Under AB 705, these are the criteria to be directly placed into transfer-level math without additional math support.
[14] Wang, X. (2015). Pathway to a baccalaureate in STEM fields: Are community colleges a viable route and does early STEM momentum matter? *Educational Evaluation and Policy Analysis, 37*(3), 376-393.

Wheelhouse: The Center for Community College Leadership and Research was established in 2016 to support California community college leaders through annual professional learning institutes and independent, actionable research. Wheelhouse is supported by the University of California, Davis, the Institutional Effectiveness Partnership Initiative (California Community College Chancellor's Office), the James Irvine Foundation and the College Futures Foundation.

Join our email list at **education.ucdavis.edu/wheelhouse-mail-list**.