The Evidence on Alternative Placement Approaches

Presenters:

• Maxine T. Roberts, Education Commission of the States
• Dan Cullinan, MDRC
• John J. Hetts, Educational Results Partnerships
• Federick Ngo, UNLV
Assessment & Placement

A National Perspective

Maxine T. Roberts, PhD
Education Commission of the States
Agenda

• Overview of Education Commission of the States
• Shifting from Traditional Assessment & Placement
• National Data & Early Findings
  • What’s Working
  • Differential Outcomes and Concerns
• Outcomes from Two Institutions
  • What’s Next?
• Summary
Who we are.

The essential, indispensable member of any team addressing education policy.
What we do.

We believe in the power of learning from experience and we know informed policymakers create better education policy.
How we do it.

We research, report, convene and counsel.
Assessment & Placement: A National Perspective

Legend: Does a state or system-wide policy on assessment and placement exist?

Shifting from Traditional Assessment & Placement

Single Score Assessment
Shifting from Traditional Assessment & Placement

Single Score Assessment → Math or English Developmental Education Courses
Shifting from Traditional Assessment & Placement

- Single Score Assessment
- High School GPA/Coursework
Shifting from Traditional Assessment & Placement

- Single Score Assessment
- High School GPA/Coursework
- Standardized Exams
Shifting from Traditional Assessment & Placement

Measures Used for Assessment

- High School GPA/Coursework
- Standardized Exams
- Non-Cognitive Measures

Single Score Assessment
Common Assessments Used in HE Systems

Advances Outcomes for Racialized Groups

Percentage point increase in student placement into college-level math

African American: 13.9
Latinx: 9.1

Improves Outcomes for Pell Grant Recipients

Placement into gateway math courses for Pell Grant recipients

- Traditional assessment: 38.5%
- Multiple measures: 45.6%

Differential Outcomes & Concerns
Gap in College-Level Math Placement Grows between Pell- & Non-Pell Recipients

Disparities in Placement into Math Pathways by Race/Ethnicity (DCMP)

• **Study focus**: How racial beliefs were used as legitimate knowledge by counselors at community college

• **Sample**: 34 counselors; 2 community colleges

• **Findings**
  
  • Counselors' beliefs about racialized groups linked with their perspectives about proper course placements

  • **Students from Pacific Palisades tend to be more successful**. Usually when they participate in their admitted students day, *nearly every one of them places into English 1*. But even from Beverly Hills, we’re *not necessarily getting the best and the brightest* so, not every one of those students is placing into English 1 necessarily. (p. 285)

  • Connection between perceptions about students’ home lives and “proper” course placement

  • [I]t’s the **culture and it’s the language barrier** for most students in that category, the **placement of lower levels**. Because now they’re not only dealing with trying their best in college, trying to get through the process, now they are **dealing at home** with a whole another **series of issues**, **culturally speaking**. So, they are in a whole different kind of—how do I say this, **environment than say your Caucasian student**." (p. 287)

Outcomes from Two Institutions & Next Steps
College A: Enrollment into Co-Requisite Math by R/E (after 4 years of implementation)

FY 2018-2019

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Enrollment into Co-Requisite Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>15%</td>
</tr>
<tr>
<td>Black</td>
<td>16%</td>
</tr>
<tr>
<td>Latinx</td>
<td>15%</td>
</tr>
<tr>
<td>Native American</td>
<td>18%</td>
</tr>
<tr>
<td>White</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td>15%</td>
</tr>
</tbody>
</table>
College A: Enrollment into Co-Requisite Math by R/E (after 4 years of implementation)

FY 2018-2019

- Asian: 15%
- Black: 16%
- Latinx: 15%
- Native American: 18%
- White: 13%
- Total: 15%
College A: What’s Next?

• Incorporating new forms of assessment
• Training faculty: Equity – focused workshops for leaders
• Focusing efforts on structural changes

FY 2013-2014 & FY 2018-2019

Enrollment into Developmental Math

- Asian: 32%
- Black: 18%
- Latinx: 51%
- Native American: 65%
- White: 42%
- Total: 49%

www.ecs.org | @EdCommission
College B: Enrollment into College-Level Math by Pell Status

<table>
<thead>
<tr>
<th>Year</th>
<th>Pell-Eligible</th>
<th>Non-Pell Eligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2016-17</td>
<td>54.3%</td>
<td>61.3%</td>
</tr>
<tr>
<td>FY 2017-18</td>
<td>52%</td>
<td>60.3%</td>
</tr>
<tr>
<td>FY 2018-19</td>
<td>39.6%</td>
<td>49.0%</td>
</tr>
</tbody>
</table>
College B: Enrollment into Developmental Math by Pell Status

<table>
<thead>
<tr>
<th>Year</th>
<th>Pell-Eligible</th>
<th>Non-Pell Eligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2016-17</td>
<td>36.3%</td>
<td>15.7%</td>
</tr>
<tr>
<td>FY 2017-18</td>
<td>30.7%</td>
<td>15.6%</td>
</tr>
<tr>
<td>FY 2018-19</td>
<td>46.3%</td>
<td>22.0%</td>
</tr>
</tbody>
</table>

FY 2016-17: 36.3% Pell-Eligible, 15.7% Non-Pell Eligible
FY 2017-18: 30.7% Pell-Eligible, 15.6% Non-Pell Eligible
FY 2018-19: 46.3% Pell-Eligible, 22.0% Non-Pell Eligible
College B: What’s Next?

- Expanding the use of multiple measures
- Data-sharing agreements
- Encouraging re-taking placement exam.
- Changing GPA requirement
- Improving student engagement on campus.
Summary
References


Thank You

Maxine T. Roberts, PhD
Principal, Education Commission of the States
mroberts@ecs.org
Thank you!

Maxine T. Roberts,
Education Commission of the States

The Center for the Analysis of Postsecondary Readiness (CAPR) is funded through a grant (R305C140007) from the Institute of Education Sciences, U.S. Department of Education.
Early Findings from Multiple Measures Assessment in Minnesota

Dan Cullinan, Research Associate
MDRC
About the Study

- Four Minnesota State Colleges and one Wisconsin Technical College:
  - Anoka Ramsey
  - Century
  - MCTC
  - Normandale
  - Madison
- Students randomly assigned to multiple measures assessment (MMA) designed by each college
- Placement data and transcript data collected for both MMA and control group students
Terms Defined

- **Gatekeeper course**: First college-level course in a subject
- **Pass rate**: Among those enrolled in a course, the percentage that passed with a C or higher
- **Bump-up zone**: Where students would normally be placed into a developmental course, but through multiple measures (combination of Accuplacer scores, HS GPA, and non-cognitive assessments) are eligible for college-level placement
What rules were tested?

- Colleges set MMA cut-off scores on the following measures:

<table>
<thead>
<tr>
<th>Pilot Measures</th>
<th>Cut-off Range (depending on College and subject)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuplacer Classic</td>
<td>One level below college-level to college-level score (sometimes waived if other measure met)</td>
</tr>
<tr>
<td>HS GPA</td>
<td>From 2.5 to 3.0</td>
</tr>
<tr>
<td>LASSI non-cognitive assessment: motivation scale</td>
<td>4 or 5 out of 5</td>
</tr>
</tbody>
</table>
## The Study Sample

<table>
<thead>
<tr>
<th>Subject/Level</th>
<th>Students</th>
<th>Percent of subject total</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>3,677</td>
<td></td>
</tr>
<tr>
<td>Developmental Ed</td>
<td>1,389</td>
<td>37.7%</td>
</tr>
<tr>
<td>Bump up zone</td>
<td>624</td>
<td>17.2%</td>
</tr>
<tr>
<td>College Level</td>
<td>1,664</td>
<td>45.2%</td>
</tr>
<tr>
<td>Math</td>
<td>4,487</td>
<td></td>
</tr>
<tr>
<td>Developmental Ed</td>
<td>3,123</td>
<td>69.5%</td>
</tr>
<tr>
<td>Bump up zone</td>
<td>703</td>
<td>15.6%</td>
</tr>
<tr>
<td>College Level</td>
<td>661</td>
<td>14.8%</td>
</tr>
</tbody>
</table>
Increased Enrollment in the First Semester

- Students randomly assigned to MMA enrolled in the fall at a higher rate than control students.
- Students bumped-up into college-level English by MMA were more likely to enroll in college at all than control group members placed into Dev. English.

![Graph showing the effect of English bump-up on college enrollment (percent). The Program group shows a higher enrollment rate compared to the Control group with a 8 percentage points difference.]
English Impacts

- Students randomly assigned to MMA increased gatekeeper enrollment by 5 percentage points (17%) in the first semester.
English Impacts

- Pass rates among enrolled were similar when comparing bump-up students to all students in the control group.

- Students bumped up in English were 28 percentage points more likely to have completed the Gatekeeper English course than their control group counterparts in the first semester.

Pass Rates in Gatekeeper English

- MMA: 63%
- Status Quo: 68%
Math Impacts

- Students randomly assigned to MMA increased Math Gatekeeper enrollment by 4 percentage points (75%) in the first semester.
**Math Impacts**

- Students bumped up in Math were 12 percentage points more likely to have completed the Gatekeeper English course than their control group counterparts in the first semester.

- The large increase in enrollment came with tradeoffs in pass rates among enrolled students.
Effects on Educational Outcomes After the First Semester

• The final report (2021) will show longer term impacts of MMA, cost effective study, and the predictive utility of non-cognitive assessments

• MDRC will analyze transcript outcomes from three semesters of follow-up and add two more student cohorts
  • Compare groups after students complete developmental courses and enroll in college-level courses

• Ultimately, we will know more about which placement system helps students succeed academically
Thank you!

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The Center for the Analysis of Postsecondary Readiness (CAPR) is funded through a grant (R305C140007) from the Institute of Education Sciences, U.S. Department of Education.
Let Icarus Fly:  
Multiple Measures in Assessment,  
the Re-imagination of Student Capacity, and the Road to College Level for All  

November 21, 2019  

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Visiting Executive, Research & Data  
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@jjhetts #LetIcarusFly  
#CollegeLevelForAll  

bit.ly/CAPRHETTS
Assessment’s “one” job

- Measure student’s capacity/predict student’s performance to get students into course where they can thrive
Variance in college level grades explained by Accuplacer, Compass, Asset - NC

Adapted from Bostian (2016), North Carolina Waves GPA Wand, Students Magically College Ready adapted from research of Belfield & Crosta, 2012 – see also Table 1: http://bit.ly/Belfield2012 (cf also Scott-Clayton, 2012)
Accuplacer, SAT, ACT - Alaska

Multiple Measures Assessment Project

- Collaborative effort of CCCCO, Common Assessment Initiative (CAI), RP Group, Cal-PASS Plus (Educational Results Partnership & San Joaquin Delta College), and >90 CCC pilot colleges
- Identify, analyze, & validate multiple measures data
  - Including HS transcript data, non-cognitive variables, & self-report
  - Focus on predictive validity (success in course)
    - using classification and regression tree models (robust to missing data, non-linear effects, and interactions)
  - Conservative approach: target ≥70% success rate
- Engage pilot colleges to conduct local replications, test models and pilot use in placement, and provide feedback

bit.ly/MMAP2019
## Multiple Measures Assessment Project: CCC Placement/Support Recommendations: Mathematics

<table>
<thead>
<tr>
<th>Placement</th>
<th>English</th>
<th>Statistics</th>
<th>Precalculus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct placement into college-level courses</td>
<td>HSGPA &gt;=2.6</td>
<td>HSGPA ≥ 3.0 OR HSGPA ≥ 2.3 and ≥C in Precalculus</td>
<td>HSGPA ≥ 3.4 &amp; Algebra 2 OR HSGPA ≥ 2.6 and enrolled in Calculus</td>
</tr>
</tbody>
</table>

Placement into college-level courses

- **English** (HSGPA ≥ 2.6):
  - Historical Placement: 27%
  - MMAP Placement: 64%

- **Math** (HSGPA ≥ 3.0 + Algebra):
  - Historical Placement: 15%
  - MMAP Placement: 40%

College level course-completion by placement & method for pilot colleges

- Success rate transfer level (traditional placement)
- Success rate transfer level (MMAP placement)
- Gateway Course Completion (2 years) f/1 level below
- Gateway Course Completion (2 years) f/2 levels below

[Graph showing success rates in English and Math]

(bit.ly/MMAPSsummary2017) plus additional data from CCCO Datamart by college

The RP Group
Research • Planning • Professional Development for California Community Colleges
What about everyone else? What maximizes their completion of gateway English and Math?

- Previously identified students were highly likely to successfully complete (~70% or higher)

- Can we identify any students more likely to complete gateway English or Math if they start in developmental education?
  - Let’s examine the students least likely to succeed based on their HS performance
### What about everyone else?

#### Regions of likelihood of success

<table>
<thead>
<tr>
<th>Placement</th>
<th>English</th>
<th>Statistics</th>
<th>Precalculus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly likely to succeed</td>
<td>HSGPA &gt;= 2.6</td>
<td>HSGPA ≥ 3.0 OR</td>
<td>HSGPA ≥ 3.4 &amp; Algebra 2 OR</td>
</tr>
<tr>
<td>(Direct placement)</td>
<td></td>
<td>HSGPA ≥ 2.3 and ≥C in Precalculus</td>
<td>HSGPA ≥ 2.6 and enrolled in Calculus</td>
</tr>
<tr>
<td>Everyone in between</td>
<td>HSGPA = 1.9 to 2.6</td>
<td>HSGPA 2.3 to 3.0</td>
<td>HSGPA ≥ 2.6 &amp; Algebra 2 or enrolled in Precalculus</td>
</tr>
<tr>
<td>Least Likely to Succeed</td>
<td>HSGPA &lt;= 1.9</td>
<td>HSGPA &lt; 2.3</td>
<td>HSGPA ≤ 2.6 and no Precalculus</td>
</tr>
</tbody>
</table>

Even lowest performing HS students more likely to complete college level if placed there directly

CA statewide success rates in first attempt at college level (no support) vs. one year throughput for students least likely to succeed in course. (error bars represent ±1 se). For details see: bit.ly/AB705Adjustments and bit.ly/MMAPAB705WEBINAR
The Once and Future of (California) Placement: College Level for All – Tomorrow’s Session

- Moderate to high performing high school students placed directly into college-level courses.
- Even lowest performing HS students more likely to complete college-level English & math if placed in college-level work (especially with additional supports)
- Flipped our understanding & responsibility
  - Students no longer have to prove their way into college level
  - We have to demonstrate that pre-college level placement will improve college level completion
Thank you!

Contact Information

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  #CollegeLevelForAll

- bit.ly/MMAP2019
- bit.ly/CAPRHETTS

The Fierce Urgency of Now

- ~Two million new community college students per year

- “We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of now. In this unfolding conundrum of life and history, there "is" such a thing as being too late. This is no time for apathy or complacency. This is a time for vigorous and positive action.”
  – Dr. Martin Luther King, Jr.
Students are forced to repeat courses successfully completed in HS

- **Within systems**
  - Highly reliable progression

- **Between systems at CCCs**
  - ~3/4 repeat ≥ 1 level
  - ~1/2 repeat ≥ 2 levels

![Bar chart showing HS to CCC Math transition](chart.png)
THE IMPORTANCE OF TRANSFER-LEVEL PLACEMENT
Fall 2007 CCC students (by levels below transfer of first attempt)

Percentage completion of transfer-level course by CCC Students in 6 years (by level of first attempt)
Among transfer-level completers, distribution of completions by F2007 first-time students
Thank you!

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The Center for the Analysis of Postsecondary Readiness (CAPR) is funded through a grant (R305C140007) from the Institute of Education Sciences, U.S. Department of Education.
Giving Community College Students Choice
The Impact of Self-Placement in Math Courses

Holly Kosiewicz, University of Southern California
Federick Ngo, University of Nevada Las Vegas

Citation
What is Directed Self-Placement (DSP)?

**self-placement | guided self-placement**

- Students choose, often in consultation with an advisor or counselor, the math and English courses they will enroll in
  - Other info (e.g., grades) may be used to inform decision

- Self-placement being implemented in CA, CT, FL

- One challenge to understanding impact of DSP on improving placement and student outcomes: it may coincide with other reforms to curriculum, instruction, student supports (e.g., FL)

**We studied a context where self-placement was sudden and likely the only reform.**
A “Natural Experiment” in DSP

- College X, a community college in Southern California, unintentionally failed to renew its placement testing license
  
  - Students enrolling in Summer and Fall 2008 were allowed to self-place in math courses
  
  - According to course catalog, students were advised to meet with a counselor before making an enrollment decision (we do not know the nature of these interactions)
  
  - Other colleges in the district continued with placement testing with multiple measures (“business as usual”)
A “Natural Experiment” in DSP

• Therefore we have a “natural experiment” to determine the impact of a DSP relative to a test-based placement policy, on student outcomes.

• Difference-in-differences design with treatment (College X) and control colleges

• **Outcomes**
  • First enrolled math course
  • “Course fit” (withdraw, pass, fail)
  • Completion of transfer-level math
  • Completing 30 degree-applicable units
Findings

How did students place under DSP?
More students chose transfer-level math or lowest level of math after DSP

Math Enrollment in College X (%)

Math Enrollment in Control Colleges (%)

Transfer-Level Math
Intermediate Algebra
Elementary Algebra
Pre-Algebra
Arithmetic

Test Placement
Self-Placement

Enrollment in "Supplemental or Tutoring" not shown
Female, Latino, and Black students were more likely to enroll in arithmetic under DSP.

---

**Female**

- Test Placement
  - Transfer-Level Math: 0
  - Intermediate Algebra: 10
  - Elementary Algebra: 43
  - Pre-Algebra: 28
  - Arithmetic: 6

- Self-Placement
  - Transfer-Level Math: 20
  - Intermediate Algebra: 15
  - Elementary Algebra: 16
  - Pre-Algebra: 25
  - Arithmetic: 15

---

**Male**

- Test Placement
  - Transfer-Level Math: 1
  - Intermediate Algebra: 20
  - Elementary Algebra: 21
  - Pre-Algebra: 23
  - Arithmetic: 7

- Self-Placement
  - Transfer-Level Math: 20
  - Intermediate Algebra: 17
  - Elementary Algebra: 25
  - Pre-Algebra: 15
  - Arithmetic: 9

---

**Latina/o**

- Test Placement
  - Transfer-Level Math: 1
  - Intermediate Algebra: 15
  - Elementary Algebra: 43
  - Pre-Algebra: 22
  - Arithmetic: 16

- Self-Placement
  - Transfer-Level Math: 12
  - Intermediate Algebra: 6
  - Elementary Algebra: 35
  - Pre-Algebra: 34
  - Arithmetic: 29

---

**Black**

- Test Placement
  - Transfer-Level Math: 0
  - Intermediate Algebra: 6
  - Elementary Algebra: 35
  - Pre-Algebra: 14
  - Arithmetic: 26

- Self-Placement
  - Transfer-Level Math: 24
  - Intermediate Algebra: 23
  - Elementary Algebra: 16
  - Pre-Algebra: 16
  - Arithmetic: 4

---

**White/Asian**

- Test Placement
  - Transfer-Level Math: 1
  - Intermediate Algebra: 23
  - Elementary Algebra: 48
  - Pre-Algebra: 16
  - Arithmetic: 22

- Self-Placement
  - Transfer-Level Math: 24
  - Intermediate Algebra: 16
  - Elementary Algebra: 22
  - Pre-Algebra: 16
  - Arithmetic: 4
Findings

What is the impact of DSP on course fit and academic outcomes?
<table>
<thead>
<tr>
<th>Withdrawal from First Enrolled Math</th>
<th>Failed First Enrolled Math</th>
<th>Pass CLM in 1yr</th>
<th>CLM in 2yrs</th>
<th>CLM in 4yrs</th>
<th>TLM in 1yr</th>
<th>TLM in 2yrs</th>
<th>TLM in 4yrs</th>
<th>Completed 30 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.06</td>
<td></td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.08</td>
<td>0.09</td>
<td>0.07</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Positive outcomes for the cohort. DSP increased probability of passing college- and transfer-level math
Positive effects of DSP mostly among male students

Bolded values are statistically significant
Positive effects for White and Asian students, more than double the effects for Black and Latina/o students.
Implications For Decision-makers

- Determine effects of reforms by student subgroup to assess equity in outcomes

- Self-placement may increase counselor influence, so more attention needed towards counselor capacity and the role of implicit bias:
  - Expanding and differentiating approaches to advising
  - Increasing resources to decrease the counselor-to-student ratio
  - Promoting professional development training focused on equity-mindedness
Citation

Thank you!
Federick Ngo
federick.ngo@unlv.edu

The Center for the Analysis of Postsecondary Readiness (CAPR) is funded through a grant (R305C140007) from the Institute of Education Sciences, U.S. Department of Education.
Difference-in-Difference Approach

- Achievement trend in control colleges
- Achievement trend in College X
- Treatment effect of self-placement
- Counterfactual achievement trend in College X
- Time of Self-placement
- Time
### Change in student outcomes after DSP

(percentage points)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal from First Enrolled Math</td>
<td>-0.064*</td>
</tr>
<tr>
<td>Failed First Enrolled Math</td>
<td>0.007</td>
</tr>
<tr>
<td>Pass CLM in 1yr</td>
<td>0.021*</td>
</tr>
<tr>
<td>Pass CLM in 2yrs</td>
<td>0.020</td>
</tr>
<tr>
<td>Pass CLM in 4yrs</td>
<td>0.000</td>
</tr>
<tr>
<td>Pass TLM in 1yr</td>
<td>0.082***</td>
</tr>
<tr>
<td>Pass TLM in 2yrs</td>
<td>0.087***</td>
</tr>
<tr>
<td>Pass TLM in 4yrs</td>
<td>0.066**</td>
</tr>
<tr>
<td>Completed 30 Units</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Positive outcomes for the cohort. DSP increased probability of passing college- and transfer-level math.
### Overall treatment effects by subgroup (percentage points)

DSP increased probability of passing college- and transfer-level math and credit completion for male students only.

<table>
<thead>
<tr>
<th>Event</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal from First Enrolled Math</td>
<td>-0.064**</td>
<td>-0.063</td>
</tr>
<tr>
<td>Failed First Enrolled Math</td>
<td>0.043**</td>
<td>-0.038*</td>
</tr>
<tr>
<td>Pass CLM in 1yr</td>
<td>-0.031</td>
<td>0.087**</td>
</tr>
<tr>
<td>Pass CLM in 2yrs</td>
<td>-0.032</td>
<td>0.086*</td>
</tr>
<tr>
<td>Pass CLM in 4yrs</td>
<td>-0.054</td>
<td>0.069</td>
</tr>
<tr>
<td>Pass TLM in 1yr</td>
<td>0.040</td>
<td>0.133***</td>
</tr>
<tr>
<td>Pass TLM in 2yrs</td>
<td>0.036</td>
<td>0.151***</td>
</tr>
<tr>
<td>Pass TLM in 4yrs</td>
<td>0.015</td>
<td>0.130**</td>
</tr>
<tr>
<td>Completed 30 Units</td>
<td>-0.019</td>
<td>0.042*</td>
</tr>
</tbody>
</table>
### Overall treatment effects by subgroup (percentage points)

Positive effects for White and Asian students more than double the effects for Black and Latina/o students.

<table>
<thead>
<tr>
<th>Event</th>
<th>Black</th>
<th>Latina/o</th>
<th>White or Asian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdrawal from First Enrolled Math</td>
<td>-0.144*</td>
<td>-0.033</td>
<td>-0.103***</td>
</tr>
<tr>
<td>Failed First Enrolled Math</td>
<td>0.057</td>
<td>-0.016</td>
<td>0.015</td>
</tr>
<tr>
<td>Pass CLM in 1yr</td>
<td>0.041</td>
<td>-0.001</td>
<td>0.058***</td>
</tr>
<tr>
<td>Pass CLM in 2yrs</td>
<td>0.020</td>
<td>-0.018</td>
<td>0.092***</td>
</tr>
<tr>
<td>Pass CLM in 4yrs</td>
<td>-0.051</td>
<td>-0.018</td>
<td>0.057*</td>
</tr>
<tr>
<td>Pass TLM in 1yr</td>
<td>0.062**</td>
<td>0.063***</td>
<td>0.128***</td>
</tr>
<tr>
<td>Pass TLM in 2yrs</td>
<td>0.070**</td>
<td>0.057***</td>
<td>0.144**</td>
</tr>
<tr>
<td>Pass TLM in 4yrs</td>
<td>0.036</td>
<td>0.035</td>
<td>0.139**</td>
</tr>
<tr>
<td>Completed 30 Units</td>
<td>-0.100*</td>
<td>0.018</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>Withdrawal from First Enrolled Math</td>
<td>Failed First Enrolled Math</td>
<td>Pass CLM in 1yr</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>College X Post-2008</td>
<td>-0.064*</td>
<td>0.007</td>
<td>0.021*</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.007)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Post-2008</td>
<td>0.008</td>
<td>0.061***</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.006)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>College X</td>
<td>-0.008</td>
<td>0.025</td>
<td>-0.042</td>
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<tr>
<td></td>
<td>(0.011)</td>
<td>(0.013)</td>
<td>(0.023)</td>
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<td>20096</td>
<td>20096</td>
<td>20096</td>
</tr>
</tbody>
</table>

Notes: Results from estimation using Model (4) [see Table 4] are shown, which include all covariates (age, sex, race, and language), college and cohort dummies, and standard errors clustered by cohort. College-level math (CLM) is elementary algebra. Transfer-level math (TLM) is any course for which intermediate algebra is a requisite (e.g., pre-calculus).

* p<.05  ** p<.01  *** p<.001
<table>
<thead>
<tr>
<th></th>
<th>Withdrawal from First Enrolled Math</th>
<th>Failed First Enrolled Math</th>
<th>Pass CLM in 1yr</th>
<th>Pass CLM in 2yrs</th>
<th>Pass CLM in 4yrs</th>
<th>Pass TLM in 1yr</th>
<th>Pass TLM in 2yrs</th>
<th>Pass TLM in 4yrs</th>
<th>Completed 30 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment Effect for Female Students</strong></td>
<td>-0.064**</td>
<td>0.043**</td>
<td>-0.031</td>
<td>-0.032</td>
<td>-0.054</td>
<td>0.040</td>
<td>0.036</td>
<td>0.015</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.009)</td>
<td>(0.019)</td>
<td>(0.026)</td>
<td>(0.027)</td>
<td>(0.019)</td>
<td>(0.018)</td>
<td>(0.020)</td>
<td>(0.015)</td>
</tr>
<tr>
<td><strong>Treatment Effect for Male Students</strong></td>
<td>-0.063</td>
<td>-0.038*</td>
<td>0.087**</td>
<td>0.086*</td>
<td>0.069</td>
<td>0.133***</td>
<td>0.151***</td>
<td>0.130**</td>
<td>0.042*</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.012)</td>
<td>(0.019)</td>
<td>(0.028)</td>
<td>(0.029)</td>
<td>(0.013)</td>
<td>(0.023)</td>
<td>(0.030)</td>
<td>(0.014)</td>
</tr>
</tbody>
</table>

Notes: These heterogeneous effects by subgroup are calculated using coefficients reported in the Appendix. The subgroup categories are drawn from the enrollment application. The reference group is white or Asian for the models estimating heterogeneous effects for Black students and Hispanic/Latino students. Math level is a dichotomous variable splitting the sample by initial math level (those who chose high/advanced math at intermediate algebra and above vs. those who chose lower-level math courses). College-level math (CLM) is elementary algebra. Transfer-level math (TLM) is any course for which intermediate algebra is a requisite (e.g., pre-calculus).

* p<.05  ** p<.01  *** p<.001
<table>
<thead>
<tr>
<th>Treatment Effect for</th>
<th>Withdrawal from First Enrolled Math</th>
<th>Failed First Enrolled Math</th>
<th>Pass CLM in 1yr</th>
<th>Pass CLM in 2yrs</th>
<th>Pass CLM in 4yrs</th>
<th>Pass TLM in 1yr</th>
<th>Pass TLM in 2yrs</th>
<th>Pass TLM in 4yrs</th>
<th>Completed 30 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Students</td>
<td>-0.144*</td>
<td>0.057</td>
<td>0.041</td>
<td>0.020</td>
<td>-0.051</td>
<td>0.062**</td>
<td>0.070**</td>
<td>0.036</td>
<td>-0.100*</td>
</tr>
<tr>
<td></td>
<td>(0.060)</td>
<td>(0.065)</td>
<td>(0.023)</td>
<td>(0.041)</td>
<td>(0.051)</td>
<td>(0.015)</td>
<td>(0.014)</td>
<td>(0.035)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Latina/o Students</td>
<td>-0.033</td>
<td>-0.016</td>
<td>-0.001</td>
<td>-0.018</td>
<td>-0.018</td>
<td>0.063***</td>
<td>0.057***</td>
<td>0.035</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.013)</td>
<td>(0.018)</td>
<td>(0.023)</td>
<td>(0.028)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.015)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>White/Asian Students</td>
<td>-0.103***</td>
<td>0.015</td>
<td>0.058***</td>
<td>0.092***</td>
<td>0.057*</td>
<td>0.128***</td>
<td>0.144**</td>
<td>0.139**</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.026)</td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.020)</td>
<td>(0.021)</td>
<td>(0.030)</td>
<td>(0.031)</td>
<td>(0.052)</td>
</tr>
</tbody>
</table>

Notes: These heterogeneous effects by subgroup are calculated using coefficients reported in the Appendix. The subgroup categories are drawn from the enrollment application. The reference group is white or Asian for the models estimating heterogeneous effects for Black students and Hispanic/Latino students. Math level is a dichotomous variable splitting the sample by initial math level (those who chose high/advanced math at intermediate algebra and above vs. those who chose lower-level math courses). College-level math (CLM) is elementary algebra. Transfer-level math (TLM) is any course for which intermediate algebra is a requisite (e.g., pre-calculus).

* $p<.05$  ** $p<.01$  *** $p<.001$  

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<table>
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<tr>
<th></th>
<th>Withdrawal from First Enrolled Math</th>
<th>Failed First Enrolled Math</th>
<th>Pass CLM in 1yr</th>
<th>Pass CLM in 2yrs</th>
<th>Pass CLM in 4yrs</th>
<th>Pass TLM in 1yr</th>
<th>Pass TLM in 2yrs</th>
<th>Pass TLM in 4yrs</th>
<th>Completed 30 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Effect for Students Choosing Lower-Level Math</td>
<td>-0.141** (0.033)</td>
<td>-0.020 (0.014)</td>
<td>-0.031* (0.010)</td>
<td>-0.034* (0.014)</td>
<td>-0.060** (0.015)</td>
<td>0.000</td>
<td>0.007</td>
<td>-0.016</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Treatment Effect for Students Choosing Higher-Level Math</td>
<td>0.007 (0.024)</td>
<td>0.021** (0.006)</td>
<td>0.115*** (0.020)</td>
<td>0.118*** (0.019)</td>
<td>0.103*** (0.020)</td>
<td>0.171*** (0.016)</td>
<td>0.182*** (0.018)</td>
<td>0.165*** (0.018)</td>
<td>0.065** (0.018)</td>
</tr>
</tbody>
</table>

Notes: These heterogeneous effects by subgroup are calculated using coefficients reported in the Appendix. The subgroup categories are drawn from the enrollment application. The reference group is white or Asian for the models estimating heterogeneous effects for Black students and Hispanic/Latino students. Math level is a dichotomous variable splitting the sample by initial math level (those who chose high/advanced math at intermediate algebra and above vs. those who chose lower-level math courses). College-level math (CLM) is elementary algebra. Transfer-level math (TLM) is any course for which intermediate algebra is a requisite (e.g., pre-calculus).

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