Framing the Problem: A Closer Look at the Data

John J. Hetts, Senior Director of Data Science, Educational Results Partnership

Let Icarus Fly

Following the evidence to rediscover our students' capacity in mathematics

San Diego Math Network

August 10, 2017

http://bit.ly/SDMN2017

John J. Hetts, Ph.D.
Senior Director of Data Science
Educational Results Partnership
jhetts@edresults.org
@jjhetts #LetIcarusFly

ERP EDUCATIONAL RESULTS PARTNERSHIP

First, the story of Daedalus and Icarus

- Daedalus crafted the labyrinth of inescapable complexity for King Minos
  - Helped Thesus escape & was imprisoned in tower with son Icarus
- To escape, Daedalus built wings of feathers & wax
- Warning: Don't fly too high, lest sun melt the wax and you plummet to your doom
  - Dangers of innovation/invention, hubris,
  - Importance of knowing your limits, listening to your wiser elders
- But most of us forget the rest of that story…

Three snapshots of backed up, leaky mathematics pipeline

- 28% of CSU students placed back into intermediate algebra or lower (mean HSGPA = 3.2)
  - 50% of African American, 37% of Hispanic/Latino, 34% of female students
  - bit.ly/CSUMathRemediation

- 75% (CCCCO Scorecard) to 85% (2011 CCCCO BSI Accountability Report: bit.ly/BSI2012) of students in CCC placed into intermediate algebra or lower
  - Even though ~60% finished at intermediate algebra or higher in HS
  - African American and Hispanic students disproportionately likely (3-4X) to be placed 3-4 levels below (pre-algebra or arithmetic) in mathematics

- Noyce Foundation (bit.ly/Noyce2010)
  - ~2/3 of students who take Algebra in 8th grade, repeat Algebra (or lower) in 9th grade
  - Half of students with a B- or better or who meet or exceed Algebra standards repeat Algebra (or lower) and are no more successful in second attempt

What do these have in common?

- As students move between segments (especially compared to when they move within segments!)
  - Disproportionately likely to repeat, go backwards
    - Even after success!
  - Standardized tests frequent gatekeeper/proxy
    - Sometimes exacerbated by course availability in 7^{th}-9^{th} grade
  - Repetition yields _at best_ moderate improvement in performance in repeated and subsequent course
  - Disproportionate impact on underrepresented populations
  - Substantial opportunity cost to repeated courses successfully completed

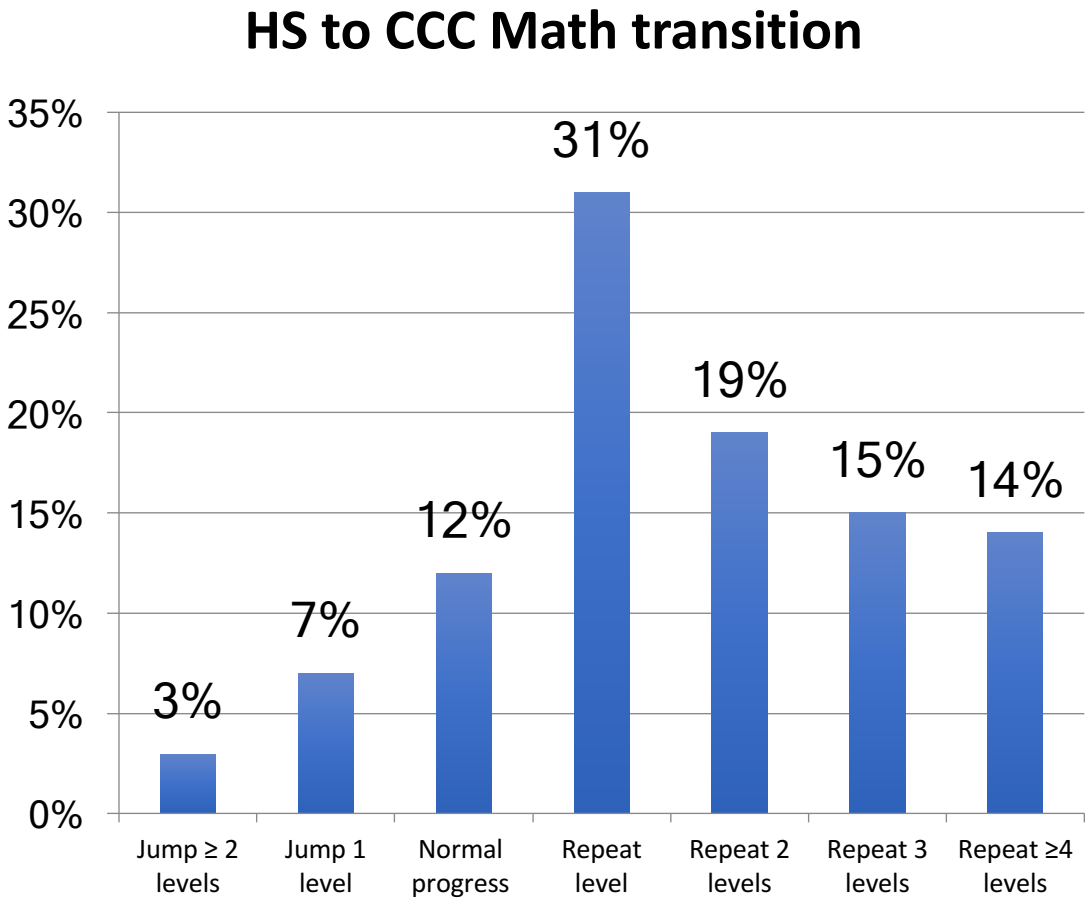
Possible explanations

- Students struggle to learn math
- We struggle to teach math effectively

- Transitions and trust
- Methods of assessment of readiness are flawed/incomplete
- Repetition of level is ineffective (and costly)
  - Especially for students that successfully completed

Transitions and intersegmental trust

- Within systems
  - Highly reliable progression with C or better
- Between systems
  - HS to CCC transition in mathematics
    - ~3/4 repeat ≥ 1 level
    - ~1/2 repeat ≥ 2 levels
    - African Americans & Hispanics ~60% more, Female students ~20% more
  - Noyce Foundation report
    - Algebra in 7th grade nearly always advance to Geometry in 8th grade
    - Algebra in 8th grade, ~2/3 repeat including 50% of students with B or better

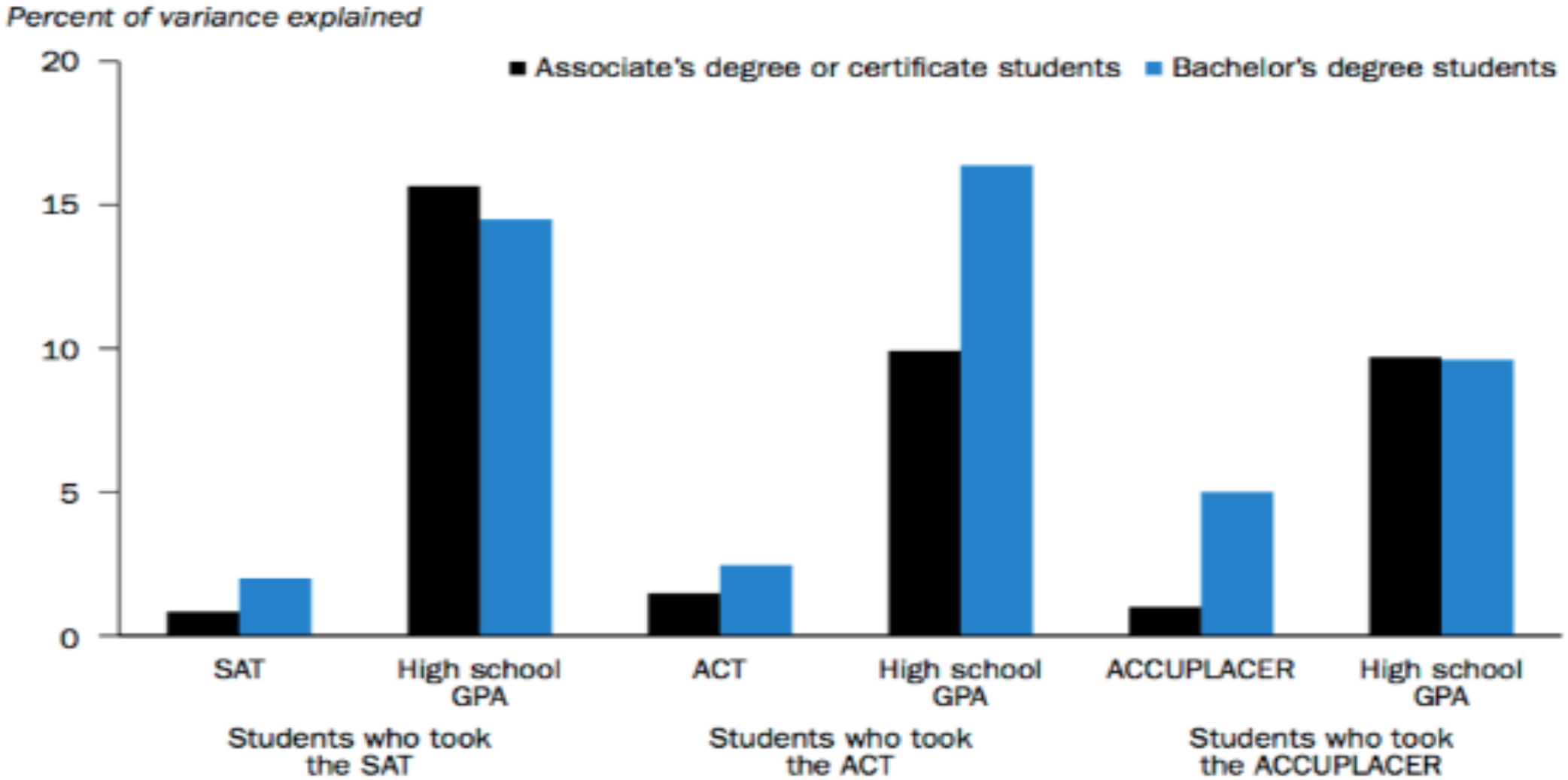


Transitions and the incomplete standardized proxy

- Standardized tests are marketed as a way for us to know the truth about student preparation/readiness
  - Can’t possibly know what’s going on behind the intersegmental veil

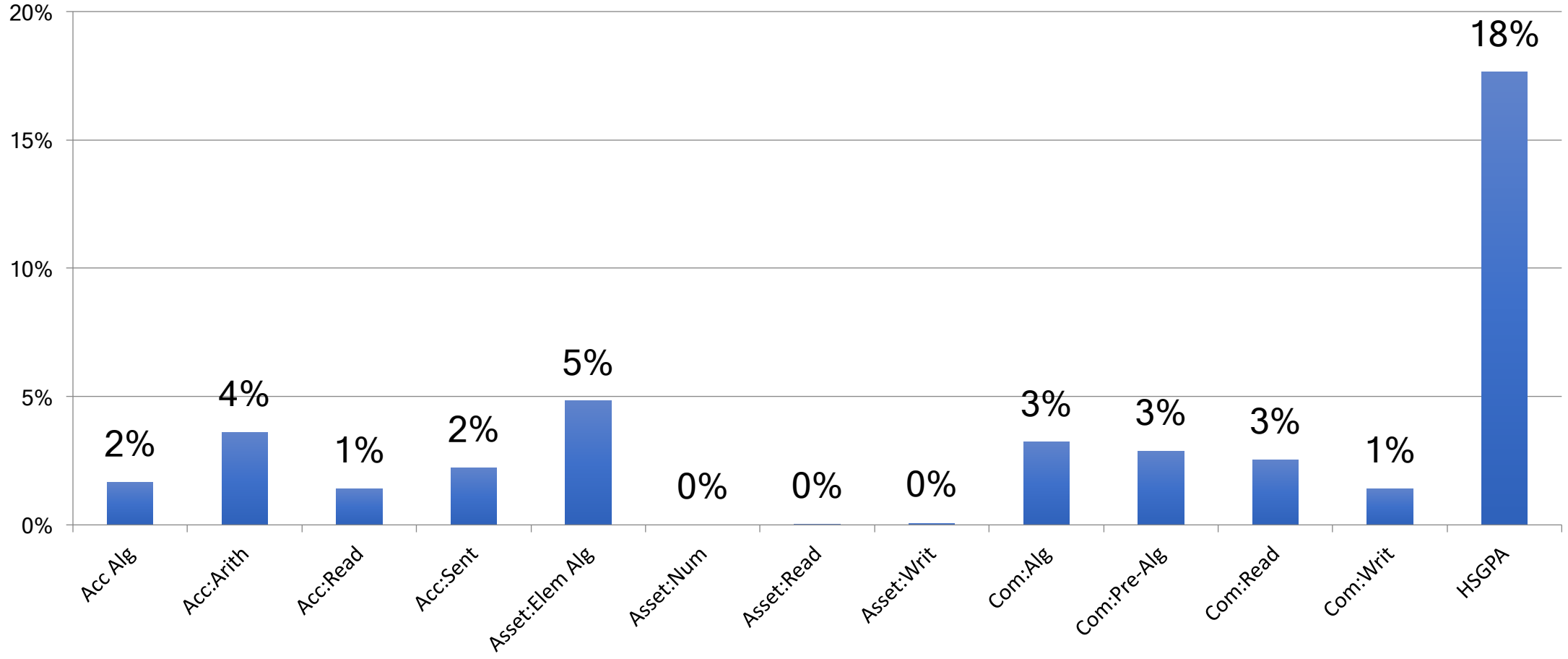
- Regularly lead to vastly different intersegmental rates of progression – why?
  - One key reason - typically weak predictor of subsequent performance

Figure 7. Among University of Alaska students who enrolled directly in college math courses, high school grade point average explained more of the variation in college math grades than did exam scores, 2008/09–2011/12



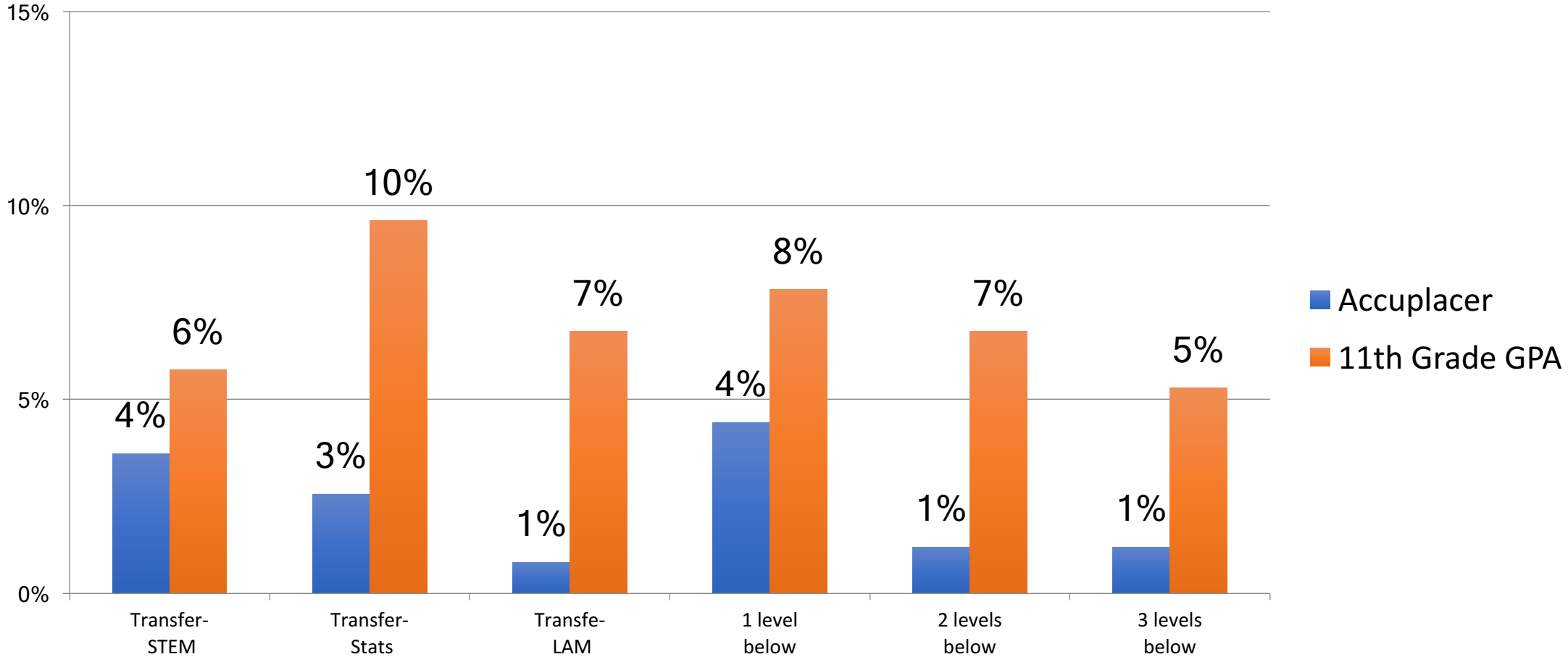
From Hodara, M., & Cox, M. (2016), **Developmental education and college readiness at the University of Alaska**: http://bit.ly/HSGPAAK

Variance in college level math grades explained by various assessments - NC



From Bostian (2016), North Carolina Waves GPA Wand, Students Magically College Ready adapted from research of Belfield & Crosta, 2012 – see also Table 1)

Variance in math grades explained by Accuplacer vs. 11th grade GPA – CA CCC



What are the consequences of poor predictive utility?

- Not very good at predicting students performance/placing students accurately
  - both overplace and underplace students
  - however, research points to underplacement being ~3X more prevalent, with ~1/3 of students severely underplaced (likely to get a B in the college level course if given chance)
  - bit.ly/CCRCPlacementAccuracy

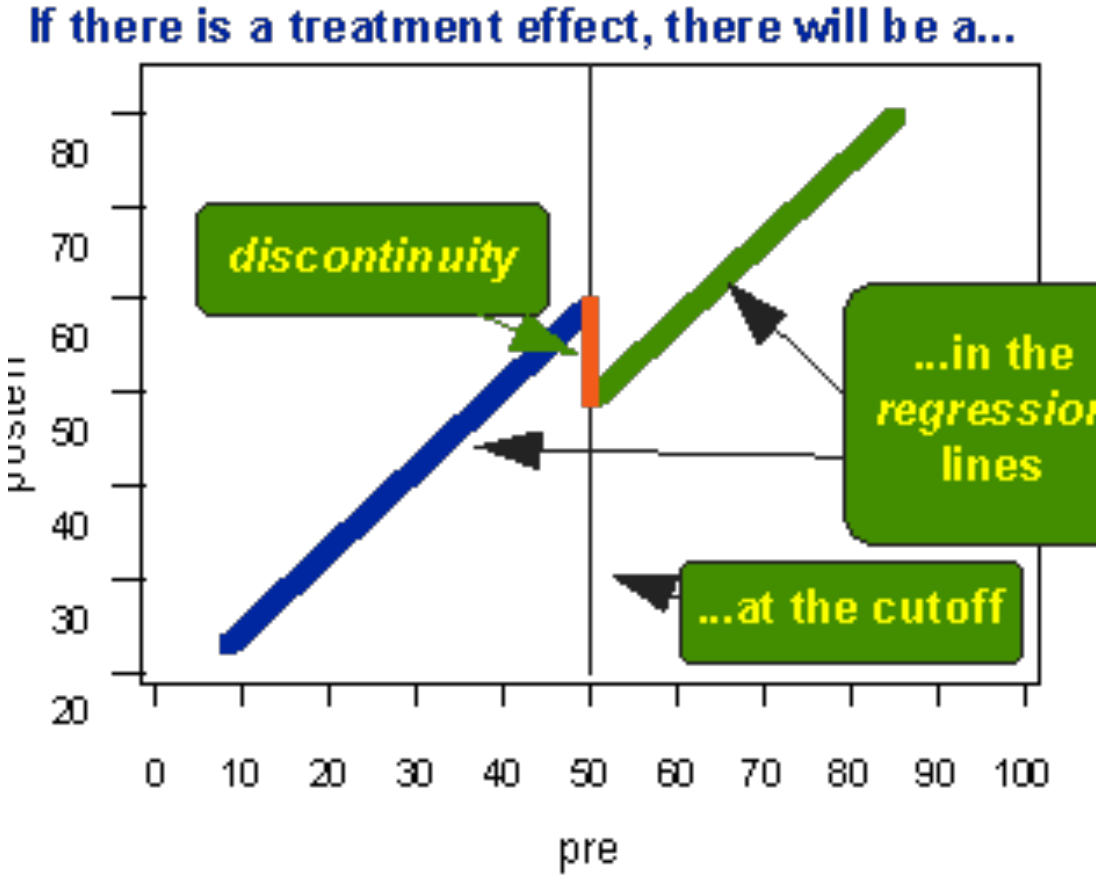
- Why isn't error symmetrical?
  - Out-group skepticism (absence of in-group trust)
  - Overplaced students more visible/problematic – likely to lead to ratcheting up of cut scores

Do developmental courses change student trajectories?

Evidence from regression discontinuity designs

Regression Discontinuity Designs

- Compares students on either side of a cut score
- Developmental education should have significant positive impact for essentially identical students
- Recent meta-analysis (Valentine, Konstantopoulos, & Goldrick-Rab, 2017): placement in developmental education has **"effects that are negative, statistically significant, and substantively large"** for:
  - gateway course completion
  - college credits earned
  - degree/transfer.
- See also http://bit.ly/CCRCDEVED



Overview of Findings on Outcomes for Developmental Students[9]

Positive Negative Null

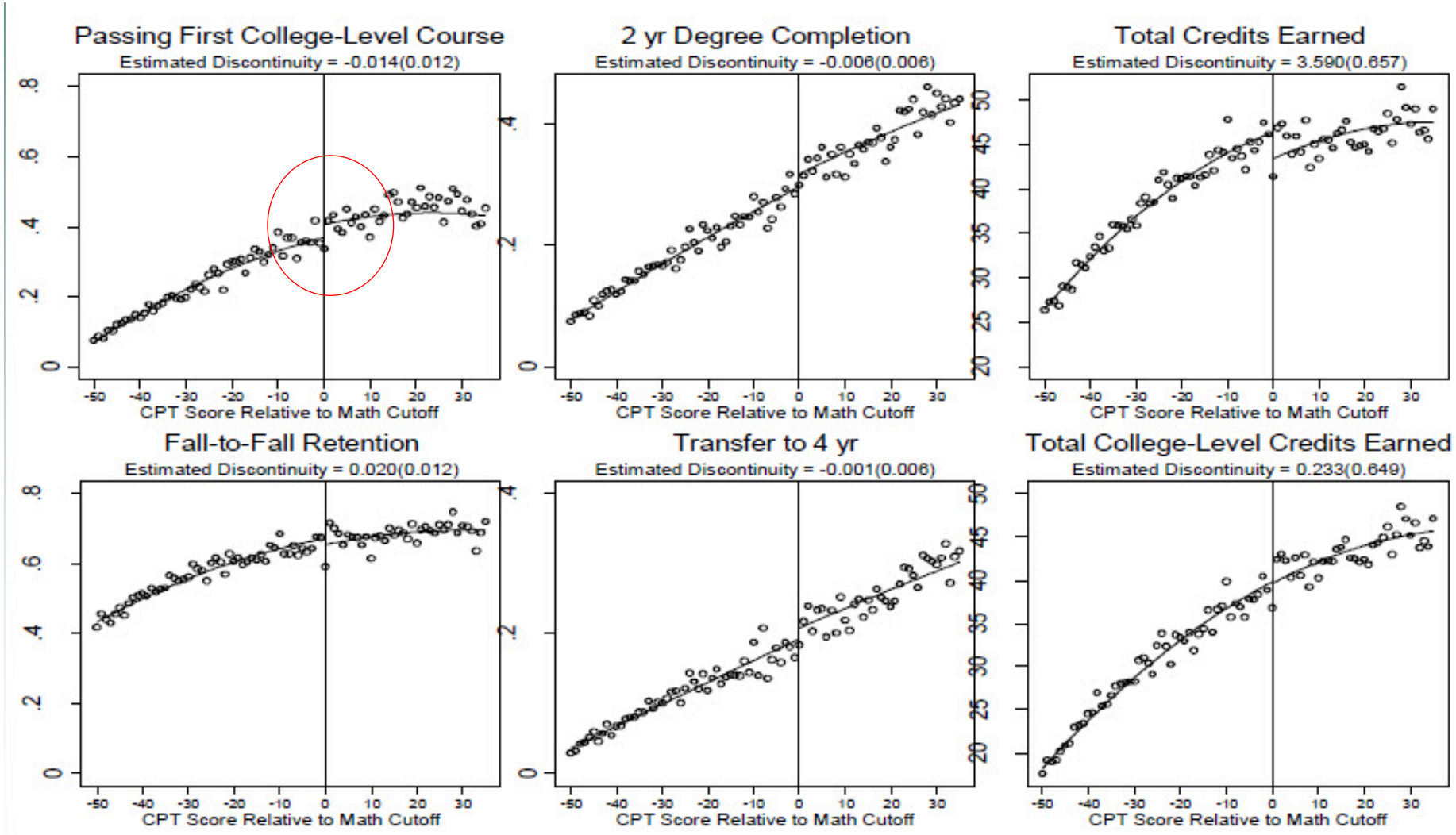
DEVELOPMENTAL MATH STUDENTS

		Short-Term Impacts			Medium- & Long-Term Impacts		
Study	Level	Persistence	Passed College-Level Math	Grade in College-Level Math	Persistence	College-Level Credits Earned	Credential and/or Transfer
TENNESSEE[10]	UPPER	NEG		NULL (conditional)	NULL	NULL (conditional)	NEG (credential)
TEXAS[11]	UPPER	NULL					NULL
OHIO[12]	UPPER				NULL		POS (transfer)
LUCCS[13]	UPPER		NEG	NEG	NULL	NULL	NULL
FLORIDA[14]	UPPER	NULL	NULL			NULL	NULL
VIRGINIA 1[15]	LOWER vs. MIDDLE		NULL				NEG (credential)
TENNESSEE	LOWER vs. MIDDLE	NULL		NULL (conditional)	NULL	NULL (conditional)	POS (credential)

Note. "Conditional" signifies that only outcomes for students who enrolled in college-level courses, or persisted in college, were compared. LUCCS stands for large urban community college system.

http://bit.ly/CCRCDEVED

Math (CCRC: 17 CUNY CCs)

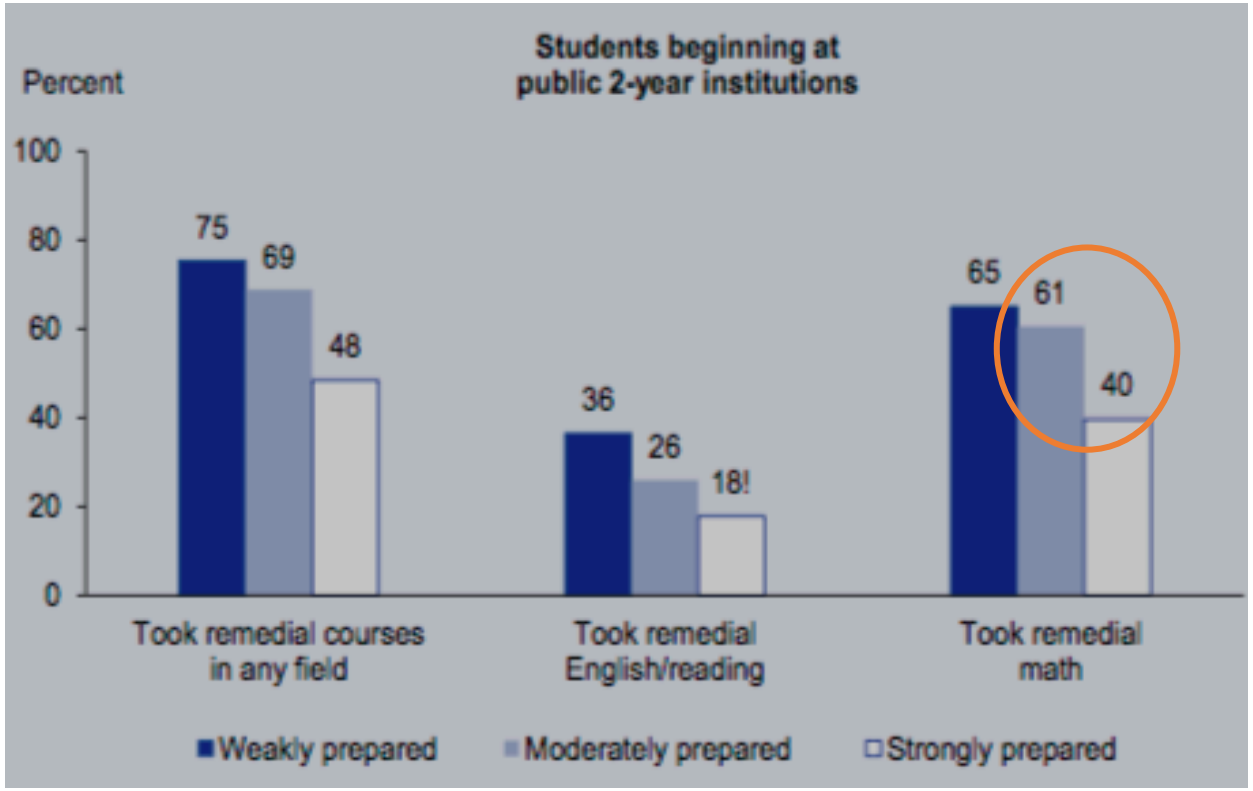


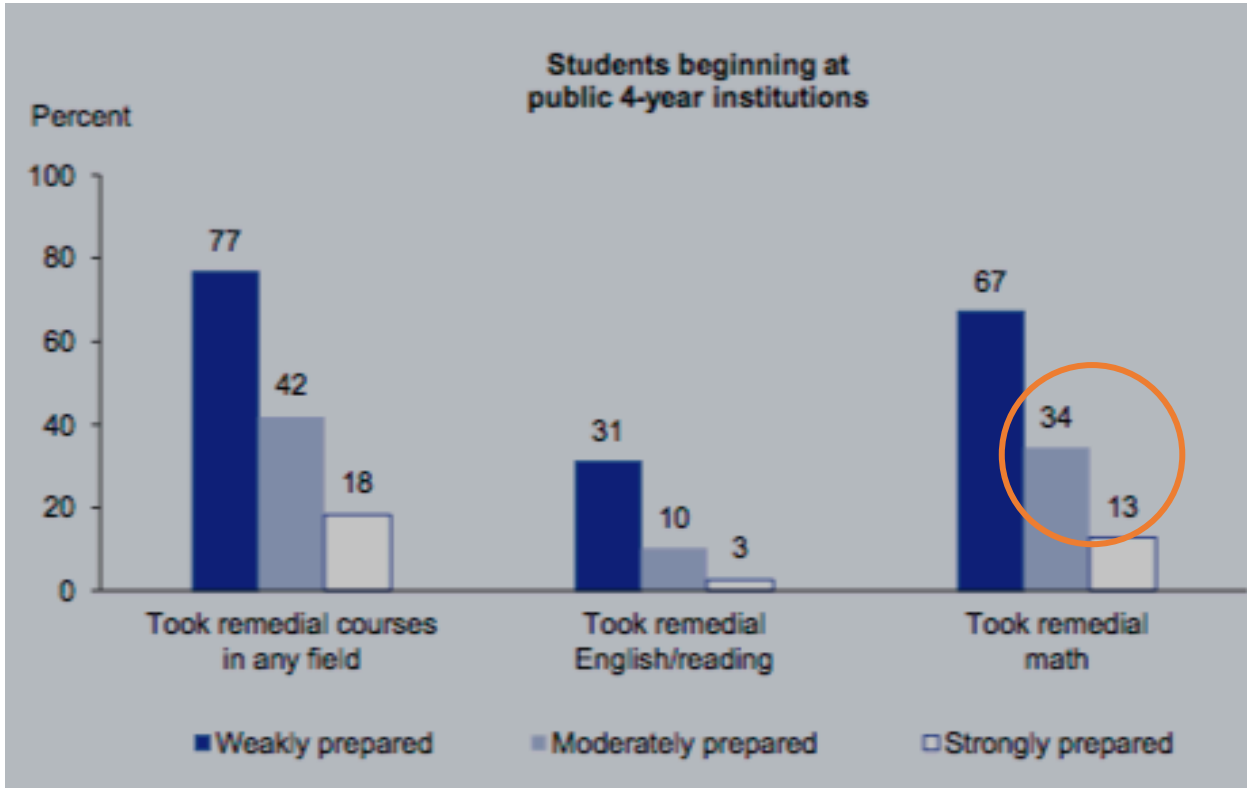
IES Report on impact of placement into Developmental Education

- Assignment to development education had no significant positive but some negative impacts for moderate to strongly prepared students (see Table A)
  - Moderate preparation = meet at least two: HSGPA >2.5, one course above Algebra 2, SAT (or ACT equivalent) > 840
  - Outcomes: completing college-level course in discipline, number of college credits completed, transfer to four-year institution, completion of four-year degree, exiting college in first two years without a degree
- http://bit.ly/IESRemedial

Moderately/strongly prepared students assigned to developmental education in 2-year colleges more often

Figure 1.
REMEDIAL COURSETAKING: Among 2003–04 beginning postsecondary students who first enrolled in public 2- and 4-year institutions, percentage who took remedial courses in various fields, by precollege academic preparation: 2003–09





Why might developmental education not demonstrate the positive effects we expect?

- Semester long intervention should have strong positive effects
- Potential beneficial effects are masked/degraded by underplacement
  - Placing high-achieving high school students in developmental education means developmental education will have minimal benefits
  - Such placement may have active negative effects
    - e.g., discouragement, cynicism, anger, disidentification, undermining of academic/math self-confidence, undermining of taking course seriously, increased time to completion/increased opportunity for life/running out of financial aid to interrupt education)
  - Distortions of standards of comparison/grading curve by underplaced students puts students who need course at significant disadvantage

How can we improve our outcomes in mathematics?

- Improve assessment method/process
- Reconsider cut scores
- Change methods of developmental education from sequential to concurrent

Multiple Measures Assessment Project

- Collaborative effort of CCCCO, Common Assessment Initiative (CAI), Cal-PASS Plus (Educational Results Partnership & San Joaquin Delta College), RP Group and now >65 CCC pilot colleges
  - Replications and extension of Student Transcript Enhanced Placement Study
- Identify, analyze, & validate multiple measures data (including HS transcript data, non cognitive variable data, & self-report HS transcript data
  - Focus on predictive validity (success in course) using categorization and regression tree models (robust to missing data, non-linear effects, and interactions)
- Engage pilot colleges to conduct local replications, test models and pilot use in placement, and provide feedback
- Participation in CalPASS and MMAP is 100% free

bit.ly/MMAP2017

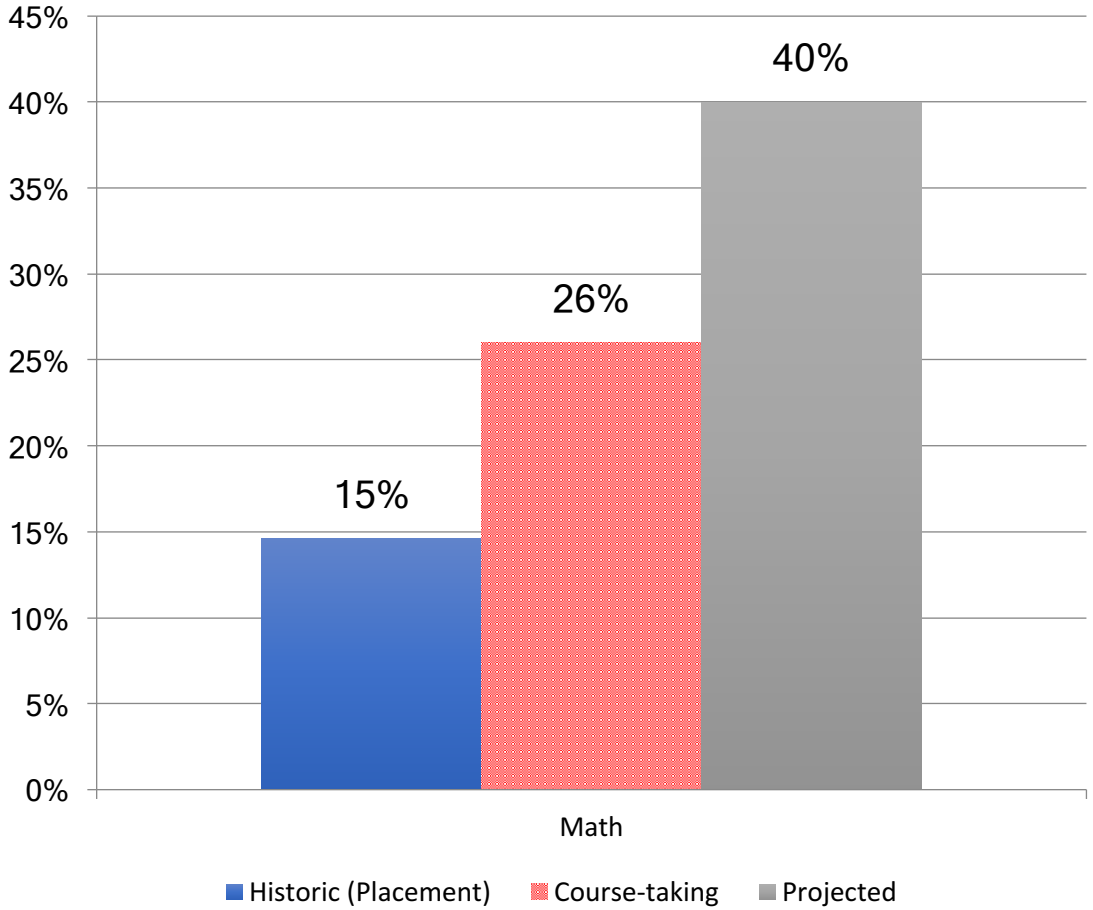
Math Transfer-Level Placement Recommendations

Transfer Level Course	Direct Matriculants	Non-Direct Matriculants
College Algebra Passed Algebra II (or better)	HS 11 GPA >=3.2 OR HS 11 GPA >=2.9 AND Pre-Calculus C (or better)	HS 12 GPA >=3.2 OR HS 12 GPA >=3.0 AND Pre-Calculus or Statistics (C or better)
Statistics Passed Algebra I (or better)	HS 11 GPA >=3.0 OR HS 11 GPA >=2.3 AND Pre-Calculus C (or better)	HS 12 GPA >=3.0 OR HS 12 GPA >=2.6 AND Pre-Calculus (C or better)

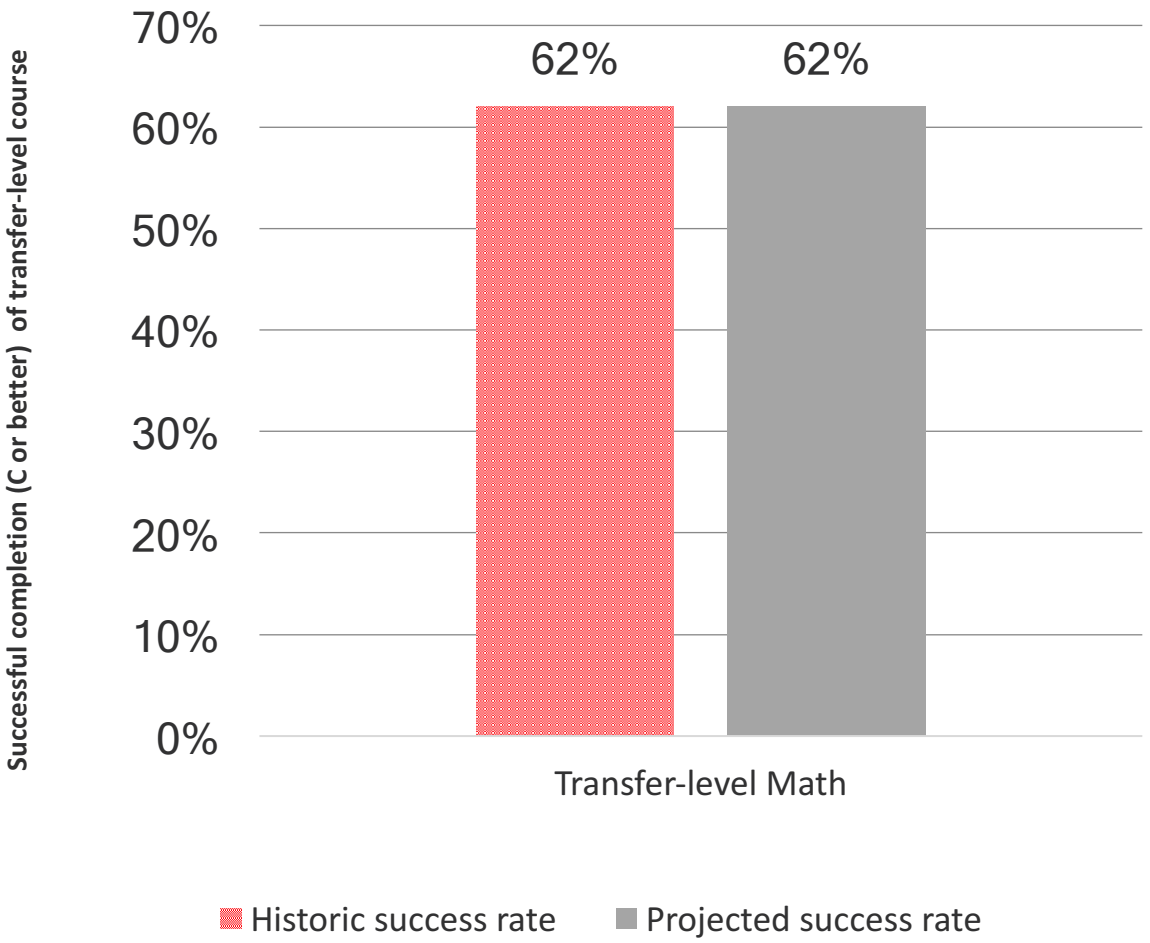
bit.ly/RulesMMAP

Projected impact on placement and success

Placement into transfer-level



Projected success sates



[bit.ly/BSI2012](bit.ly/BSI2012) and bit.ly/MMAPProjection -

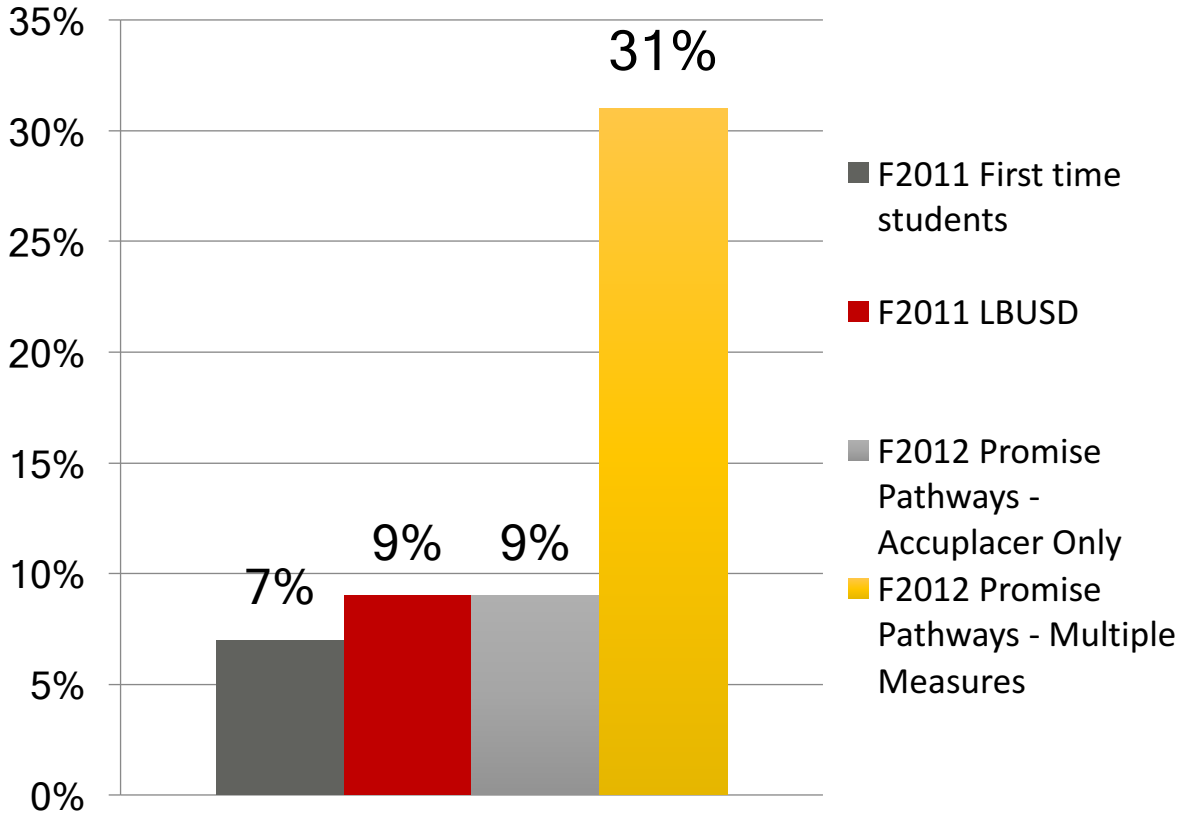
Considering alternative math pathways: is intermediate algebra critical for success in statistics?

- Based on statewide data on actual performance in Statistics in the CCC's, ASCCC allowed implementation of MMAP rules at local discretion of the college for using algebra as prereq
- http://bit.ly/ASCCCPrereq

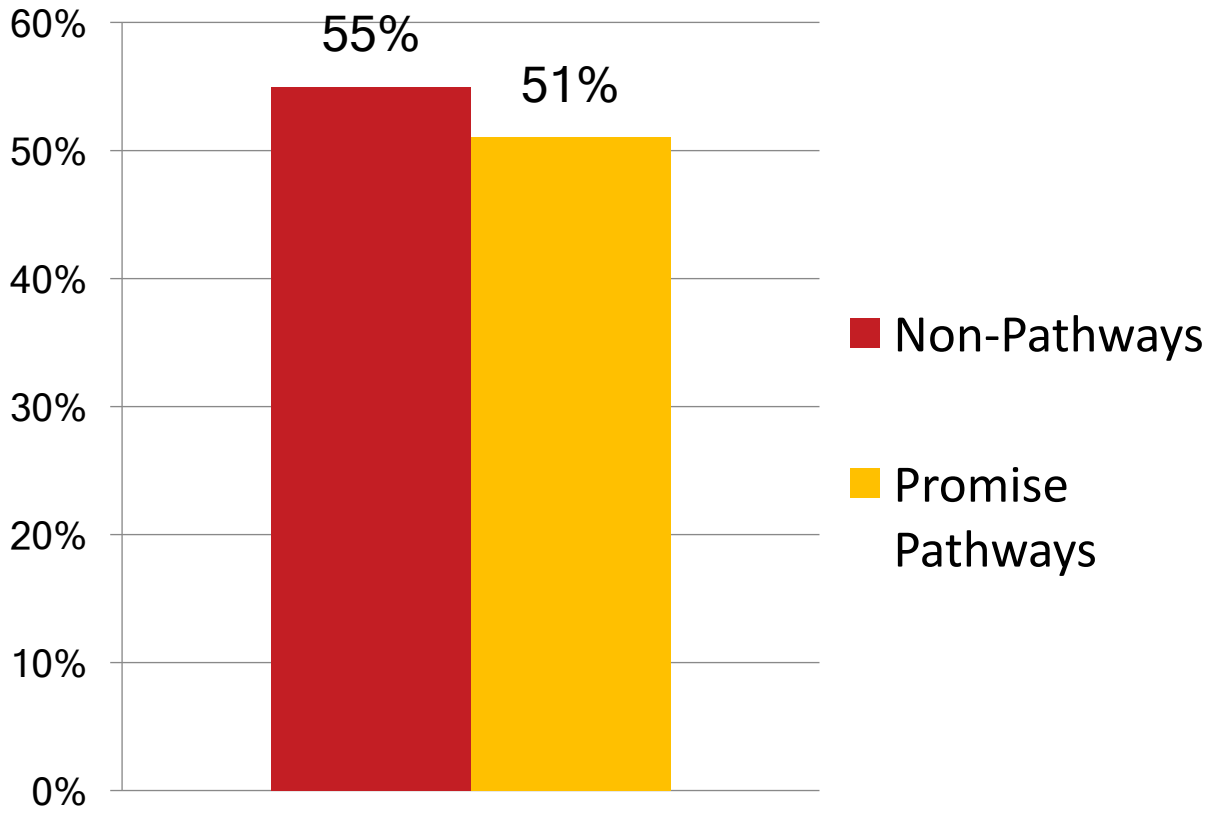
Highest Math successfully completed in HS	Any	Higher than Algebra 2	Algebra 2	Algebra 1	Neither prereq met
All students	69%	79%	63%	49%	49%
MMAP statistics placement (or higher) rules met	77%	80%	72%	60%	74%
MMAP statistics placement rules not met	48%	47%	50%	44%	41%

Multiple Measures Placement at LBCC: Transfer-level Placement & Success Rates F2012

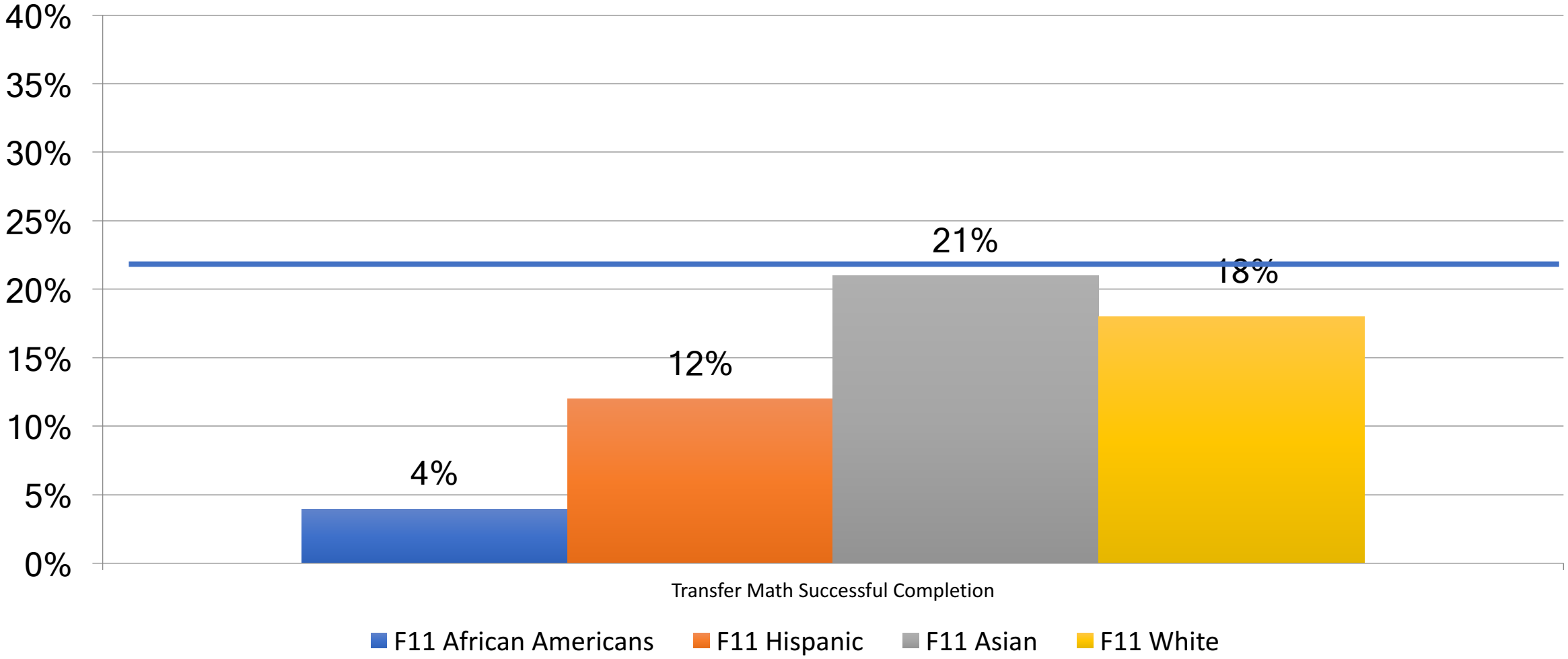
Placement into transfer-level math



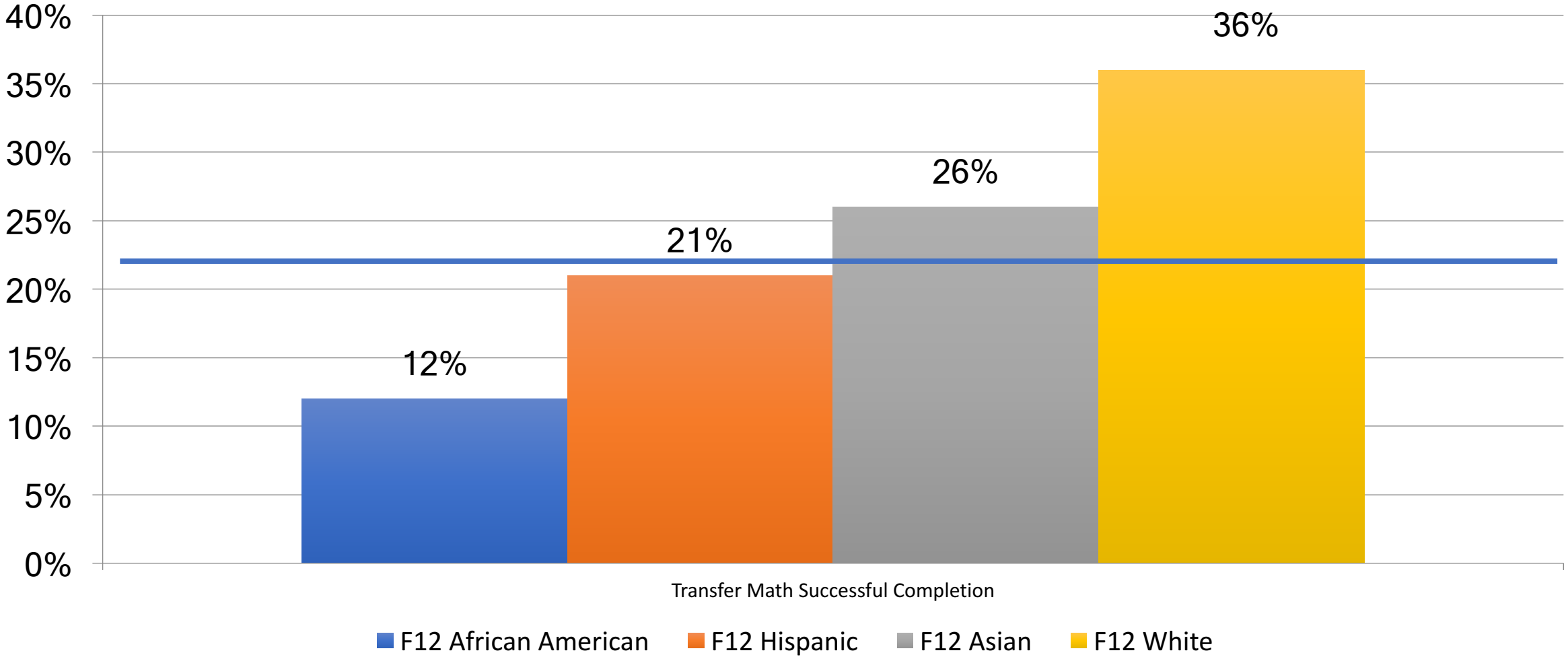
Success rates in transfer-level math



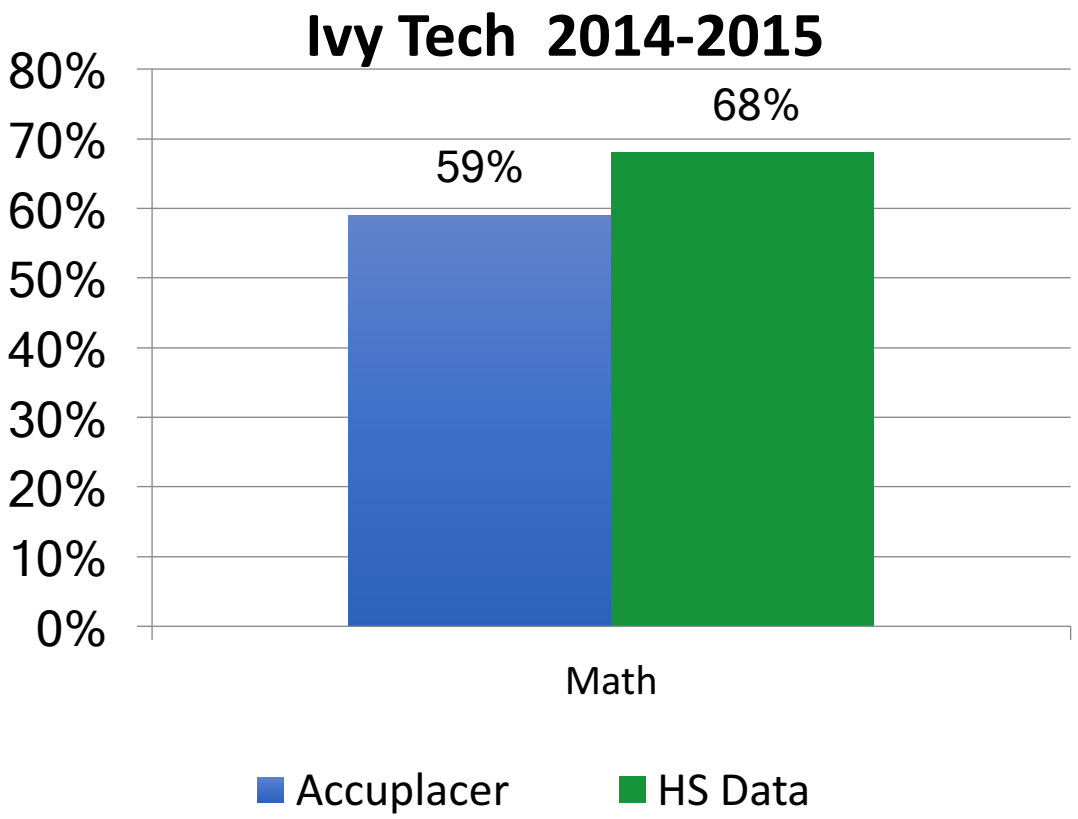
Potential equity & completion impact: LBCC F2011 Baseline Equity Gaps for 2-year rates of achievement



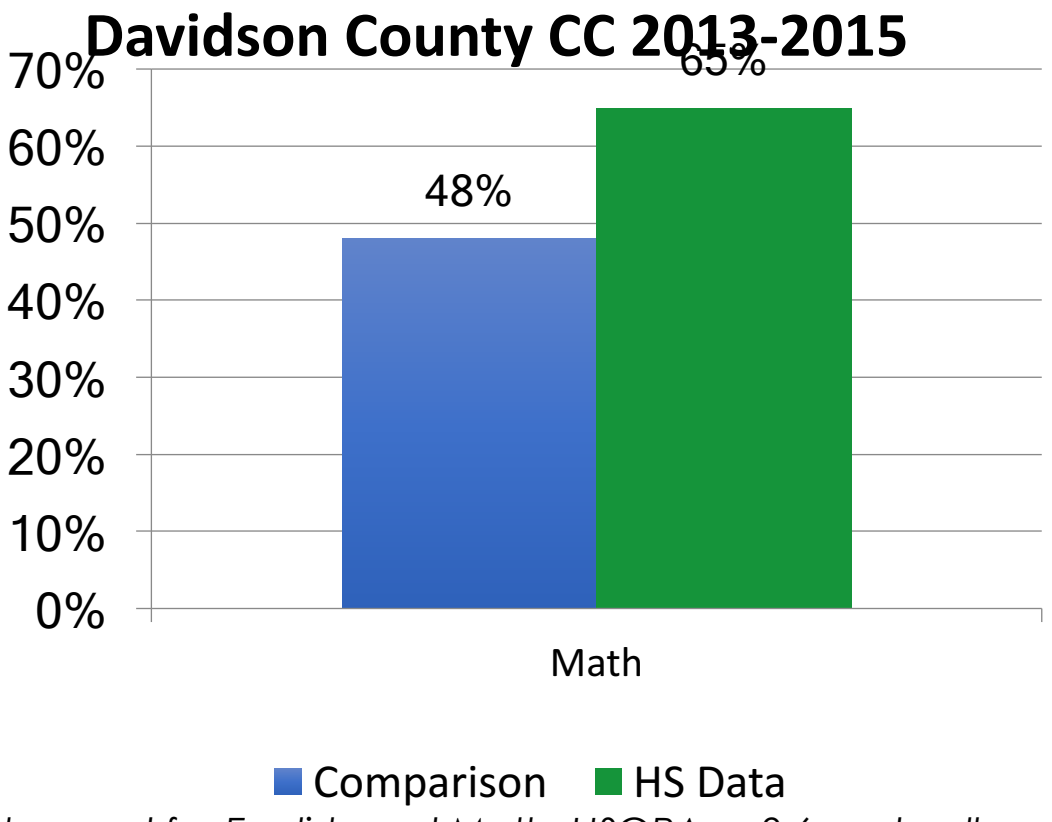
LBCC: F2012 2-year rates of achievement



Transfer-level course completion, recent national examples at scale: http://bit.ly/CCCSEMM



Rules used for English and Math: HSGPA >=2.6



Rules used for English and Math: HSGPA >=2.6 and college directed (completion of four years of mathematics including one year beyond Algebra 2)

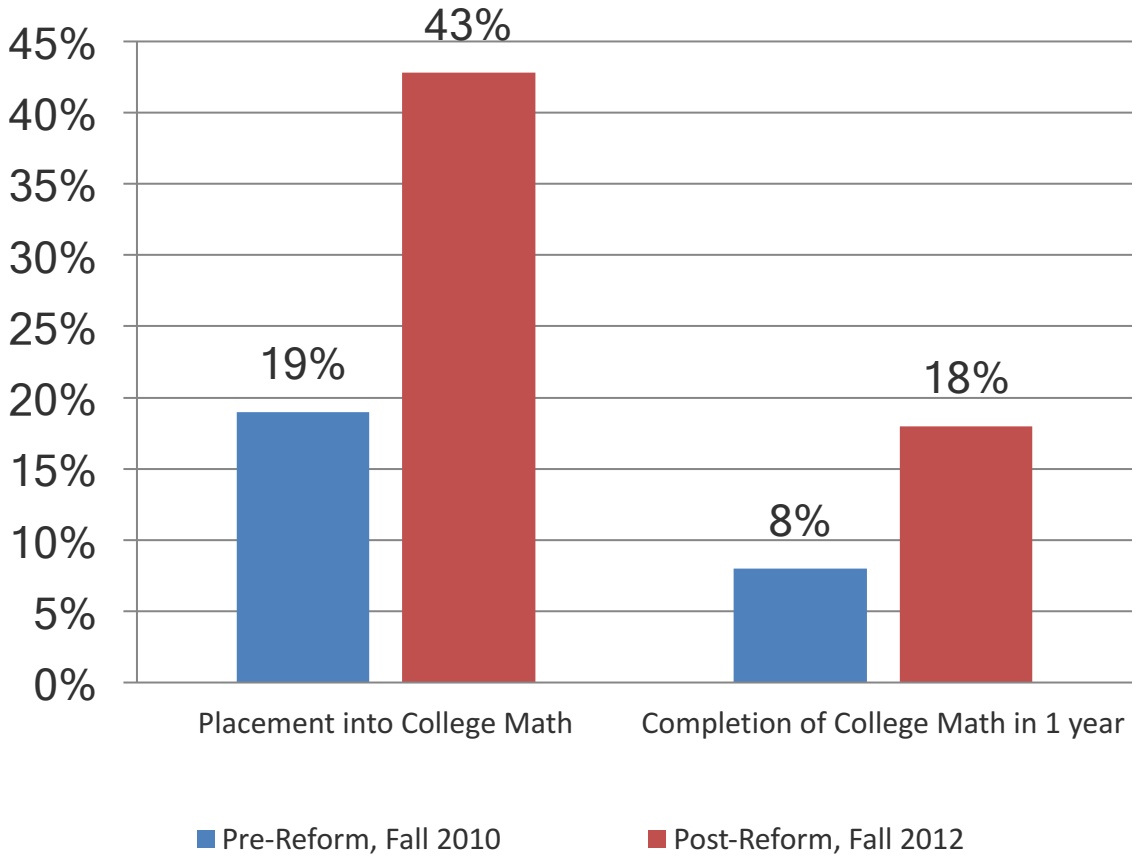
Reconsider cut scores

Resources/references:

- http://bit.ly/Kalamkarian2015 (Kalamkarian, Raufman, & Edgecombe, 2015)
- http://bit.ly/Rodriguez2014 (Rodriguez, 2014)

Developmental Math Reform – Virginia Community College System

- Intentionally increased percentage assigned to college-level math
- *(Also, below college-level introduced new assessment instrument, redesigned remedial math into modular setup, increased alignment of math to educational goals)*



Converging bodies of evidence from accelerated and corequisite developmental education

- **Two to five** times transfer-level course completion
  - Especially when using alternative math pathways
- Comparable or higher success rates
- Works across demographic groups & placement levels
- Tremendous equity implications

Accelerated Developmental Education

- http://bit.ly/RPCAP
- http://bit.ly/CAPEval
- http://bit.ly/RPAcceleration

Corequisites:

- http://bit.ly/2015ALP (Coleman, 2015)
- http://alp-deved.org
- http://bit.ly/CCACoreq
- http://bit.ly/Kalamkarian2015 (Kalamkarian, Raufman, & Edgecombe, 2015)
- http://completecollege.org/wp-content/uploads/2016/07/Serving-the-Equity-Imperative-Final.pdf
- http://completecollege.org/wp-content/uploads/2016/01/TBR-CoRequisite-Study-Update-Fall-2015-pages-2.pdf

Key takeaways

- Students that successfully complete work should progress naturally
- We should trust our students and our educational colleagues
- Our approach to intersegmental transitions is hurting our students
  - Directly and indirectly
- Fairer, holistic, and more accurate assessment, alternative approaches to providing support to students that actually need it, and thoughtful approaches to alternative math pathways hold tremendous promise for helping our students succeed in mathematics

Summary

- The evidence strongly suggests that:
  - we have been systematically and substantially underestimating our students' capacity to succeed in mathematics
  - students, especially successful students, should be allowed to progress normally (and relatively rarely repeat courses previously completed) as they transition between different segments
  - our math pathways should be responsive to different mechanisms for demonstrating mathematical reasoning/capacity
  - we should put far more trust in the efforts of our students and our educational colleagues
  - we need to remember Daedalus' second instruction to Icarus as well
    - It's just as important not to fly too low.

Thank you!

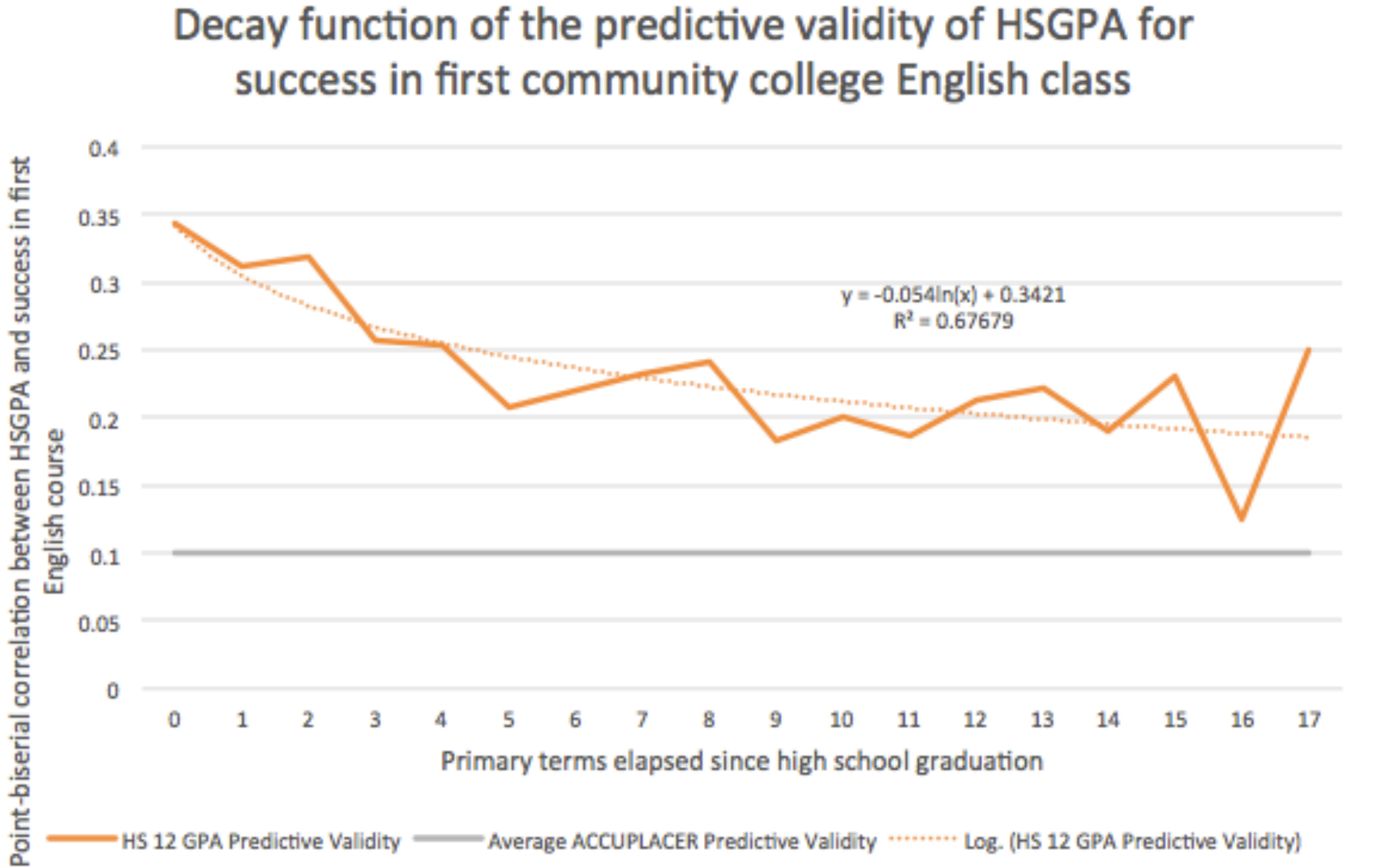
Contact Information

- John Hetts
- Educational Results Partnership
- jhetts@edresults.org
- 714-380-2678 cell
- Twitter: @jjhetts #LetIcarusFly

- http://bit.ly/SDMN2017

The Fierce Urgency of Now

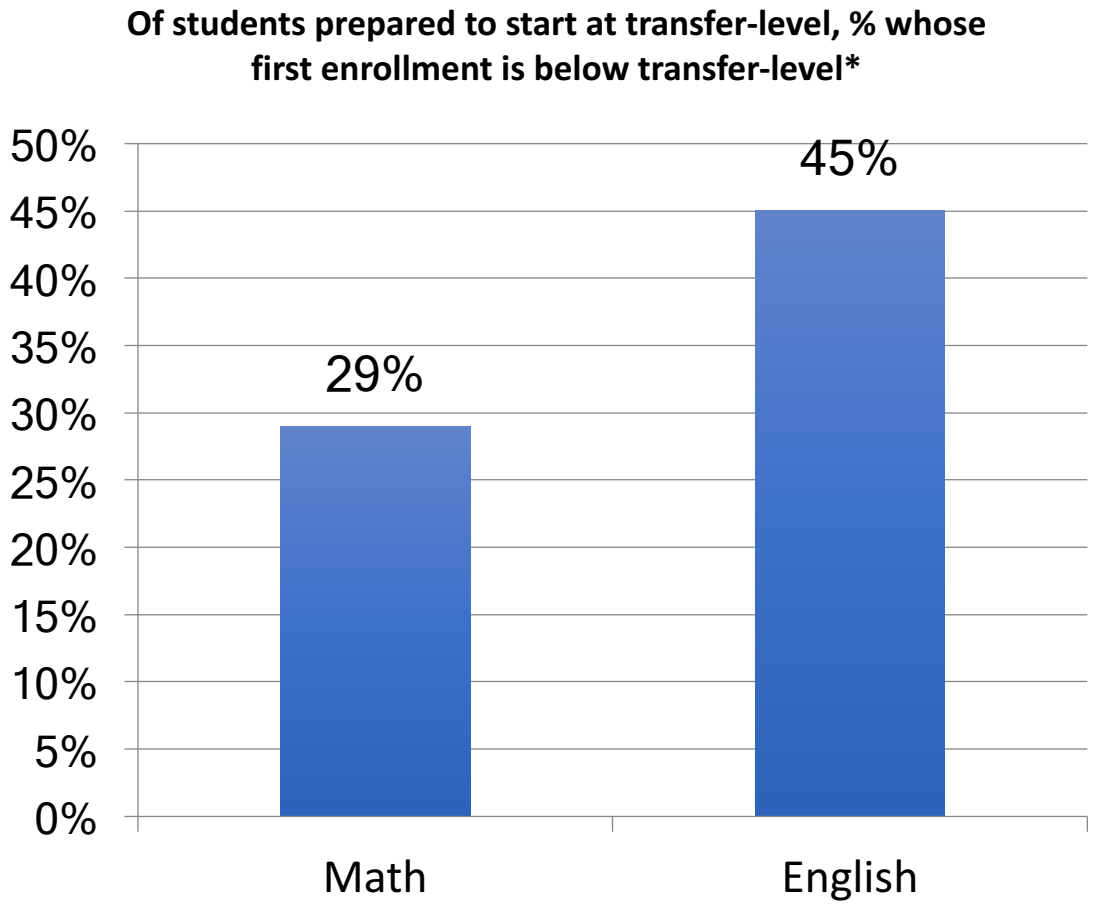
- “We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of now. In this unfolding conundrum of life and history, there "is" such a thing as being too late. This is no time for apathy or complacency. This is a time for vigorous and positive action.”
  - Dr.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



Hayward et al (in preparation). Decay Function of the Predictive Validity of High School GPA

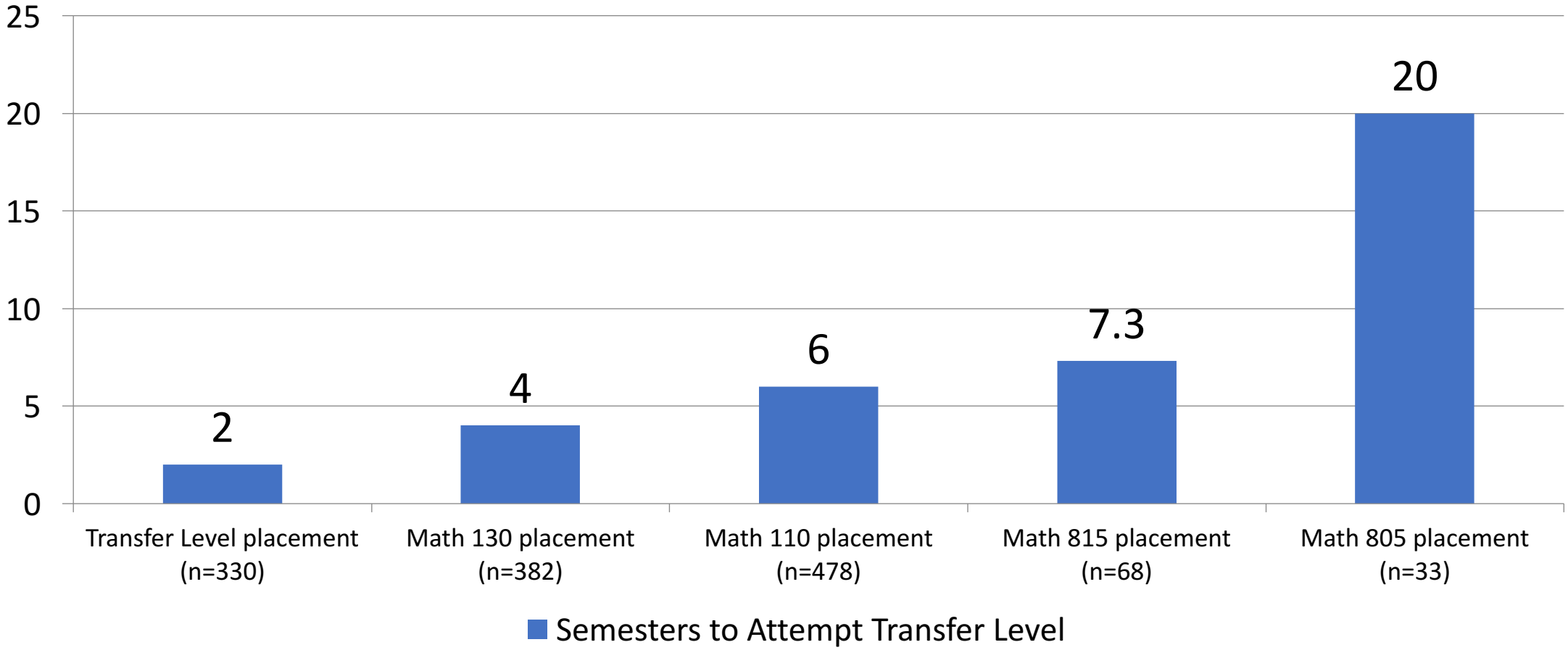
Quick examination of underplacement

- For students otherwise doing everything right:
  - Met MMAP recommendations for placement into transfer-level English or Mathematics
    - HSGPA≥=2.6 for English
    - HSGPA ≥ 3.0 and C or better in Algebra or higher (or met other rules)
  - Matriculated directly to community college
  - Took English or Mathematics course in first year

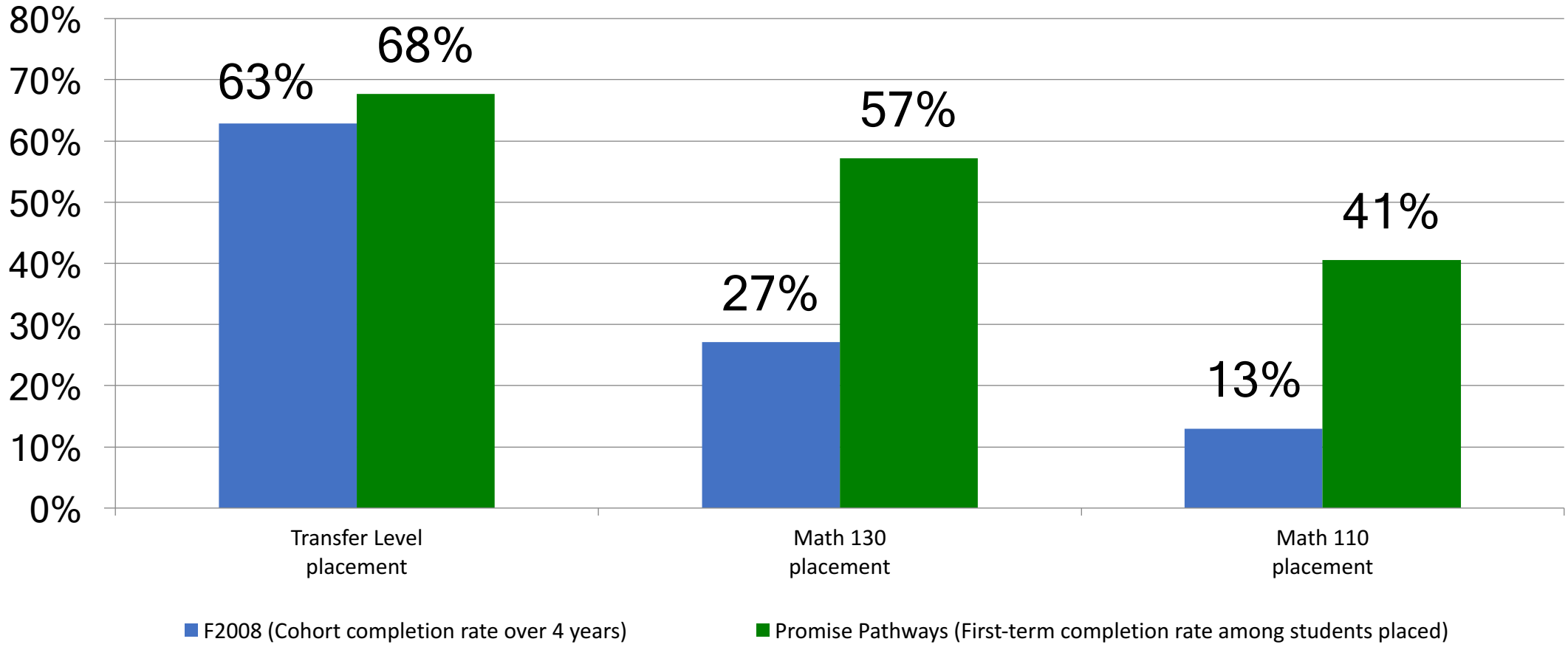


*Note: higher percentage of students ready in English than Math & students less likely to take Math in first year

Broader Context: F2012 Non-Pathways Students in Transfer Math: Semesters to Reach Transfer Level (by Accuplacer)



Cohort completion rates for Transfer-Level Math: F2008 First time students vs. Promise Pathways (by Accuplacer Placement)



Acceleration of Developmental Education

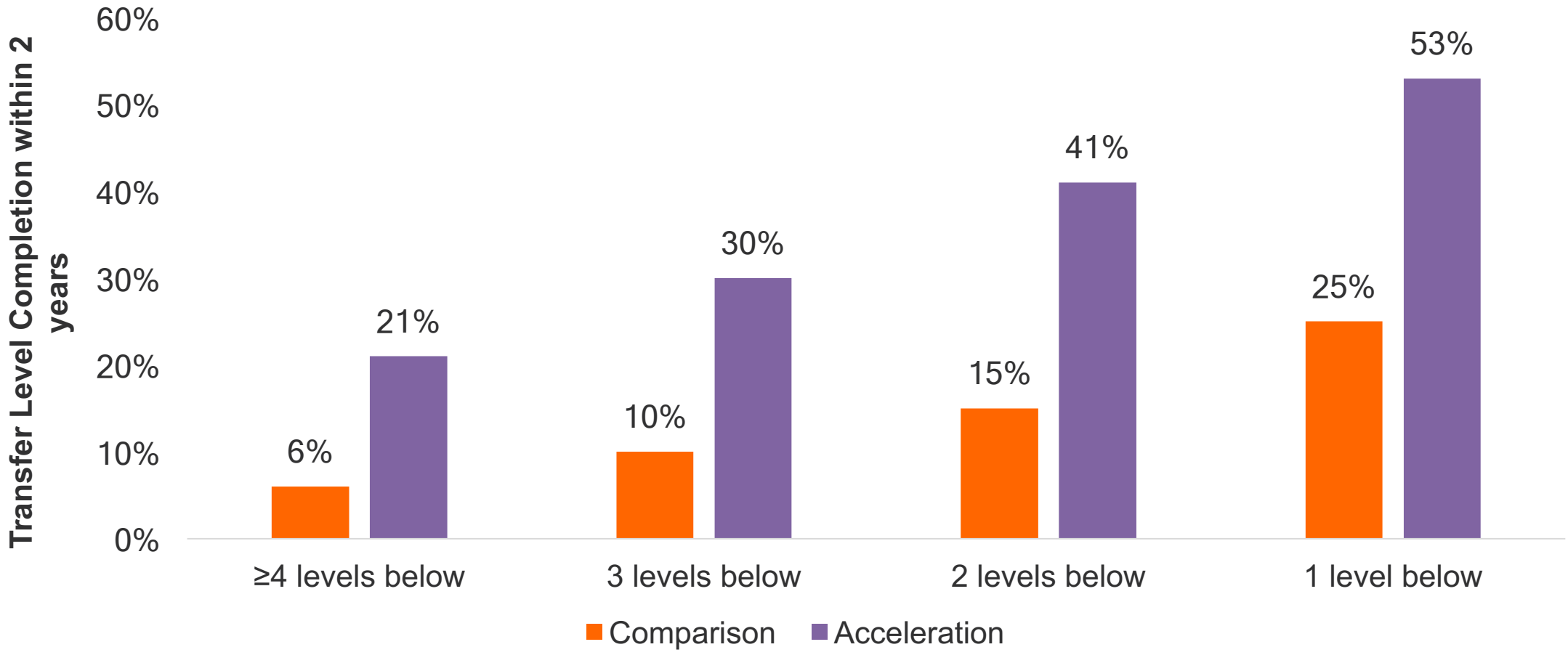
Resources/references

- http://bit.ly/RPCAP
- http://bit.ly/CAPEval
- http://bit.ly/RPAcceleration

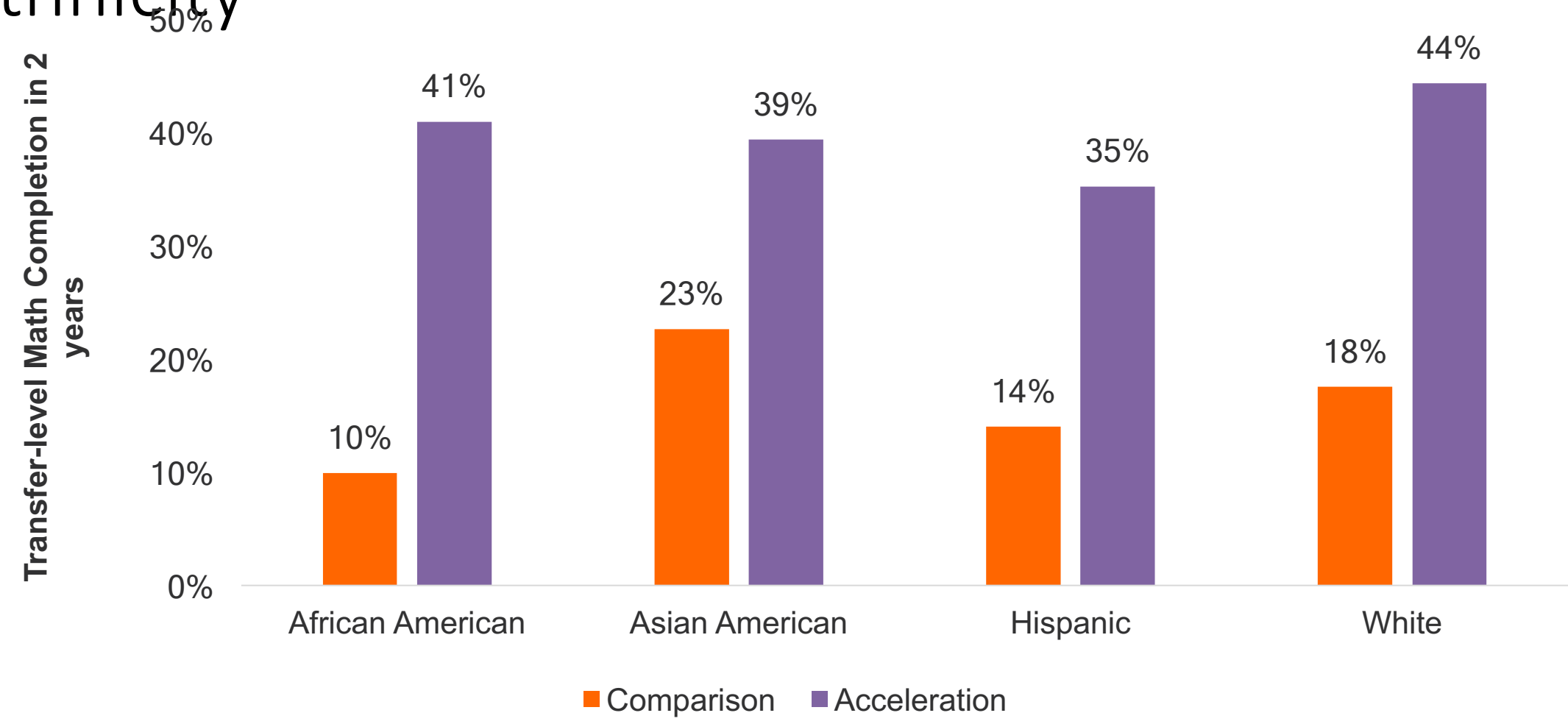
Evaluation of 2011-2012 pilot year of California Acceleration Project

- Summary of Findings (Hayward & Willett, 2014)
  - Large and robust effects of acceleration that work for
    - Students of all backgrounds
    - Students at all placement levels
  - Not a function of selection/cherry-picking
  - Examples from Math

Regression Adjusted Effects – Math



Completion of transfer-level math for traditional and accelerated pathways by ethnicity

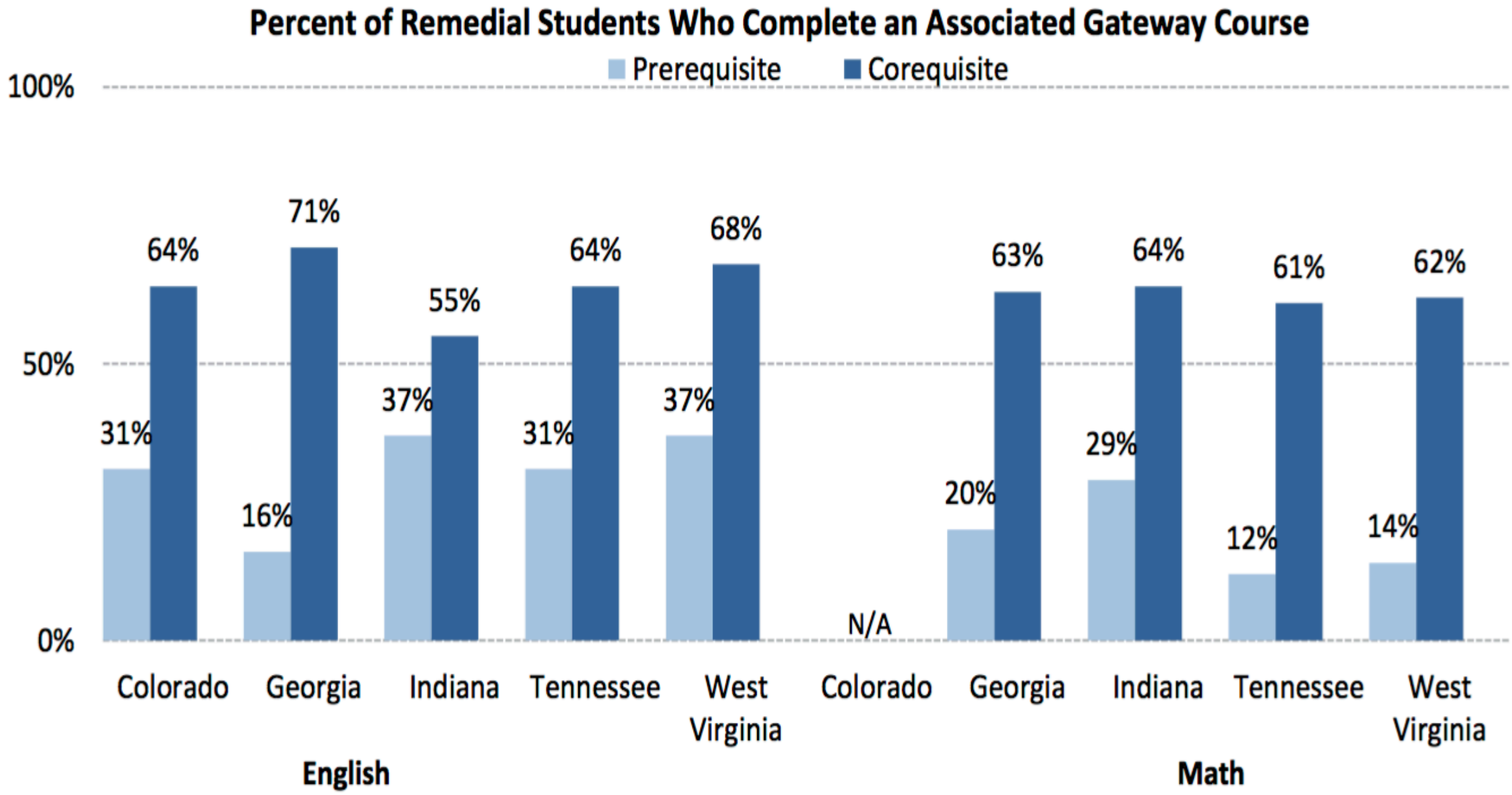


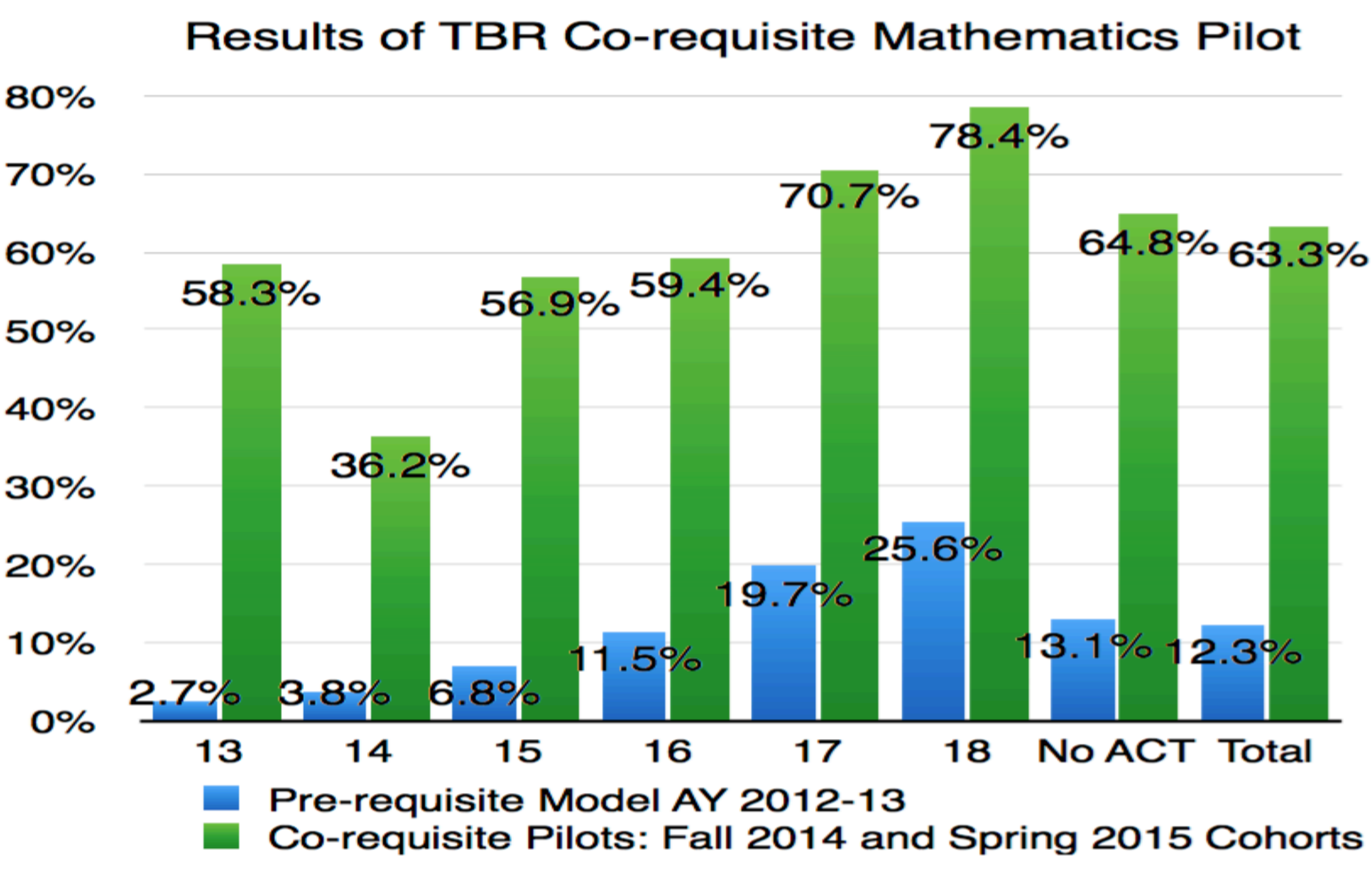
Corequisite models of developmental education

Resources/references:

- http://bit.ly/2015ALP (Coleman, 2015)
- http://alp-deved.org
- http://bit.ly/CCACoreq
- http://bit.ly/Kalamkarian2015 (Kalamkarian, Raufman, & Edgecombe, 2015)
- http://completecollege.org/wp-content/uploads/2016/07/Serving-the-Equity-Imperative-Final.pdf
- http://completecollege.org/wp-content/uploads/2016/01/TBR-CoRequisite-Study-Update-Fall-2015-pages-2.pdf

Figure 7.


Percent of Remedial Students Who Complete an Associated Gateway Course
Prerequisite
Corequisite
100%
50%
0%
31%
64%
16%
71%
37%
55%
31%
64%
37%
68%
N/A
20%
63%
29%
64%
12%
61%
14%
62%
Colorado
Georgia
Indiana
Tennessee
West Virginia
Colorado
Georgia
Indiana
Tennessee
West Virginia
English
Math


Results of TBR Co-requisite Mathematics Pilot
80%
70%
60%
50%
40%
30%
20%
10%
0%
58.3%
36.2%
56.9%
59.4%
70.7%
78.4%
64.8%
63.3%
2.7%
3.8%
6.8%
11.5%
19.7%
25.6%
13.1%
12.3%
13
14
15
16
17
18
No ACT
Total
Pre-requisite Model AY 2012-13
Co-requisite Pilots: Fall 2014 and Spring 2015 Cohorts

Comparison of TBR Co-Requisite Mathematics with Completion of Traditional Remediation