Scaling Innovation in Higher Education

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DEVELOPMENTAL MATHEMATICS: FOR WHOM?
“58% of NELS:88 students at two-year colleges undertook remedial coursework, compared to 26% of students entering four-year colleges. That difference is statistically highly significant.”

(Attewell, Lavin, Domina, & Levey, 2006)
Conference Board of Mathematical Sciences (CBMS) Survey Reports 2010

Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States

by Richelle Blair, Ellen E. Kirkman, and James W. Maxwell

Publication Date: 2013
Number of Pages: 374 pp.
Publisher: AMS
ISBN 978-0-8218-9412-5 (Print)
CBMSSURVEY/2010(Print)
## Higher Education Mathematics Course Enrollment

<table>
<thead>
<tr>
<th></th>
<th>4 Year Institutions</th>
<th>2 Year Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>College Algebra and below</td>
<td>57%</td>
<td>58%</td>
</tr>
<tr>
<td>Calculus</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>Advanced Courses</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Other Courses (2 Year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL Enrollment (in thousands)</td>
<td>1469</td>
<td>1614</td>
</tr>
</tbody>
</table>

Source: Adapted from the CBMS 2010 Census Report, Table S.2
DEVELOPMENTAL MATHEMATICS: TO WHAT ENDS?
“58% of recent high school graduates who entered community colleges took at least one developmental course. Only about one quarter of these students (28%) went on to earn any degree or certificate within 8.5 years”

—Community College FAQs, CCRC

### TABLE 2
Effect of enrolling in one or more remedial course on student progress through higher education.

<table>
<thead>
<tr>
<th>Outcome: Student earned 10 or fewer credits</th>
<th>Bivariate</th>
<th>Logistic regression</th>
<th>Propensity matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic Coefficient</td>
<td>0.456***</td>
<td>-0.634***</td>
<td>-0.593***</td>
</tr>
<tr>
<td>Predicted probabilities for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial students</td>
<td>0.1120</td>
<td>0.0183</td>
<td>0.0838</td>
</tr>
<tr>
<td>Nonremedial students</td>
<td>0.0740</td>
<td>0.0339</td>
<td>0.1420</td>
</tr>
<tr>
<td>N</td>
<td>6879</td>
<td>6879</td>
<td>3292</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Student left college for at least one year before receiving first degree</th>
<th>Bivariate</th>
<th>Logistic regression</th>
<th>Propensity matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic Coefficient</td>
<td>0.666***</td>
<td>-0.101</td>
<td>-0.096</td>
</tr>
<tr>
<td>Predicted probabilities for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial students</td>
<td>0.4248</td>
<td>0.2535</td>
<td>0.3948</td>
</tr>
<tr>
<td>Nonremedial students</td>
<td>0.2751</td>
<td>0.2732</td>
<td>0.4179</td>
</tr>
<tr>
<td>N</td>
<td>6879</td>
<td>6879</td>
<td>3292</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Student earned a college degree (two-year college entrants only)</th>
<th>Bivariate</th>
<th>Logistic regression</th>
<th>Propensity matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic Coefficient</td>
<td>-0.328***</td>
<td>0.105</td>
<td>0.179</td>
</tr>
<tr>
<td>Predicted probabilities for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial students</td>
<td>0.2842</td>
<td>0.2882</td>
<td>0.3404</td>
</tr>
<tr>
<td>Nonremedial students</td>
<td>0.3553</td>
<td>0.2672</td>
<td>0.3105</td>
</tr>
<tr>
<td>N</td>
<td>2661</td>
<td>2661</td>
<td>1670</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Student earned a college degree (four-year college entrants only)</th>
<th>Bivariate</th>
<th>Logistic regression</th>
<th>Propensity matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistic Coefficient</td>
<td>-1.159***</td>
<td>-0.316***</td>
<td>-0.288***</td>
</tr>
<tr>
<td>Predicted probabilities for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial students</td>
<td>0.5211</td>
<td>0.7367</td>
<td>0.5685</td>
</tr>
<tr>
<td>Nonremedial students</td>
<td>0.7761</td>
<td>0.7933</td>
<td>0.6373</td>
</tr>
<tr>
<td>N</td>
<td>4173</td>
<td>4173</td>
<td>1623</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome: Years to Bachelor’s degree</th>
<th>OLS Coefficient</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.633***</td>
<td>0.150***</td>
<td>0.211***</td>
</tr>
<tr>
<td>Predicted time to degree for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial students</td>
<td>5.070</td>
<td>5.100</td>
<td>4.970</td>
</tr>
<tr>
<td>Nonremedial students</td>
<td>4.437</td>
<td>4.950</td>
<td>4.759</td>
</tr>
<tr>
<td>N</td>
<td>3413</td>
<td>3413</td>
<td>1226</td>
</tr>
</tbody>
</table>

**SOURCES:** NELS:88

* p < 0.05    ** p < 0.01    *** p < 0.001
High Rates of Failure in Gateway Courses

Students Passing a Math Course that Counts Toward an Associate’s Degree

Fall 2010 enrollments in math courses that students could apply toward a degree

- About 17,600 African American students
  - 70% (12,300 students) remained enrolled until the end of the term
  - 41% (7,300 students) received a passing grade

- About 108,700 Hispanic/Latino students
  - 75% (81,900 students) remained enrolled until the end of the term
  - 49% (53,500 students) received a passing grade

- About 98,600 White students
  - 80% (78,500 students) remained enrolled until the end of the term
  - 60% (58,900 students) received a passing grade

Source: Passing when it counts. EdSource Issue Brief, February 2012
www.edsource.org/pub12-passing-when-it-counts.html
Over 600,000 students are studying calculus in high school this year, roughly 1/3 of the 1.8 million who will go directly from HS to college.
The Widening Earnings Gap of Young Adults by Educational Attainment

The difference in median annual earnings of college and high school graduates when members of each generation were ages 25 to 32.

Source: Pew Research Center
WRESTLING WITH INNOVATION
The New Mathways Project

- Tight structure
- Centralized control

Statway/Quantway

Redesigning math pathways to student achievement

The New Mathways Project

- Loose structure
- Local control
College Math Success by Subgroup

Source: Carnegie Foundation for the Advancement of Teaching, 2015
Reflections on Innovation at Scale

• Innovation as ornamentation
• Working in the fog of collective amnesia
• Myth of the sufficiency of highly effective practices
  – The proper role of data: Is data king?
  – What are the catalysts to turning effective practices into increased levels of student achievement?
• Rhetoric scales faster than practice
National and State
- Financial aid
- Governance

System
- Transfer
- Applicability
- Articulation

Institutional
- Content
- Sequence structure
- Student supports
- Faculty supports
- Advising

Classroom
- Delivery
- Technology
- ...

Content
- Sequence Structure
- Delivery
- Student Supports
- Faculty Supports

Placement
Principles of the NMP Model

Developmental mathematics students should have access to:

1. Multiple pathways aligned to specific fields of study
2. Acceleration that allows students to complete a college-level math course in one year
3. Intentional use of strategies to help students develop skills as learners directly linked to their courses
4. Curriculum design and pedagogy based on proven practice coupled with a context sensitive improvement strategy
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
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Critical Components of Scaling Innovation

- Legitimation
- Big ‘P’ and little ‘p’ policy changes
- Coordinated mobilization
- State math task forces

The Charles A. Dana Center at the University of Texas at Austin
The key to scaling innovation in higher education: Legitimation

The **coordination of efforts** by mathematicians (the professional math associations, TPSE Math, Common Vision 2025) and leaders of the associations of higher education.
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Demand for participating in the NMP State Math Task Force project is high. States seeking to join the network include: Arkansas, Connecticut, Maryland, Michigan, New Jersey, Oklahoma, Oregon, and Washington.

The Dana Center is currently working with eight states:

- Colorado
- Georgia
- Indiana
- Missouri
- Montana
- Nevada
- Ohio
- Texas
“...charged with determining how the System’s colleges could dramatically improve success rates in gateway mathematics courses without compromising the disciplinary integrity of these courses.”

—From University System of Georgia: Transforming College Mathematics
Recommendations from the University System of Georgia Mathematics Task Force

1. Focus on supporting success in college credit-bearing, gateway mathematics courses for all students.
2. Aligning gateway mathematics course sequences with academic programs of study. In particular, College Algebra should not be the default class for non-STEM majors.
3. Implement a co-requisite approach to support student success in gateway mathematics courses.
4. Develop year-long mathematics pathways for students with significant gaps in preparation.
5. Use multiple measures to place students in gateway courses and appropriate supports.
6. Terminate use of COMPASS as an exit examination.
7. Align the outcomes of gateway mathematics courses with the Common Core Georgia Performance Standards (CCGPS) for Mathematics.
8. Develop advising systems and protocols for placing students in gateway mathematics courses and co-requisite supports that align with their intended programs of study.

The Charles A. Dana Center at the University of Texas at Austin
Ohio Board of Regents' Charge to the Mathematics Steering Committee

To develop expectations and processes that result in each campus offering pathways in mathematics that yield
(1) increased success for students in the study of mathematics;
(2) a higher percentage of students completing degree programs; and
(3) effective transferability of credits for students moving from one institution to another.
Recommendations from the Ohio State Math Task Force

1. Improve student success in entry-level courses by aligning mathematics to academic programs of study and by improving instructional delivery mechanisms
2. Develop, implement, and evaluate co-requisite strategies to support underprepared students
3. Redesign OTM course criteria and processes to focus on student learning outcomes
4. Establish a statewide network of mathematics chairpersons
5. Improve communication among mathematics faculty and stakeholders across institutions
6. Develop quality measures for improving student success in mathematics; then collect, analyze, and share relevant data
7. Strengthen collaboration and communication between K12 and higher education on mathematics curriculum and instruction
UNDERGRADUATE MATHEMATICS: THE FUTURE
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3. Mathematics can become the exemplar among disciplines in improvement, in identifying areas of consensus in a highly heterogeneous higher education landscape, and in developing and scaling innovation.
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The Correlational Study: STEM

$r(10) = -.64, p = .025$

% Female PhDs

Field-specific Ability Beliefs

High score = need brilliance

Leslie, Cimpian, & Meyer, in prep.
DEVELOPMENTAL MATHEMATICS: THE REAL GOALS OF REFORM
The Real Goals of Reform

• Make mathematics a vehicle for upward social mobility, not a burial ground for students’ aspirations.

• Narrow the gap between mathematics as it is used and what students learn in their courses.

• Improve learning infrastructure to help us get better at providing students with high quality mathematics education.