Making Math Count:

Theory and Research on the Dana Center Mathematics Pathways (DCMP)

Building Accelerated Math Pathways and Early Findings on their Impact on Students' Success

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The DCMP seeks to ensure that **ALL** students in higher education will be:

- **Prepared** to use mathematical and quantitative reasoning skills in their careers and personal lives,
- **Enabled** to make timely progress towards completion of a certificate or degree, and
- **Supported** and **Empowered** as mathematical learners.
Modernizing Entry-Level Mathematics Programs: The Case for Mathematics Pathways

**Figure 1.** Drivers that create barriers for students.

*The Case for Mathematics Pathways* (Dana Center, 2016)

[https://dcmathpathways.org/resources/making-case-math-pathways](https://dcmathpathways.org/resources/making-case-math-pathways)
Status Quo in Developmental Mathematics: Long Course Sequences

Student Progression Through the Developmental Math Sequence

100% (63,650) Referred to 3+ Levels of Remediation

26% Did Not Enroll in Next Course

15% Level 3+ Course

7% Level 2 Course

4% Level 1 Course

2% Passed Gatekeeper Math

22% Did Not Pass/Complete Course

Bailey, Jeong & Cho, 2010
What is the “right math”?

2-Year College Student Enrollment into Programs of Study

- Require Calculus: 20%
- Do not require Calculus: 80%

4-Year College Student Enrollment into Programs of Study

- Require Calculus: 28%
- Do not require Calculus: 72%

Emerging National Math Pathways

<table>
<thead>
<tr>
<th>Meta-Major</th>
<th>Math Pathway</th>
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<tbody>
<tr>
<td>Liberal Arts, Fine Arts, and Humanities</td>
<td>Quantitative Reasoning Pathway</td>
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<tr>
<td>Social Sciences and Social Services</td>
<td>Statistics Pathway</td>
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<tr>
<td>Nursing and Health Professions</td>
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<tr>
<td>Business and Accounting</td>
<td>Business Math Pathway</td>
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<tr>
<td>Teacher Preparation</td>
<td>Elementary/Middle School Teacher Math Pathway</td>
</tr>
<tr>
<td>Science, Technology, Engineering, and Math</td>
<td>STEM Pathway—Calculus</td>
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Dana Center Mathematics Pathways
DCMP Project Pathways

**STATISTICS PATHWAY** is designed for students seeking a college-level statistics course as part of their general education requirement for majors in fields including:

- Nursing
- Social Work
- Criminal Justice

**QUANTITATIVE REASONING PATHWAY** is designed for students pursuing a field of study in which general education math is a requirement. These fields include majors in:

- Communications
- Graphic Design
- Paralegal

**STEM-PREP PATHWAY** is designed for students seeking a STEM or mathematics-intensive major in fields including:

- Petroleum Engineering
- Computer Science
- Chemistry
Mathematics pathways are structured so that:

1) All students, regardless of college readiness, enter directly into mathematics pathways aligned to their programs of study.

2) Students complete their first college-level math requirement in their first year of college.

Students engage in a high-quality learning experience in math pathways designed so that:

3) Strategies to support students as learners are integrated into courses and are aligned across the institution.

4) Instruction incorporates evidence-based curriculum and pedagogy.
Scaling the NMP Model in Texas (2012-2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Colleges engaged in training and coaching</th>
<th>Colleges implementing the NMP model</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>2013</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>2014</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td>2015</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
State Level Work: 4 Phases of Implementation

1) Build urgency and intrinsic motivation for change by empowering math leaders to develop a common understanding of the problem and strategy for improvement.

2) Enable scale by creating the policy and practice conditions for system-wide implementation.

3) Enact the DCMP principles at institutions by building faculty and institutional capacity and aligning institutional structures and policies.

4) Support within institutions and sustain new normative practice.
The Dana Center Mathematics Pathways Evaluation

Overview and Early Findings

Elizabeth Zachry Rutschow, Senior Research Associate, MDRC
What is MDRC?

• **Who are we?**
  – Nonprofit, nonpartisan education and social policy research firm
  – Mission: Improve opportunities for low-income communities

• **What do we do?**
  – **Program design and evaluation**
    • *We both design and evaluate interventions and scale what works*
  – **Rigor**
    • *Use the most rigorous standards of evaluation*
  – **Dissemination**
    • Heart of work → Disseminate findings to inform policy and practice
Sample DCMP problem

A research report estimates that individuals who smoke are 15 to 30 times more likely to develop lung cancer than individuals who never smoke. If the lifetime risk of developing lung cancer for non-smokers is about 1.9%, what is the lower limit of the estimated risk for smokers according to the report?

The lower limit of the estimated risk for smokers according to this report is __________ %.
The DCMP model

• Four principles → all DCMP institutions
  – Revised content
  – Acceleration

• Curricular supports → some DCMP institutions
  – Design for course content
  – Revised pedagogy
FIGURE 1. A Comparison of Mathematics Offerings for Students with Two Levels of Developmental Need

Traditional Developmental Math

- Semester 1: Beginning Algebra
- Semester 2: Intermediate Algebra
- Semester 3: College Algebra
  - Most students take these algebra courses.
  - Quantitative Reasoning
  - Statistics
  - Some students choose to take these courses.

Dana Center Mathematics Pathways

- Semester 1: Statistics
  - Meta-majors: social sciences, social services, nursing and health professions
  - Foundations of Mathematical Reasoning
    - Students are advised to follow the mathematics pathway that best supports their college and career plans.
  - Quantitative Reasoning
    - Meta-majors: liberal arts, fine arts, humanities
  - Path to Calculus*
    - First term — algebraic content
    - Meta-majors: science, technology, engineering, math
  - Path to Calculus*
    - Second term — trigonometric content

*Evaluation of these courses is outside the scope of this study.
The DCMP’s Key Pedagogical Changes

- Active learning
- Small group work
- Problems contextualized in real-life situations
- Multi-step problems building on previously learned content or answers
- Constructive perseverance – understanding the role struggle plays in learning
- Multiple solution methods
- Word problems (reading)
- Written explanations of work
A Mixed Methods Study of the DCMP

- **Four study components across four Texas colleges**
  - RCT
  - Implementation study
  - Student survey
  - Cost study

- **The RCT**
  - El Paso Community College, Trinity Valley Community, Eastfield College, and Brookhaven College
  - 4 cohorts: Fall 2015, Spring 2016, Fall 2016, Spring 2017
  - Tracking outcomes for at least 2 semesters

- **Deliverables**
  - Interim report (May 2017)
  - Final Report (June 2019)
Research Questions

1. Do DCMP students have better academic outcomes than students in traditional developmental math programs? Are these outcomes mediated through changes in student engagement?

2. To what degree is there fidelity to the DCMP model across colleges? What aspects of the DCMP are consistent across sites? What adaptations were made and why?

3. How do the curriculum and pedagogy in the DCMP courses differ from the colleges’ traditional developmental math courses?

4. Is the DCMP cost-effective relative to business as usual?
The Interim Report: The Sample

- 563 students
- 1 semester of data
  - Most students were in the developmental math class
- Most students were in majors aligned with pathways
- 80% = 2 developmental course needs
The Interim Report: Key Implementation Findings

Success with four big changes:

1. **Alignment with four-year colleges**
   - Progress was made with some continuing challenges

2. **Advising revisions: More time was spent with students to identify correct major**
   - Some students were targeted, but not all eligible students

3. **Changes to course content: Integration of statistics and quantitative reasoning**
   - Strong implementation → The course content was very different

4. **Pedagogy change: Contextualization of content and use of more student-centered approaches**
   - Relatively strong implementation → Students had a qualitatively different classroom experience
# The Interim Report: Impact Findings

<table>
<thead>
<tr>
<th></th>
<th>Program group</th>
<th>Standard group</th>
<th>Difference</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered (%)</td>
<td>87.8</td>
<td>85.9</td>
<td>1.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Registered for developmental math course (%)</td>
<td>77.9</td>
<td>67.8</td>
<td>10.1***</td>
<td>3.7</td>
</tr>
<tr>
<td>Passed developmental math course (%)</td>
<td>47.1</td>
<td>36.6</td>
<td>10.5**</td>
<td>4.1</td>
</tr>
</tbody>
</table>
Findings in Context

• **Findings are promising but it’s still early**
  – DCMP students are well positioned to take college-level math classes... but how will they perform?

• **The DCMP study is unique in...**
  – The level of rigor
  – The analysis of implementation
  – A deeper look inside the classroom

• **What can states take from this?**
  – Creating policies at state-level can ease institutions transition