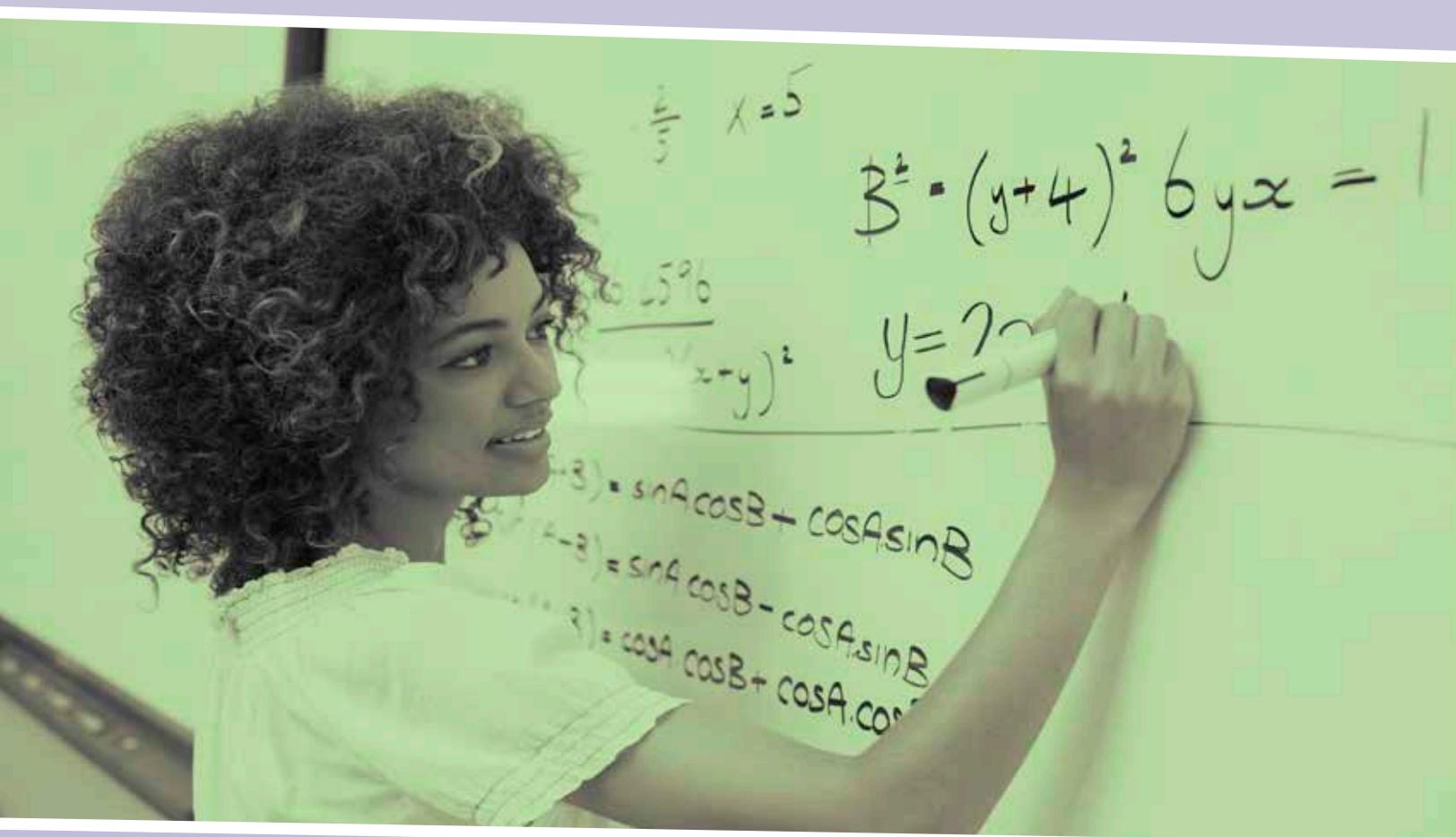


Assessment and Placement Policies and Practices in Developmental Math

**Evidence from Experimentation in a Large Urban
Community College District in California**



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ACKNOWLEDGEMENTS

First, we want to thank the Large Urban Community College District, its research department, its math faculty, and its students, for their active participation in this research projects over the past five years. We also would like to thank all the members of the advisory committee to this project: Paco Martorell, Sarah Reber, Lucrecia Santibanez, Juan Esteban Saavedra, and Gary Painter for invaluable feedback during the first two years of the projects.

In addition, we would also like to thank a number of researchers that supported the team at different parts of the project: Bo Kim, Will Kwon, Nicholas Mills, and Lindsay Poland. Special thanks to a number of undergraduate students who benefitted from the Undergraduate Research Program (URAP) at USC for their invaluable research assistance at different points throughout the duration of the project: Samantha Castillo, Haley Demian, Anoush Djobashian, John Hernandez, Dorothy Le, Janet Nahn, Robert Raad, and George Wu.

This research was supported by a grant from the Institute of Education Sciences, U.S. Department of Education, through Grant R305A100381 to the University of Southern California. Additional support was received from an internal grant from the Advancing Scholarship in the Humanities and Social Sciences (ASHSS) Initiative of the University of Southern California, Office of the Provost. Opinions are those of the authors alone and do not necessarily reflect those of the granting agencies or of the authors' home institutions.

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UNIVERSITY OF SOUTHERN CALIFORNIA

NOVEMBER 2015

Background and Overview

Community college students who start their educational journey in developmental education tend to fare poorly in degree attainment. For every 100 students who enter community college in California, 80 of them will start in a developmental math or English course (Grubb, 2013; NCPPHE & SREB, 2010). Of these 80 students, only about 25 students will take a transfer-level course within 6 years (Bahr, 2010). In an era where a college credential is necessary for middle-class jobs, the trend of a substantial number of remedial students exiting the college pipeline is disconcerting, particularly in California which enrolls the nation's largest community college student population (CCCCO, 2013). These statistics represent some of the challenges of the community colleges: while some students are ready for college-level work and intend to transfer to a four-year institution, others arrive at college less prepared (Sengupta & Jepsen, 2006).

In response to this concern, researchers at the Pullias Center for Higher Education at the University of Southern California have looked at ways in which the largest community college system in the nation provides educational opportunities for the least academically prepared students. This report examines assessment and placement policies used to assign students to developmental education in California and summarizes findings from seven studies related to key decisions throughout the process. We discover how colleges place students impacts persistence and transfer, that there are various ways to improve placement policies, and that students will benefit from additional support to bolster their math confidence when they enter college. To conclude, we outline steps that policymakers and practitioners can take to improve the process.

This report highlights findings related to the assessment and placement policies with the aim of helping practitioners, policymakers and other stakeholders creatively rethink how to effectively assess and place students in developmental math. Here are the seven findings:

1. Establishing an effective assessment and placement A&P system is complex. More support and training is needed for faculty and administrators charged with this task. (Melguizo, Kosiewicz, Prather, & Bos, 2014).
2. Community college faculty and administrators have the opportunity to improve placement and success in developmental math by engaging in a systematic process of calibration of the cut scores of assessment and placement tests (Melguizo, Bos, Ngo, Mills, & Prather, 2015).
3. The largest barrier for developmental math students is attempting their initial course (Fong, Melguizo, & Prather, 2015).
4. The diagnostic test places students more accurately than the computer-adaptive test (Ngo & Melguizo, 2015).
5. The inclusion of multiple measures in the placement process can increase access to higher-level math without decreasing students' chances of success (Ngo & Kwon, 2015).
6. Students are likely to underestimate their math preparation (Fong & Melguizo, 2015).
7. Thoughtful implementation of self-placement, or allowing students to self-place, may improve placement outcomes (Kosiewicz, 2014).

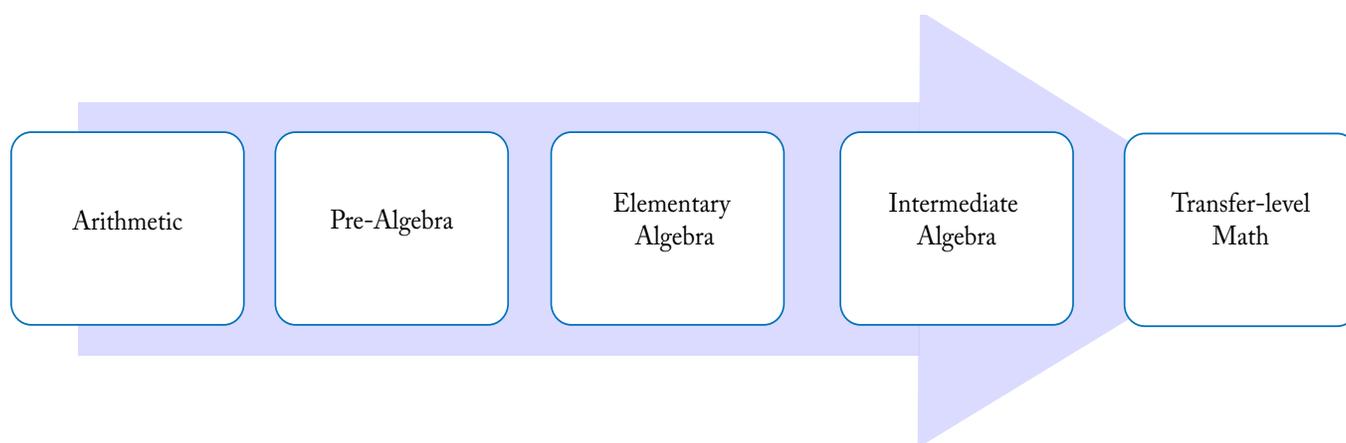
What is Developmental Education?

Remedial, basic skills, or developmental education is defined as foundational skills in mathematics and English deemed necessary for students to be successful in college-level work (Center for Student Success, 2007). Developmental courses are typically structured as course sequences (see Figure 1), which completed successfully can eventually lead to college-level math or English. The rationale behind requiring students to take developmental courses is to prepare students for college-level coursework.

Intuitively, this rationale makes sense. If students are not adequately prepared for college-level work, developmental education should help students catch up. However, previous research has shown that lengthy developmental sequences can have a ‘cooling out’ effect on the students because it adds time towards completing a degree. This can act as a barrier to completion (Fong et al., 2015; Bailey, Jeong, & Cho, 2010). Further, it can increase the amount of money students need to pay for college. Students usually pay tuition fees but often do not receive degree-applicable credit for these courses. Therefore, there are monetary and time costs associated with ineffective developmental education for both the student and the institution (Melguizo, Hagedorn, & Cypers, 2008).

Several reasons exist as to why developmental education may be ineffective. Our research focuses on assessment and placement (A&P) policies because it is the first step that determines where students start in their college trajectory. This research suggests that the way students are assessed and placed into developmental education is an area where reform can take place to improve the efficiency and effectiveness of developmental education overall.

Figure 1: Developmental math sequence in the Large Urban Community College District¹



¹ One college had a developmental math course 5 levels below transfer called World Numbers.

LARGE URBAN COMMUNITY COLLEGE DISTRICT

In particular, the focus of the research has been on developmental math, utilizing data from a large, urban community college district (LUCCD) located in Southern California. LUCCD is one of the largest community college districts in California, serving over 220,000 full- and part-time students annually, the majority of whom are students of color. Because California community college districts operate under a decentralized governance structure, districts have considerable discretion over how and when they place students in course sequences (Melguizo, Kosiewicz, Prather, & Bos, 2014). This unique governance structure implies that there is a lot of space for the colleges to experiment and innovate.

DEVELOPMENTAL MATH

The reasons for focusing on developmental math are: 1) a larger proportion of students place into developmental math than developmental English; 2) developmental math sequences tend to be more consistent across colleges, making the findings more generalizable; and 3) fewer students complete the developmental math sequence and/or math pre-requisite for attaining a certificate or degree than English. Thus, our research examined the implications of different colleges' A&P policies as they relate to developmental math.

Goals of the Research

The broad guiding research question was: How are community colleges assessing and placing students in math and what are the effects of placement decisions on the educational outcomes of community college students?

Several characteristics of the LUCCD made it an ideal study site to answer this research question:

- ◆ Colleges are allowed to select their own placement instrument (some of the common ones include ACCUPLACER, MDTP, and COMPASS);
- ◆ Colleges are allowed to determine their own cut scores; and
- ◆ Colleges have flexibility in choosing "multiple measures" criteria (e.g., prior math experience, HS GPA) as part of their placement process.

Evaluating the different assessment and placement (A&P) processes of various colleges can foster innovative thinking. The purpose of this report is to help stakeholders think differently about the A&P policies and student success in developmental math. Initial inquiry revolved around: 1) describing the A&P process at each of the nine colleges and 2) evaluating the way colleges were setting the placement cut off and its effect on students' outcomes. Answering these two questions led to other questions. Below are the salient findings from seven different studies conducted throughout the span of five years. All studies related to developmental math A&P can be found on the Pullias website: <http://www.uscrossier.org/pullias/research/projects/sc-community-college/>

How are community college students assessed and placed in math at LUCCD?



1. Student enters the assessment and placement office.



2. Student fills out requisite paperwork.



3. He or she either takes the computer adaptive test (ACCUPLACER or COMPASS) or the diagnostic placement test (MDTP).



6. Students are placed into a level of math based on their adjusted score.



5. Students' scores on the assessment sub-test are combined with any points they are awarded via multiple measures.



4. He or she fills out the background questionnaire which is used to award additional measure points.



7. Students decide whether or not to enroll.



Findings

1 Establishing an effective A&P system is complex. More support and training is needed for faculty and administrators charged with this task. (Melguizo, Kosiewicz, Prather, & Bos, 2014).

How are community college students assessed and placed in developmental math? In order to answer this question, we spent one year conducting site visits and formal interviews with math faculty and assessment and matriculation coordinators.² The A&P process to assess and place students in developmental math varies widely across the district. While a recent policy has been passed to standardize the placement test statewide in California³, the current policy remains that colleges can choose from a list of state-approved placement tests, determine their own cut score and use multiple measures that colleges deem appropriate.

Three factors determine student placement into developmental math in the LUCCD:

- Placement Test: COMPASS, ACCUPLACER, MDTP, or alternative
- Cut Scores: Pre-determined scores that discriminate students in various math levels
- Multiple Measures: additional information to guide placement like HS GPA, college plans

Seven out of the nine colleges report using one of the two computer adaptive tests: the ACT's COMPASS or the College Board's ACCUPLACER, mainly for efficiency. It is important to mention that each of these exams include a number of sub-tests (i.e., Algebra Readiness, Calculus) that place students in the different courses of the developmental sequence. Some colleges structure the branching system so that students who scored high in one of the lower-level sub-tests can seamlessly transition into a higher-level sub-test and consequently be placed in a higher-level math course. Colleges are able to mitigate testing time and costs, and facilitate quicker placement. However, the study notes that faculty and administrators tend to ground their perceptions of placement efficacy on anecdotes rather than evidence.

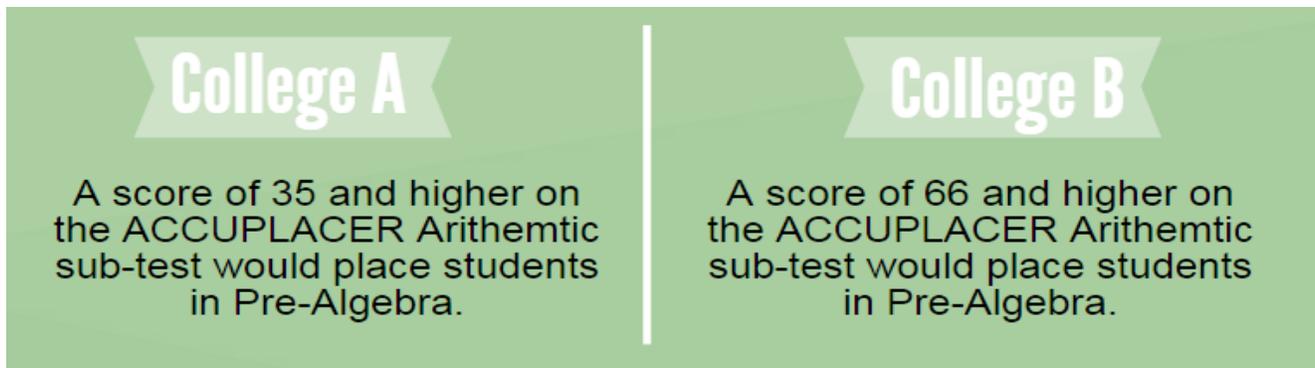
Because there is no hard and fast rule to determine math cut scores, each college independently determines its own. In some cases, faculty pretend to be the student and take the placement math test and in other cases, faculty and administrators refer to research reports or testing company guidelines. Unsurprisingly, the actual cut scores vary considerably by college. For example, a student who took that test in College A and obtained a score of 35 would have been placed four levels below college-level math. That same student would have been placed five levels below college-level math at College B (see Figure 2). It is important to remind the reader that there are high costs in terms of money and time associated with placing students in lower-level math courses. First, the enrollment rates of students in lower-level courses are much lower than the one in the higher courses of the sequence. Second, the average passing rate is also lower in the lower courses of the sequence. This implies that a student, who was initially placed in Arithmetic as opposed to Pre-Algebra, can not only delay enrollment, but spend at least an additional semester taking a course that doesn't count towards a degree and is not transferable.

The implications from this study are that faculty and administrators charged with determining placement rules must find ways to effectively place students, rigorously evaluate cut scores, and determine which additional measures can address shortcomings inherent in the current tests. The good news is this is possible, as shown in the next finding.

² Researchers gathered background information on the assessment and placement (A&P) policies for each of the nine LUCCD colleges from the web. Also, researchers interviewed faculty and district personnel to understand how the A&P policies were carried out in the nine colleges. Researchers also complemented the interview data with student transcript data to see 1) how math placement decisions were made across the colleges and 2) how the placement decisions impact student math outcomes.

³ The California Community College System is implementing the Common Assessment Initiative which will create a comprehensive assessment system for the state. Relatedly, SB 1456 Student Success Act of 2012 provides funding for the Common Assessment Initiative.

Figure 2. Variability in math placement cut score



2 Community college faculty and administrators have the opportunity to improve placement and success in developmental math by engaging in a systematic process of calibration of the cut scores of assessment and placement tests (Melguizo, Bos, Ngo, Mills, & Prather, 2015).

Are colleges accurately setting the placement cut scores? As previously mentioned, each college is allowed to determine the cut scores that sort students into different math courses. The big discrepancies between the cut scores set by the different colleges suggest that they need to engage in a systematic evaluation of the cut scores to guarantee placement in the appropriate math course.

In our research, we develop a rigorous and systematic procedure that can be used by community colleges around the state and the nation to evaluate and calibrate their cutoffs using a technique called the Regression Discontinuity Design (RDD). We study the impact of being placed in the lower-level course as opposed to the higher-level course on the likelihood of course success and credit accumulation. The idea behind comparing students who just missed the cut score with students who slightly exceeded the cut score is that the two groups should theoretically be very similar and therefore comparable.⁴ If the cut score was set accurately, research should find that the two groups exhibit similar educational outcomes. Because many community college students do not attend full time, researchers also accounted for the length of time students take to achieve these milestones using discrete time survival analysis.

Several results stood out from studying different placement cut scores and the time it takes students to achieve meaningful milestones:

- Consistent with previous literature, students placed in the lower-level courses had lower pass rates in the following math course in the sequence than those who were placed in the higher-level courses directly.
- However, by incorporating the time dimension, thereby analyzing the length of time it takes for students to accomplish the outcomes, in some cases, the penalty of being placed in a lower-level course diminished and in some cases reversed.
- The results illustrated that some colleges saw little negative or positive impact on their placement decisions, suggesting well-calibrated cutoffs in those colleges.
- The results of this study suggest that the RDD is a technique that can be used by colleges to calibrate their cut scores in placement tests.

Considering that there are both instructional expenses and opportunity costs associated with students enrolling in developmental math courses, college administrators and math faculty may want to fine-tune placement cut scores by looking at outcomes for students just around the cut-off.

⁴ This wouldn't be true if the students somehow knew about the cut score and manipulated their placement. If this was the case, the students around the cut score would not be comparable.

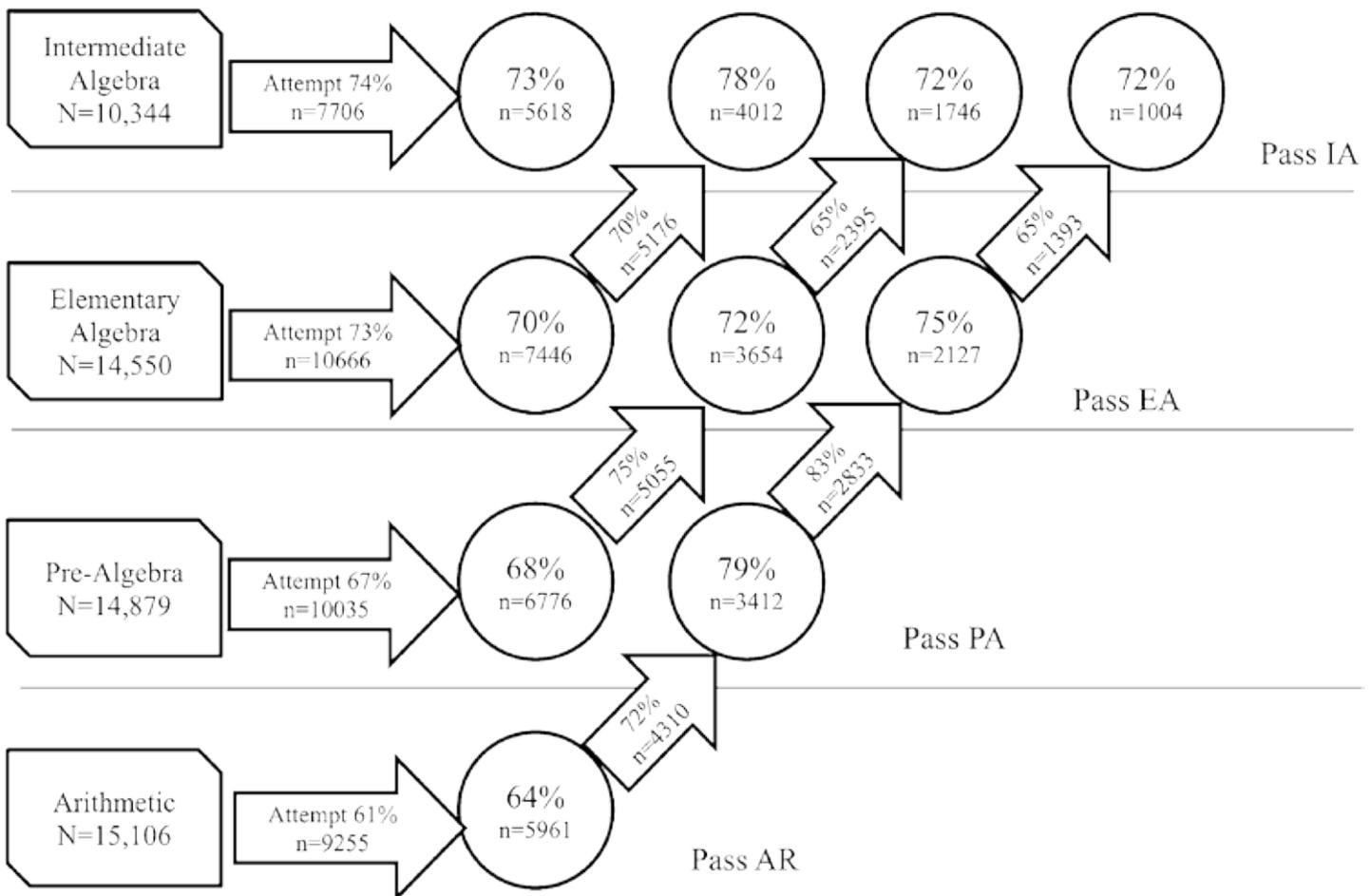
3 The largest barrier for developmental math students is attempting their initial course (Fong, Melguizo, & Prather, 2015).

Understanding the challenges of placing students correctly, the next question to consider is: *How are students progressing through the developmental math sequence?* As mentioned above, the first decision point after students have been assessed is whether or not to enroll in the recommended math course. We found that students placed in the lowest levels of the developmental math sequence were far less likely to enroll than those placed directly in transfer-level courses (Melguizo, Kosiewicz, Prather, & Bos, 2014). Specifically, roughly 45% of students placed five levels below transfer never enrolled in a math course, compared to 18% of students placed one level below transfer.

This relationship also holds between placement level and course completion. The higher that students started in their math trajectory, the more likely that they successfully completed transfer-level math within three years.

Across levels, most students exit the sequence by not attempting or not passing their initial course (see Figure 3). The key is whether students attempt the higher-level course. As shown in Figure 3, only a small number of students make it through to the highest levels. However, Figure 3 also suggests that when students attempt those courses, these courses are helping students gain the skills necessary to successfully progress towards college level math.

Figure 3. Percentage of students attempting and passing each level of the developmental math trajectory based on initial placement



To better define successful progression through the sequence, here are some points to consider:

- A nuanced interpretation of student progression ought to consider whether the student attempted the course since students who attempt their subsequent courses exhibit comparable success rates to their initially higher-placed peers.
- A much smaller number of students attempt and pass lower-levels of the math trajectory (i.e., Arithmetic and Pre-Algebra) compared to the higher-levels (i.e., Elementary Algebra and Intermediate Algebra).
- The graduation course requirement can explain the drop off in students who attempt Intermediate Algebra. The math pre-requisite for graduation at the time of our study was Elementary Algebra. This illustrates the importance of focusing on the appropriate math pre-requisites of specific community college districts and systems when defining successful progression.

A Deeper Dig into A&P

Some of the initial goals for studying the A&P process were: 1) to understand the A&P process as it related to student success and 2) to develop a technique to help colleges calibrate their cut scores. Throughout the process, we began to question the role of the other main components of the A&P process. What is the impact of using multiple measures to improve placement? Why use a diagnostic test rather than a computer adaptive test? Are students better judges of their math needs? The next set of studies explores these questions.

4 The diagnostic test places students more accurately than the computer-adaptive test (Ngo & Melguizo, 2015).

Do the types of placement tests matter? The majority of the public two year colleges across the nation use either ACCUPLACER or COMPASS.⁵ These are computer-adaptive tests that identify student skills in Arithmetic, Algebra, and College-Level Math using an algorithm that responds to student performance (Mattern & Packman, 2009). The computer-adaptive format adjusts the question level based on students' pattern of answers. In effect, it produces a single measure of students' math skill.

But computer tests are not the only option for placement testing. In the LUCCD, colleges use either one of the two popular computer-adaptive tests or the Mathematics Diagnostic Testing Project (MDTP). MDTP is a diagnostic test aimed at assessing student proficiency on a range of topics, which instructors can theoretically use to inform their classroom instruction. Another purpose of the diagnostic test is to inform placement decisions.

Researchers looked at what happened after two LUCCD colleges switched from using the MDTP to using a computer-adaptive test. They examined placement accuracy and whether students persisted through their placed course and passed it successfully within one year. They found the following:

- Students placed using results from computer-adaptive tests were more negatively impacted by the placement decision than prior cohorts placed by MDTP
- They were less likely to enroll and persist onto the next math course after the placement test switch
- Consistent with other studies, we found that the diagnostic test can provide information on student proficiency on a range of subtopics such as fractions, exponents, and reasoning which can improve math placement decisions and/or tailor instruction in math courses

⁵ ACT is phasing out COMPASS in 2016.

Overall, this analysis of placement policy experimentation showed that switching from using a math diagnostic for placement to using a computer-adaptive test led to a larger negative effect of assignment to remediation on early college outcomes, including initial math enrollment and completion of gatekeeper math courses.

5 The inclusion of multiple measures in the placement process can increase access to higher-level math without decreasing students' chances of success (Ngo & Kwon, 2015).

Does incorporating additional measures such as prior math experience and high school GPA improve placement decisions?
 There is growing interest in using multiple measures to place students in developmental courses. These measures can include students' prior academic achievement, educational goals, or even some measure of motivation. This approach is based on the assumption that using multiple measures, instead of a single assessment test, will improve equity in the placement process and increase access to higher-level math courses, particularly for students of color.

In the LUCCD, each college can choose the types of multiple measures used for placement and how many additional points to award for these measures. Figure 4 shows the range of multiple measures used to award points at each of the nine colleges in the district.

While overall only 6% of all assessed students benefitted from multiple measures in the LUCCD, the researchers found that the benefits were particularly salient for African-American and Latina/o students, who were able to enroll in higher-level courses due to these additional points. This research found that boosting students up to higher-level courses through measures like high school GPA and prior math experience increased access to higher-level math without decreasing students' chances of success in the course. Using multiple measures may be an improvement over using placement tests alone.

Figure 4. Multiple measures used for math placement

College	Academic Background			College Plans	Motivation
	HS Diploma/ GED	HS GPA	Prior Math		
A			✓		
B		✓	✓	✓	
C					
D			✓		
E		✓			
F				✓	✓
G		✓		✓	
H		✓			
J	✓		✓		✓

Several implications emerged from this study:

- Prior math background and/or high school GPA should be used to better assess and place students in developmental math.⁶
- Using multiple measures can increase access to higher-level courses without compromising course success and eventual credit accumulation.
- There may be other promising measures such as academic background, college plans, or motivation that can improve placement accuracy and should be rigorously explored.
- Colleges should validate multiple measures by comparing the outcomes of boosted students with peers placed at the same level. If the boosted students perform as well as their peers, the measure should be adopted for determining placement.

6 Students are likely to underestimate their math preparation (Fong & Melguizo, 2015).

A unique feature of diagnostic tests is that they give students the option of choosing their sub-test. In colleges that use a computer adaptive test (e.g., ACCUPLACER or COMPASS), the test automatically refers students to a higher or lower sub-test. However, as previously mentioned, some colleges assess students via a paper and pencil diagnostic test called the Mathematics Diagnostic Testing Project (MDTP) and students are allowed to select from one of the four sub-tests (i.e., Arithmetic, Elementary Algebra, Intermediate Algebra, and Pre-Calculus). Then, the sub-test scores were combined with any points awarded via multiple measures to determine the total placement scores. In this study, we wanted to take advantage of the fact that students at College H were given the choice to select the assessment sub-test. The research question we asked is: *How confident are students in their math ability prior to starting community college?* To explore this question we looked at the choices made by the students in the diagnostic test. Our assumption was that if students took Intermediate Algebra in high school, it would make sense for them to take the Intermediate Algebra or Pre-Calculus sub-test. In reality we didn't find a direct one-to-one correspondence between prior math experience and sub-test.

This research looked at whether students chose the appropriate sub-test based on the highest math course taken in high school and whether this varied by different racial groups. Based on College H's A&P policy, if a student chooses to take the Elementary Algebra sub-test, s/he would be placed either in Elementary Algebra or Intermediate Algebra. However, regardless of their score, students would not be able to place in College Level Math. Thus, students' choice of sub-test implies whether they have access to higher-level math. Also, whether students appropriately choose the assessment sub-test has implications on whether they successfully progress through the math sequence and, ultimately, complete their degree.

Findings from this study include:

- Across different racial groups, approximately a range of 39 to 62 percent of the assessed students chose to take lower-level sub-test than what they took in high school. 39% of Asian Americans versus 62% of African Americans chose to take the lower sub-test.
- Women and underrepresented racial minorities at this college tend to choose assessment sub-tests associated with lower-level difficulty, perhaps due in part to lower math confidence.
- There is confusion about the alignment between the high school and community college math sequence. For example, Geometry does not clearly align with the community college Algebra-focused sequence.

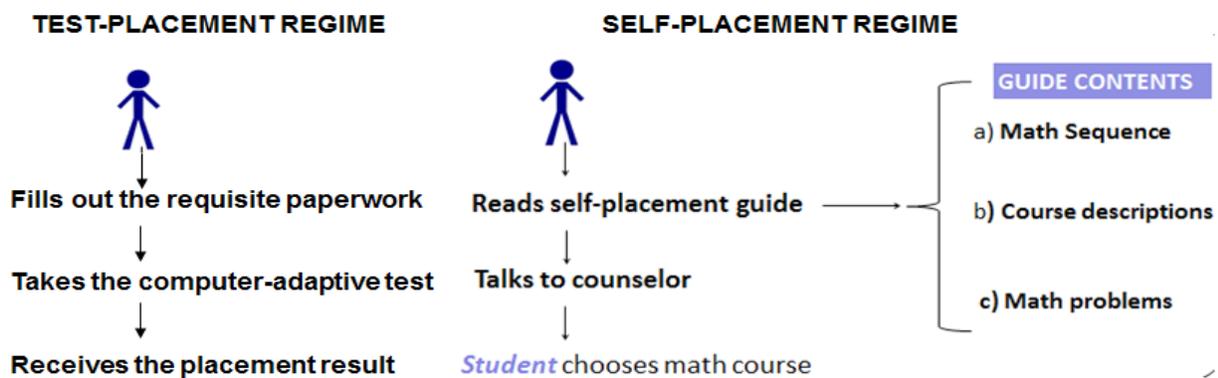
6 This is consistent with other findings: Armstrong, 2000; Belfield & Crosta, 2012; Scott-Clayton, 2012; Jaffe, 2012; Lewallen, 1994; Long Beach Promise Group, 2013.

7 Thoughtful implementation of self-placement, or allowing students to self-place, may improve placement outcomes (Kosiewicz, 2014).

Should students be allowed to self-place into math courses? In this study, a researcher examined whether giving students more latitude over their placement decisions can promote educational success. In Spring 2008, one LUCCD college, College X forgot to renew its COMPASS test license with the ACT and, therefore, was forced to allow students to determine their math placement level for the 2008 summer and fall semesters.

As shown in Figure 5 (below), students in this college experienced a different placement policy system compared to students at the other colleges in the district.

Figure 5. Comparison of students' experiences under different policy systems



This study used a difference-in-difference estimation strategy to test the impact of Directed Self-Placement (DSP), relative to a test-based placement strategy, on proximal and distal academic outcomes.

Below were some of the findings:

- When students are test-placed, students tend to be predominantly placed in the two lowest developmental math levels. However, when given the option to self-place students distributed themselves more evenly across the math sequence.
- Relative to periods of test-placement, larger percentages of African American, Latino and female students assigned themselves to the lower developmental math levels when DSP was in use.
- Overall, students allowed to self-place into the math outperformed students who test-placed into the same sequence on a range of math- and credit-related outcomes.

Policy Implications

The seven studies raise several questions and points for different stakeholders to consider:

- 1. College faculty and administrators need to engage in a systematic process to calibrate the way they set placement test cut scores.**
 - a. Are placement cut scores too high? If so, many students, who could be benefiting from enrolling in the higher-level course directly, end up enrolling in lower-level courses. This is problematic as it increases the time to pass the math pre-requisite and attain a certificate or degree.
 - b. Are placement cut scores too low? This means that students might not be prepared for the demands of the course, and will result in above average failing rates.
- 2. Community college students are taking too long to achieve academic milestones.** As open-access institutions, community colleges educate nontraditional students who may attend school part-time due to personal circumstances. For these students, achieving academic outcomes can be prolonged. Factoring in the length of time to completion can better reflect what it means for students to successfully achieve academic milestones.
- 3. Using multiple measures can ensure that the largest possible number of students is attempting and passing the courses needed to attain their desired educational outcomes.** We found evidence that using student background information in addition to assessment data can improve placement accuracy. As policymakers and practitioners refine their assessment and placement policies, it is important to recognize that a score on a standardized test is only one factor in predicting student success.
- 4. Students need to be better supported in mitigating negative stereotypes about math abilities.** Students, particularly women and underrepresented racial minorities, tend to attempt lower math courses than their placed course level. Part of the solution might be to provide counseling services and early intervention programs to help boost students' math confidence. Another solution would be to better align community college and high school math sequences so that students have a better understanding of what each math level means.
- 5. A longer math sequence may serve as a barrier to student completion.** For students placed in the lower-levels of math course, each additional course can be a barrier to persistence. Colleges must find a way to not only prepare students for college level math, but also to retain them throughout the sequence.

Further Reading

LIST OF FEATURED STUDIES

Finding 1: Melguizo, T., Kosiewicz, H., Prather, G., & Bos, J. (2014). How are community college students assessed and placed in developmental math?: Grounding our understanding in reality. *The Journal of Higher Education*, 85(5): 691-722. Doi: 10.1353/jhe.2014.0025

Finding 2: Melguizo, T., Bos, H., Ngo, F., Mills, N., & Prather, G. (available online). Using a regression discontinuity design to estimate the impact of placement decisions in developmental math. *Research in Higher Education*.

Finding 3: Fong, K., Melguizo, T., & Prather, G. (2015). Increasing success rates in developmental math: The complementary role of individual and institutional characteristics. *Research in Higher Education*, DOI: 10.1007/s11162-015-9368-9.

Finding 4: Ngo, F. & Melguizo, T. (2015). How can placement policy improve math remediation outcomes? Evidence from experimentation in community colleges. *Educational Evaluation and Policy Analysis*, forthcoming.

Finding 5: Fong, K. & Melguizo, T. (2015). Utilizing additional measures of high school academic preparation to support students in their math self-assessment.

Finding 6: Ngo, F. & Kwon, W. (2015). Using multiple measures to make math placement decisions: Implications for access and success in community colleges. *Research in Higher Education*, 56(5), 442-470.

Finding 7: Kosiewicz, H. (2014, November). Giving community college students voice: The effects of mathematics self-placement on academic achievement. Paper presented at the annual conference of Association for the Study of Higher Education, Washington, D.C.

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With a generous bequest from the Pullias Family estate, the Earl and Pauline Pullias Center for Higher Education at the USC Rossier School of Education was established in 2012 (the center was previously known as the Center for Higher Education Policy Analysis). The gift allows one of the world's leading research centers on higher education to continue its tradition of focusing on research, policy, and practice to improve the field.

The mission of the Pullias Center for Higher Education is to bring a multidisciplinary perspective to complex social, political, and economic issues in higher education. Since 1996 the center has engaged in action-oriented research projects regarding successful college outreach programs, financial aid and access for low- to moderate-income students of color, use of technology to supplement college counseling services, effective postsecondary governance, emerging organizational forms such as for-profit institutions, and the retention of doctoral students of color.

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