

MINDING THE MATH GATE

April 30 | 9:30am-3:30pm The Center for Healthy Communities, Oakland

WELCOME & OVERVIEW

Heather Hough, PACE Pamela Burdman, Just Equations





PACE is an independent, non-partisan research center. PACE bridges the gap between research and policy, working with scholars from California's leading universities and with state and local policymakers to increase the impact of academic research on educational policy in California.

JUST EQUATIONS

Re-conceptualizing the role of math in ensuring educational equity



66

the inability to predict mathematics achievement and participation based solely on student characteristics such as race, class, ethnicity, sex, beliefs, and proficiency in the dominant language

- Rochelle Gutierrez, University of Illinois

PREVAILING ARCHITECTURE OF MATH OPPORTUNITY



EQUITY DIMENSIONS OF MATH EDUCATION



Readiness Policies & Structures

MATH OPPORTUNITY POLICIES

- Redesigning postsecondary math pathways
- Rethinking postsecondary admissions policies
- Redesigning high school math pathways

FOCUS FOR TODAY

Advance the role of math in fostering, not limiting, equity by:

 Deepening thinking about role of math in educational equity, and the goal of equity in math education.

Highlight ways that math opportunity issues impact equity in college admissions.

 Surface ways that policy, practice, and research on math opportunity can enhance equity in college admissions.

ADMISSIONS REQUIREMENTS & HIGH SCHOOL MATH COURSE-TAKING Minahil Asim, UC Davis



EMERGING HIGH SCHOOL MATH PATHWAYS

Kyndall Brown, California Mathematics Project, UCLA Suyen Machado, UCLA Center X Osvaldo Soto, Discrete Math Project Collaborative, SDSU

EMERGING HIGH SCHOOL MATHEMATICS PATHWAYS

Kyndall Brown California Mathematics Project/UCLA

THE TRADITIONAL HIGH SCHOOL PATHWAY

- Algebra I-Geometry-Algebra II-Precalculus-Calculus
 - If taking I course a year, must start in 8th grade
 - If starting in grade 9, summer school or double up
- Pedagogy
 - Teacher Centered
 - Procedural
- Common Core Standards
 - 8th grade standards
 - Expressions and Equations
 - Functions

ALGEBRA II AS A GATEKEEPER (WESTED 2012)

- Cal-PASS data set
- •2004/2005-2009/2010
- •24,279 students
- •24 unified school districts

ALGEBRA II AS A GATEKEEPER (WESTED 2012)

- Algebra II pass rate in grade 10 when taking
 Algebra I for the first time in grade 8-70.50%
- Algebra II pass rate in grade II when taking Algebra I for the first time in grade 9-40.46%
- Proportion of the sample who ever passed two semesters of Algebra II-44.24%

ALGEBRA II AS A GATEKEEPER (WESTED 2012)

- Algebra II pass rate among students who first took Algebra I in grade 9-16.74%
- •Algebra II pass rate among students who did not take math in grade 12-32.06%

NEED FOR ALTERNATIVES

Pedagogical Shifts

- Standards for Mathematical Practice
- Algebra II as a pre-requisite for 4th year mathematics courses
- Statistics validates Algebra I and Algebra II

OPPORTUNITIES AND CHALLENGES

- California Mathematics Readiness Challenge Initiative Grant (CMRCI)
 - 4th Year Mathematics Courses
 - A-G Requirements
- High School Counselors
- College Admissions Counselors

BIG DATA IN HIGH School classrooms: Opening New Math Pathways

Suyen Machado UCLA Center X



Introduction to Data Science

OVERVIEW

- The genesis of the IDS curriculum
- Challenges to new mathematics pathways

THE BIRTH OF A CURRICULUM













WE LEARNED:

- Even with simple tools, it's hard to analyze data.
- ► 4 8 weeks isn't enough time to scratch the surface of data analysis.
- Algebra II teachers are compelled to teach to standardized tests.

PROPOSED SOLUTION

Create a year long course about Data Science

✓ Use a mix of "large" data sets and data sets generated by students.

- Address as many Algebra II topics as possible while emphasizing probability and statistics standards
- Teach students how to analyze data with code.







USING R, STUDENTS WOULD BE:

- Creating and interpreting statistical plots
- Conducting inference using bootstrap based methods
- Creating multiple linear regression models, CART, k-means
- Learning about different sources of data including web scraping

THE CURRICULUM WOULD:

- Provide teachers with daily lessons
- Teach students concepts using in-class activities
- ✓ Apply what they've learned using R based labs



Introduction to Data Science

INTRODUCTION TO DATA SCIENCE (IDS)

- ✓ Meets "c" requirement (mathematics) for A-G
- ✓ IDS = Statistics, so validates Algebra II in California
- ✓ Piloted by 10 teachers in Los Angeles Unified School District in 2014 2015
- As of 2019-2020, offered in 17 Southern California districts at 57 schools by 62 teachers






RESULTS FROM LAUSD

- Students score 10% higher on the Levels Of Conceptual Understanding in Statistics (LOCUS) Assessment
- ✓ IDS students met their requirements at the same rate as students who did not take it for high school graduation & CSU/UC admissions

RESULTS FROM CENTINELA VALLEY UNION HIGH SCHOOL DISTRICT (CVUHSD)

- Students score 8% higher on the Levels Of Conceptual Understanding in Statistics (LOCUS) Assessment
- About 25% of students who took the course met the requirements for high school graduation and CSU/UC admissions

CHALLENGES

IMPLEMENTATION

- ✓ High school math teachers are brave
- Need lots of professional development to get them comfortable teaching topics they're largely unfamiliar with
- ✓ High-level support is essential for their success
- Build online communities for teachers to exchange ideas

TECHNOLOGY

Servers are beautiful things

Servers are challenging

MATH REQUIREMENTS

Counselors & administrators are reluctant

☑ UC/CSU admissions messaging re: math pathway

Common Core Mathematics Standards: Moving the goal post + admissions requirements not revised/revisited

NEW PATHWAYS OFFER A CHANCE FOR:

- Students who struggled with or failed Algebra II to be lured into mathematics via data science
- ✓ Students to see more relevance of mathematics in their lives
- ✓ The Algebra II gateway barrier to college removed
- Meeting the mathematics demands of 21st century

WANT MORE INFO? VISIT: WWW.IDSUCLA.ORG

THANK YOU

Discrete Math Project Collaborative



https://dmpc.sdsu.edu/

Osvaldo Soto (San Diego State University) Trang Vu (San Diego Unified School District) Anne Marie Almaraz (Sweetwater Unified High School District Melody Morris (Sweetwater Unified High School District







Outline

Overview

- Brief history of DMPC
- Who DMPC serves (districts, students)
- Early outcomes

Challenges

History of DMPC

- Began with CA Mathematics Readiness Challenge Initiative (2016)
 - Ovie Soto (Director), Bill Zahner (SDSU Math Dept), Randy Philipp (SDSU College of Education), Mike O'Sullivan (SDSU Math Dept. Chair)
 - SUHSD Admin/ToSA's
 - Focus on advance Standards for Mathematical Practice
 - Beyond symbol manipulation: Something to LOVE in math for everyone!
 - Discrete Math includes many non-traditional topics...
 - Wrote a curriculum that supports desired pedagogical shifts: targeting SMPs

A Typical Day: Goals

What do <u>STUDENTS</u> DO in a DMPC class?

- Learn through problem-solving
- Present their thinking
- Write and reflect on their work and peers' work
- Findage in sense-making
- Propose and refine definitions
- Habitually asking "Why?"

Reason at a variety of levels of formality

College Readiness:

Advance SMP's

Changes in Ways of thinking

Dispositions toward math

- Status
- Identity
- Content knowledge

Example: Thai 21 – Game Rules

- Number of players: 2
- Starts with 21 flags.
- Take turns
- On each player's turn, they must take 1, 2, or 3 flags.
- (Version 1) The player who takes the last flag wins.

Play the game several times with a partner. (10 - 15 min)

Can you find a way to win every time... regardless of what your opponent does?

What We Chose: Content

What's in our Discrete Math Course? Modules

- Combinatorial Games
- Graph Theory: Connectivity, Traceability, Planarity, Colorability
- Iteration and Recursion/Sequences and Series
- Cryptography
- Counting/Combinatorics

DMPC's Target Student Population: A DMPC Teacher's Perspective

Students who:

- Could benefit from looking at math from a problem solving perspective
- Believe all of math is symbol manipulation
- Have potential math skills that have not been tapped in previous courses



DMPC's (Original) Target Student Population

- College-intending Seniors
- 'STEM undecided' (... but we want them back)
- Passed Int 1 3 with "C" or better or struggled in IM 3
 - Already took pre-calc
 - Did not want to take calculus
 - Intending computer science majors
 - Already took calculus
- Imperial Valley: Can it work as a 3rd year course?

DMPC's Early Outcomes: A DMPC Teacher's Perspective

"I didn't know this was math" – Anonymous Student

 Students who may not have taken a fourth year are taking and succeeding at a fourth year (!)

/ Groups of students building agency in mathematics

Students growing in their identity as doers of mathematics

Early Outcomes

 Survey results indicated that students' dispositions towards mathematics were positively influenced by taking the course.

> INTEGRATED MATH III-B

PRE-CALCULUS-B

Affective

		Mean	N	Std. Deviation	Std. Error Mean
If I can't solve a problem in five minutes, I usually give <u>up.*</u>	Before	2.87	340	1.173	0.064
	Now	2.28	340	1.120	0.061
I feel that struggling with a math problem is an important part of learning <u>math.*</u>	Before	3.55	337	1.048	0.057
	Now	3.89	337	1.029	0.056
When another student or the teacher challenges my solution, I feel <u>uncomfortable.*</u>	Before	2.96	339	1.069	0.058
	Now	2.60	339	1.034	0.056
I feel comfortable sharing my mathematical ideas or asking questions about another person's ideas in a whole class discussion.*	Before	3.31	340	1.142	0.062
	Now	3.71	340	1.104	0.060
In mathematics, you can be creative and discover things by yourself.*	Before	3.32	339	1.124	0.061
	Now	3.80	339	1.026	0.056
I like solving math <u>problems.*</u>	Before	2.84	337	1.171	0.064
	Now	3.27	337	1.147	0.063

Achievement: Grades

2017-2018 Discrete Math Grade for Students Who Received a D or F Spring 2017 by Course 2016-17 Spring..



SDSU Course-taking & Achievement

Coming Soon: Summer 2019

Challenges

Continue refining:

- Curriculum & assessments
- PD for principals and counselors, new (and veteran) teachers to sustain the program at SUHSD

Evaluation:

- Do changes in students' affects and dispositions lead to higher levels of mathematical content knowledge?
- Are students who took Discrete Mathematics successful in their college mathematics courses?
- What college math courses do they take? (Course-taking pathways/obstacles)
- What are their grades in college mathematics?

Group Discussions



GROUP DISCUSSIONS

High School Math Course-Taking

- What skills and experiences do we want students to have at high school graduation to support college and career readiness and success?
- What do we still need to know about how course sequences support this vision?
- What are the implications for policy, including admissions policy?
- What are the next steps for policy, practice, and research?

Working Lunch

12:00pm-1:00pm



EMERGING EVIDENCE ON COLLEGE ADMISSIONS TESTING

Mayra Lara, The Education Trust-West Saul Geiser, Center for Studies on Research in Higher Education Michal Kurlaender, UC Davis, PACE

UC and the SAT/ACT

RESEARCH FINDINGS 1994 - 2019

Saul Geiser Center for Studies in Higher Education University of California, Berkeley

UC Admissions in the Aftermath of Prop 209

Prop 209 and its impact

- 1995: Regents' resolution SP-1 barring use of race
- 1996: Prop 209 passed
- 1998: Prop 209 takes effect
- Underrepresented minority admissions fall by half at top UC campuses; cascade effect

College Destinations of Top Applicants Denied Admission to Berkeley and UCLA, 1997 to 2002



UC Admissions in the Aftermath of Prop 209

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UC policy responses

- School-centered outreach
- Top 4% Plan/ELC
- Holistic review
- Class-based admissions preferences
- Admissions testing: search for alternatives to the SAT/ACT

Standardized Regression Coefficients for HSGPA, SAT I and SAT II Scores by UC Campus, 1996-1999

Regression equation: UCGPA = HSGPA + SAT I + SAT II

	HSGPA	SATI	SAT II
UC Berkeley	.21	02*	.27
UC Davis	.30	.04	.27
UC Irvine	.25	.09	.21
UC Los Angeles	.23	.05	.26
UC Riverside	.31	.16	.10
UC San Diego	.27	.03*	.25
UC Santa Barbara	.36	.11	.15
UC Santa Cruz**	n/a	n/a	n/a
UC System	.27	.07	.23

* Not statistically significant at <.01 level.

** Does not assign conventional grades.

Initial Findings

Curriculum-based achievement exams like the SAT II Subject Tests predict UC performance at least as well as nationally norm-referenced exams like the SAT or ACT.

"The benefits of achievement tests for college admissions – greater clarity in admissions standards, closer linkage to the high school curriculum – can be realized without any sacrifice in the capacity to predict success in college."

Geiser, S. & R. Studley, (2002). "UC and the SAT: Predictive Validity and Differential Impact of the SAT I and SAT II at the University of California." *Educational Assessment*, vol. 8, no. 1, pp. 1-26.

Beyond Prediction: Testing for Achievement

• Desirable properties of achievement tests:

- Criterion- vs. norm-referenced assessment
- Better alignment with K-12 standards
- Minimize test prep
- Less adverse impact
- "Signaling effect" for disadvantaged students and schools
- President Atkinson's 2001 address to ACE
- BOARS' 2002 Policy on Admissions Testing

The SAT and ACT Respond to UC

What changed

- SAT drops verbal analogies and quantitative comparisons
- Both ACT and SAT add Writing Test
- Intended to position national exams as achievement tests
- Foreshadows later efforts to have college admissions tests adopted for state K-12 accountability purposes

What didn't change

- Both SAT and ACT retain norm-referenced design
- Bell-curve assumption is last remaining vestige of IQ tradition in college admissions
- "A test at war with itself": Norm-referenced assessment for college admissions vs. standards-based assessment for K-12 accountability

Creating the Bell Curve



Raw score: Number of questions correctly answered

Frequency Distribution of Scaled Scores Among California SAT Takers



Norm-referenced tests are designed to produce the same distribution from one year to the next and are ill-suited to measure change over time in educational achievement



Source: UC Corporate Student System and College Board annual College-Bound Seniors Reports for California.
Study Variables

Sample: All California resident applicants for UC freshmen admission from 1994 through 2016

- SAT scores
 - \circ Composite of verbal + math
 - Includes ACT-equivalent scores
- High school GPA
 "Weighted" for AP/honors
- Family income
 - Log of family income in constant 2012 \$
- Parents' education
 - Highest-educated parent
- Underrepresented minority status
 - Self-identification as Latino/a or Black
 - Excludes Native Americans

Correlations

Conditioning effect of socioeconomic background on SAT/ACT scores vs. HSGPA

	Family Income	Parents' Education	Race/ Ethnicity
High school GPA	.11	.14	17
SAT/ACT scores	.36	·45	38

Variance in SAT/ACT Scores and High School GPA Explained by Family Income, Education and Race/Ethnicity, 1995 to 2016



Source: UC Corporate Student System data on all California residents who applied for freshman admission from 1995 through 2016 and for whom complete data were available on all covariates.

New Findings, Part 1

Compared to other admissions criteria like high school GPA, SAT/ACT scores are more sensitive to social background factors like parental education, income, and race/ethnicity.

The conditioning effect of socioeconomic background has grown substantially over the past quarter century and now accounts for 39% of all test-score variation among UC applicants.

Policy implication: The growing correlation between social background and SAT/ACT scores makes it difficult to rationalize treating scores purely as a measure of individual merit or ability, without regard for group differences in opportunity to learn.

Relative Weight of Family Income, Education, and Race/Ethnicity in Explaining SAT/ACT Scores, 1995 to 2016

Regression equation: SAT/ACT score = $b_1(Log of Income) + b_2(Parent Education) + b_3(URM Status)$



admission from 1995 through 2016 and for whom complete data were available on all covariates.

Racial Segregation in California Public Schools Los Angeles Schools by Level of Segregation (2016) Number of Schools Percent of schools **Majority nonwhite** 95% 958 (50-100% nonwhite) **Intensely segregated** 785 78% (90-100% nonwhite) **Apartheid schools** 26% 264 (99-100% nonwhite)

Racial Segregation in California Public Schools

Over the past 25 years, California public schools have become among the most racially segregated in the US

Orfield, D. & Ee, J. (2014) "Segregating California's Future," UCLA Civil Rights Project.

Rapid increase in "intensely segregated" schools (90% or more URM)

Over half of all Latino/a students, and 39% of African Americans, attend intensely segregated schools

Double segregation by race and poverty

Black students on average attend schools that are two-thirds poor, while the average for Latinos is 70%.

Racial segregation is associated with multiple forms of disadvantage that combine to magnify test-score disparities among racial minorities

Card, D. & Rothstein, J. (2006). "Racial segregation and the black-white score gap." NBER Working Paper 12078. Cambridge, MA: National Bureau of Economic Research.

New Findings, Part 2

Race/ethnicity has an independent conditioning effect on SAT/ACT scores after controlling for family income and education.

The conditioning effect of race on SAT/ACT scores has grown substantially in the past 25 years, mirroring the massive resegregation of California public schools during the same period.

Statistically, race/ethnicity has become more important than either family income or education in accounting for test-score differences among California high school graduates who apply to UC.

Policy implication: "Class based" or "race neutral" affirmative action is unlikely to prove an effective proxy for redressing racial/ethnic disparities in college admissions.

Percent Latino and Black Applicants by SAT/ACT vs. High School GPA Deciles



Source: UC Corporate Student System data on all CA resident freshman applicants from 2016 for whom complete data were available on all covariates.

Percent First-Generation College Applicants by SAT/ACT vs. HSGPA Quintiles



Percent First-Generation College

Source: UC Corporate Student System data on California residents who applied for freshman admissions between 1994 and 2011 for whom complete data were available on all covariates.

Conclusion

National standards for fairness in testing encourage colleges and universities to take into account the conditioning effects of socioeconomic background on test performance. UC considers family income and education in evaluating applicants' test scores, but Prop 209 bars it from considering race/ethnicity.

Race has an independent effect on SAT/ACT scores among UC applicants, mirroring the growing concentration of Latino and Black students in California's poorest, most intensely segregated schools.

Policy implication: If UC cannot legally consider the effect of race and racial segregation on test performance, neither should it consider SAT/ACT scores. Race-blind implies SAT/ACT-blind admissions.

UC and the SAT/ACT Research Findings: 1994 to 2019

ADDITIONAL SLIDES FOR Q & A

Score Gaps Between Racial/Ethnic Categories: California SAT Takers, 1998 to 2014



Source: College Board College-Bound Seniors Reports for California.

ACT Writing: Scaled Score vs. Number Correct



Probing the UC findings

Changes in racial/ethnic composition of UC applicants vs. all California SAT takers Underrepresented Minorities as a Proportion of California High School Graduates, SAT Takers, and UC Applicants, 1998 to 2011



Probing the UC findings

Problem of missing SES data for California SAT takers Percent Not Responding to SAT Questionnaire Items on Family Income, Parents' Education, and Race/Ethnicity: California SAT Takers, 1998 to 2013



Prediction Errors



Relative Weight of High School GPA and SAT/ACT Scores in Predicting 5-Year Graduation Rates, Before and After Controlling for SES: All UC Freshmen vs. Underrepresented Minorities



Source: UC Corporate Student System data, 1994 to 2005. All estimates are statistically significant at .001 confidence level.

Percent of Variance in UCGPA Predicted by HSGPA and Test Scores With and Without Bonus Points for AP/Honors

Regression equation: UCGPA = α HSGPA + β SATI + ϕ SATII

HSGPA 1998 1999 2000 Weighting R² Rank Rank R² Rank \mathbb{R}^2 No Bonus Point 21.32% 21.46% 23.54% 1 1 1 Half Bonus Point 20.67% 2 21.10% 2 22.87% 2 3 **Full Bonus Point** 3 3 19.22% 19.82% 21.19%

Explained Variance in First-Year UCGPA

Explained Variance in Second-Year UCGPA

HSGPA	1998		1999		2000	
Weighting	R²	Rank	R²	Rank	R²	Rank
No Bonus Point	14.91%	1	13.88%	1	16.37%	1
Half Bonus Point	14.33%	2	13.34%	2	15.79%	2
Full Bonus Point	13.16%	3	12.28%	3	14.65%	3

Source: UC Corporate admissions and longitudinal data for first-time CA resident freshmen entering in Fall 1998, 1999, and 2000. N = 50,472.

Frequency Distribution of SAT I Scores: All CA SAT I Takers vs. SAT I Takers Who Also Took SAT II





New California Resident Admits and Enrolled Freshmen as a Percentage of California High School Graduates

Source: UC Corporate Student System (for CA resident admits and new freshmen), California Department of Finance Demographic Research Unit (for CA public high school graduates), California Postsecondary Education Commission (for CA private high school graduates from 1994 to 2009), and Western Interstate Commission on Higher Education (for CA private high school graduates from 2010 to 2012).

Percent Latino and Black Applicants by SAT/ACT vs. High School GPA Deciles



Source: UC Corporate Student System data on all CA resident freshman applicants from 1994 through 2011 for whom complete data were available on all covariates.

Criterion-referenced scoring

"In addition, BOARS Testing Principles should explicitly prefer tests that are not only curriculum-based but also scored by reference to achievement standards."

-- BOARS' 2009 revision of UC Principles for Admissions Testing

Administrative utility

"BOARS' review of the history of the development of admissions tests and of their use at the University of California points clearly to the fact that the original decision to adopt the testing requirement and create the Eligibility Index was driven only in part by policy goals. Pragmatic needs to reduce the size of the eligibility pool and to rank-order applicants to selective campuses in a simple, efficient way also played substantial roles. In BOARS' current view, these pragmatic reasons—while important—are insufficient justification in themselves for the adoption of a test requirement or the selection of a specific test battery."

-- BOARS' 2002 policy

Group Discussions



GROUP DISCUSSIONS

College Admissions Testing

- Based on the existing research, how should we think about college admissions testing?
- What else do we still need to do know about admissions testing?
- What are the next steps for policy, practice, and research?

Pulling it Together



Wrap-Up





THANK YOU

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