TOWARD A MATHEMATICS OF OPPORTUNITY

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Washington SBCTC Guided Pathways Launch Summit

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JUST EQUATIONS
Re-conceptualizing the role of math in ensuring educational equity
WHY MATHEMATICS?

(a) It’s a gatekeeper in the education system.

(b) It’s an important foundation for STEM fields.

(c) Quantitative reasoning is essential for students in their lives and careers.

(d) All of the above.
WHY MATHEMATICS?
## Problem: Low Success Rates

### Washington Students Meeting Math Standards

<table>
<thead>
<tr>
<th>Student Population</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>49%</td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>22%</td>
</tr>
<tr>
<td>Black/African American</td>
<td>28%</td>
</tr>
<tr>
<td>Hispanic/Latinx</td>
<td>31%</td>
</tr>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>26%</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>51%</td>
</tr>
<tr>
<td>White</td>
<td>67%</td>
</tr>
<tr>
<td>Overall</td>
<td>49%</td>
</tr>
</tbody>
</table>

*Source: Washington Office of Superintendent of Public Instruction*
## Washington CTC Students Needing Remedial Math (2016-17)

<table>
<thead>
<tr>
<th>Students</th>
<th>Percentage</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underrepresented students of color</td>
<td>78%</td>
<td>82,614</td>
</tr>
<tr>
<td>Students receiving need-based aid</td>
<td>75%</td>
<td>79,436</td>
</tr>
<tr>
<td>All recent high school graduates</td>
<td>70%</td>
<td>74,000</td>
</tr>
</tbody>
</table>

*Source: Precollege Education & First Year Outcomes, Washington SBCTC, 2018*
IT’S THE “AFTER MATH”

“Who is putting the math books in the horror section?”
WHAT ABOUT MATH EQUITY?
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
PREVAILING ARCHITECTURE OF MATH OPPORTUNITY
MISCONCEPTIONS ABOUT MATH ABILITY:

- **Math ability is innate**: Only some people are good at math.

- **There is a right way to do math**: It lacks creativity or expression.

- **Speed and acceleration matter**: Process and depth are secondary.
EXISTING EDUCATIONAL INEQUITIES

- Poorly resourced schools
- Differential access to a strong curriculum, good teaching
- Income inequality
- Insufficient support for students’ needs
- Existing bias and stereotype threat
- Psychic effects on students of the above
MATH AS PEDIGREE
PEDIGREE VS. PREPARATION

- **Pedigree** preserves the position of individuals and groups that already enjoy privilege.

- **Preparation** is intended to provide individuals the foundation they need to succeed at the next level.
“PURPOSE OF MATH”

- Expand professional opportunity
- Understand and critique the world
- Experience wonder, joy, and beauty

Source: NCTM, Catalyzing Change, 2018
What work is happening (or could be happening) at your institution to disrupt this architecture of math opportunity?
2012 (Obama Council)
“introductory mathematics courses ... dull and unimaginative”

2013 (NRC)
“educational offerings ... have not kept pace with the large and rapid changes in how the mathematical sciences are used in science, engineering, medicine, finance, social science, and society at large”

2015 (Common Vision)
“current college algebra courses serve two distinct populations...neither group is well-served by the current version of the course.

2014 (JPB)
“incentivize innovation for the sake of students and the health of our discipline”
EQUITY DIMENSIONS OF MATH EDUCATION

Content
Instruction
Assessment

Readiness Policies & Structures
RETHINKING INSTRUCTION

- performance
- speed
- symbolic
- elite
- ability
- “giftedness”
- tests and grades
- formulas
- procedures
- answer

- learning
- depth
- multi-representational
- equitable
- effort
- everyone can learn
- feedback for learning
- thought
- creativity
- process

Source: Jo Boaler, Stanford University
POSITIVE ATTITUDE TOWARD MATH (PAM)

- PAM = interest + self-perceived ability

- “uniquely predicts individual differences in children’s math achievement”

- independent of factors like IQ, memory, and anxiety.

Source: Psychological Science, 2018
RETHINKING ASSESSMENT
RETHINKING ASSESSMENT:

- High stakes vs. low stakes
- Timed tests
- Bubble tests vs. performance assessments
- Disparate impact
- Uses: admissions, placement, learning
WHO IS UNDER-PREPARED? VS.
WHAT IS UNDER-PREPARED?

- Inadequate instruction?
- Inaccurate assessment?
- Unreasonable expectations?
- Misaligned curricula?
REFORMS: COMMUNITY COLLEGE PLACEMENT

RESEARCH FINDINGS

- College placement tests have limited predictive validity
- High school grades are better predictors
- Students of color more likely to underestimate their abilities

NEW POLICIES

- Multiple measures placement (de-emphasize tests)
- Co-requisite approach places majority of students into college-level courses (with support if needed)
DISCUSSION

Where are the opportunities for your institution to make significant progress regarding math instruction and assessment?
RETHINKING CONTENT
WHY DIVERSIFY MATH CONTENT?

It’s the quantitative reasoning!

- Demand for deeper learning (K12 & college remedial math)
- Relevance (general education requirements to majors)
- New uses of mathematics (various disciplines & majors)
- **Community college students**: 20 percent choose STEM majors

- **Four-year university students**: 27 percent choose STEM majors

- **B.A. holders**: 18 – 31 percent use Algebra 2 and beyond

- **Community college programs**: One out of 441 programs studied required students to have mastered Algebra 2 content.

*Sources: NCES, Anthony Carnevale, National Center on Education and the Economy*
SUPPORT OF MATH CHAIRS FOR MATH GRADUATION REQUIREMENT, 1960

- Public universities: 10%
- Public colleges: 15%

Source: CBMS, 1972
GENERAL EDUCATION
MATH: 4-YEAR INSTITUTIONS

- 1960: < 33%
- 2010: ~90%

Sources: CBMS, 1972; Schield, 2010
THEN AND NOW: WHAT CHANGED?

+ Sputnik: pressure to prepare next generation for global competition

+ Expansion: higher, more diverse enrollment in higher ed

+ Curriculum change: growth of general education

= Gatekeeper role for mathematics
MATHEMATICAL SCIENCE ENROLLMENTS: 4-YEAR INSTITUTIONS

- 1960: 744,000
- 2015: 2,738,000

Sources: CBMS, 1972; Schield, 2010
UPPER DIVISION
MATHEMATICAL
SCIENCE
ENROLLMENTS:
4-YEAR INSTITUTIONS

- 1960: 16%
- 2015: 8%

Source: CBMS 1972, 2018
STATISTICS
ENROLLMENTS:
4-YEAR INSTITUTIONS

- 1960: 3%
- 2015: 17%

Source: CBMS 1972, 2018
## Trends in Two-Year Math Enrollments

<table>
<thead>
<tr>
<th>Area</th>
<th>1970</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial math enrollments</td>
<td>33% of enrollments</td>
<td>57% of enrollments</td>
</tr>
<tr>
<td>Statistics enrollments</td>
<td>3% of enrollments</td>
<td>7% of enrollments</td>
</tr>
<tr>
<td>Mathematical science</td>
<td>584,000</td>
<td>2 million</td>
</tr>
<tr>
<td>enrollments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Enrollment</td>
<td>2.3 million</td>
<td>7.7 million</td>
</tr>
</tbody>
</table>
Majority placed into remedial math

Most never graduate

Most affected: students of color, low income students, language minority students, students with disabilities
EMERGING PATHWAYS

- Traditional Algebra-to-Calculus pathway
- Non-STEM math pathways, such as
  - statistics
  - quantitative reasoning
  - mathematics modeling
  - data science
- Equity and access to STEM fields
“students are placed into course sequences designed to align with their personal interests, chosen fields of study, and career goals”

Charles A. Dana Center

“a gateway math course - or set of math courses whose end point is a gateway math course - aligned with a students’ intended program of study”

WestEd, 2018
PROMISE: STRIKING RESULTS

- Carnegie Math Pathways – Statway
  - 22 institutions studied
  - students *3+ times as likely* to complete required math course in *half the time*

- California Acceleration Project
  - 8 community colleges studied
  - students *4.5 times as likely* to complete transfer-level math course

Sources: Huang 2018, Hayward & Willett, 2014
### Diversifying gen ed math at elite universities

<table>
<thead>
<tr>
<th>HARVARD</th>
<th>STANFORD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making Sense: Language, Logic, and Communication</td>
<td>Cancer Epidemiology</td>
</tr>
<tr>
<td>Analyzing Politics</td>
<td>Riding the Data Wave</td>
</tr>
<tr>
<td>Nutrition and Health</td>
<td>Feeding Nine Billion</td>
</tr>
<tr>
<td>Myths, Paradigms, and Science</td>
<td>Remote Sensing of the Oceans</td>
</tr>
</tbody>
</table>

*Source: Burdman, 2015*
PROMISE: DIVERSIFYING GEN ED AT PUBLIC UNIVERSITIES

- **Arizona State University:**
  - Removed *College Algebra* as gen ed math requirement (2010)

- **Georgia System:**
  - *Introduction to Mathematical Modeling* or *Quantitative Skills* instead of *College Algebra* for non-STEM majors (2013)

- **UCLA and UC Berkeley**
  - New life sciences math courses emphasize statistics (2013-14)

- **UC Berkeley**

- **Indiana** (2016)
  - Five math pathways – *Quantitative Reasoning*, *Calculus*, *Business Math*, *Elementary Education*, *Trades & Industry*
DIVERSIFYING MED SCHOOL REQUIREMENTS

- Association of American Medical Colleges (2009)
  - Demonstrate **quantitative numeracy** and facility with the language of mathematics
  - **Interpret data sets** and communicate those interpretations using visual & other tools
  - **Make statistical inferences** from data sets
  - **Extract relevant information** from large data sets
  - **Make inferences** about natural phenomena using mathematical models
  - Apply **algorithmic approaches** and principles of **logic**
  - Quantify and interpret changes in **dynamical systems**
RETHINKING POSTSECONDARY MATH PATHWAYS

STATISTICS
- Psychology

QUANTITATIVE REASONING
- Arts, Humanities & English
- Applied Arts & Sciences

ALGEBRA-TO-CALCULUS
- Biology
- Engineering & Architecture
- Math

Public & Protective Services
- Hospitality & Culinary Arts
- Library & Information Services
- Agriculture & Natural Resources
- Physical Sciences

Source: WestEd, Just Equations, 2018
RETHINKING YOUR PATHWAYS

• What proportion of students start in remedial math?
• What proportion of students remain in an algebra pathway?
• How are students advised into a math pathway (by intention and in practice)?
• How do math pathways connect to guided pathways at your institution?
THEN AND NOW: TRENDS IN 2-YEAR MATH ENROLLMENTS 1970-2010

Remedial and statistics enrollments as percentage of mathematical science enrollments

- Remedial math enrollments:
  - 1970: approximately 30%
  - 2010: approximately 50%

- Statistics enrollments:
  - 1970: approximately 5% (1970 data point)
  - 2010: approximately 7% (2010 data point)
THEN AND NOW: TRENDS IN 2-YEAR MATH ENROLLMENTS – 5 YEARS LATER

Remedial and statistics enrollments as percentage of mathematical science enrollments

- Remedial math enrollments
- Statistics enrollments

1970 2010 2015
EQUITY DIMENSIONS OF MATH EDUCATION:

- Content
- Instruction
- Assessment

Readiness Policies & Structures
RETHINKING MATH READINESS POLICIES

- **High school** placement, tracking, acceleration, and graduation policies

- **Postsecondary** admissions, placement, general education, transfer, and graduation policies
NEW POLICY DIRECTIONS — POSTSECONDARY

- De-emphasis on placement tests
- Use of co-requisites and other just-in-time support strategies
- De-emphasis on advanced algebra for all students.
NEW DIRECTIONS: HIGH SCHOOL

- Common Core State Standards
  - Emphasize statistics
  - Practice standards
  - More than one pathway through math

- New Courses
  - Introduction to Data Science (LAUSD)
  - Computer Science (Ohio)
  - Financial Literacy (Virginia)
  - Mathematics for Social Justice
“PURPOSE OF MATH”

- Expand professional opportunity
- Understand and critique the world
- Experience wonder, joy, and beauty

Source: NCTM, Catalyzing Change, 2018
PURPOSE OF EDUCATION?
An education that prepares every student for civic and political engagement not only supports political equality but may also lead to increased economic fairness.

- Danielle Allen
QUESTIONS?

MATH PROBLEMS?

Call

1-800-[(10x)(13i)^2]-[\sin(xy)/2.362x]
THANK YOU

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