CSPCC #0910240
PtC #1430540

National Evaluation of Undergraduate Mathematics Efforts

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NSF INCLUDES Multi-Scale Evaluation Conference
Knoxville, TN, February 24, 2017

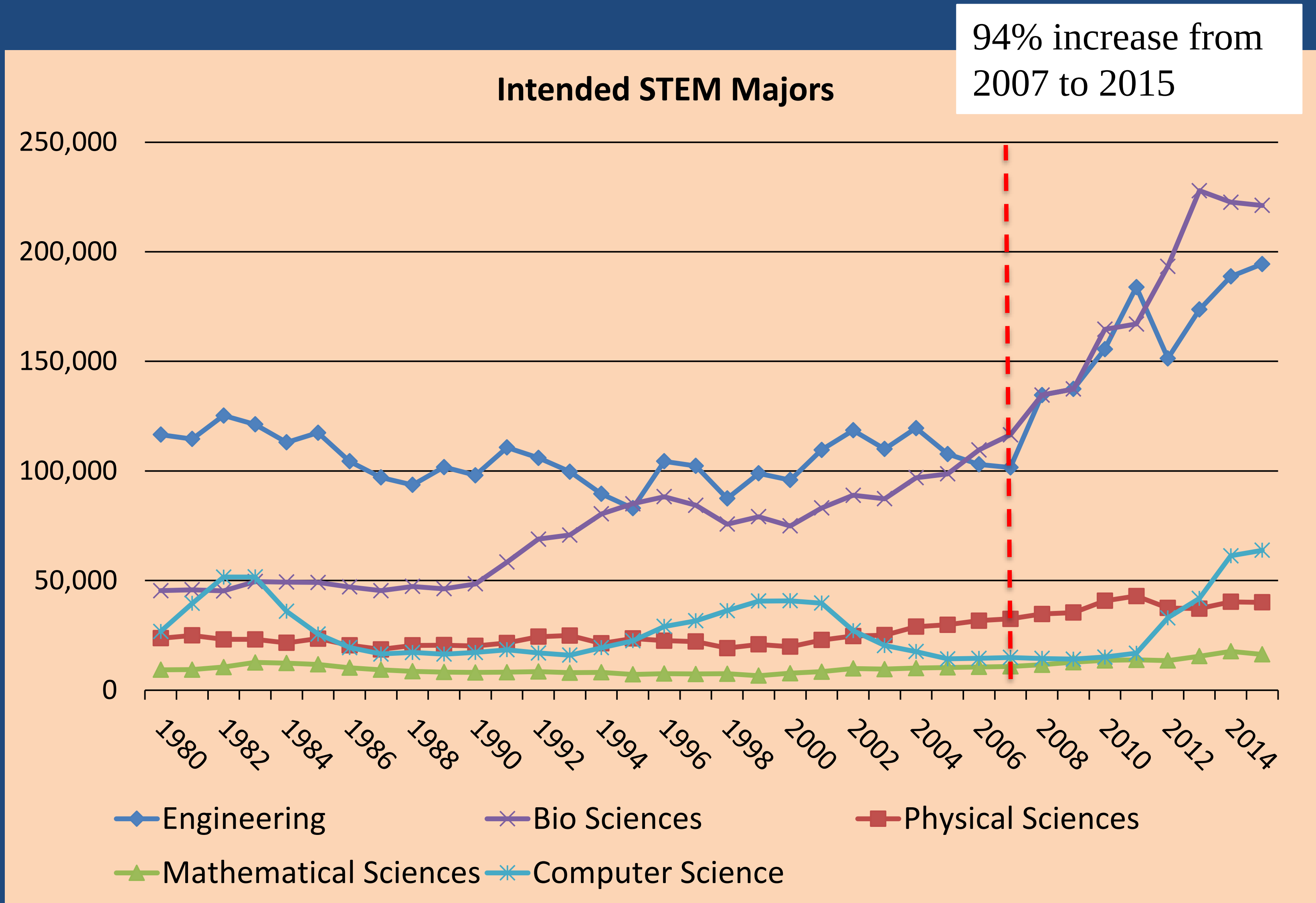
PDF file of these slides available at
www.macalester.edu/~bressoud/talks

Office of Science and Technology Policy

Report to the President:
Engage to Excel   Feb., 2012

President's Council of Advisors on Science and Technology (PCAST)

Recommendation 3-1: “This national experiment should fund … college mathematics teaching and curricula developed and taught by faculty from mathematics-intensive disciplines other than mathematics, including physics, engineering, and computer science.”



94% increase from 2007 to 2015
Intended STEM Majors
250,000
200,000
150,000
100,000
50,000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Engineering
Bio Sciences
Physical Sciences
Mathematical Sciences
Computer Science

Today math departments teach greater numbers of students, who are less prepared, using fewer resources, and with increased expectations for student success.

Persistence

—FAILING THE FUTURE—

PROBLEMS OF PERSISTENCE AND RETENTION IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) MAJORS AT ARIZONA STATE UNIVERSITY

ASU Freshman STEM Improvement Committee

Submitted to Executive Vice President & University Provost Elizabeth Capaldi

July 2, 2007

Forty-three percent of students who received an A in precalculus and who had declared a STEM major that required calculus chose not to take calculus.

Switchers by grade in Calculus I.

Women:

A: 10%   B: 13%   C: 24%

Men

A: 6%   B: 6%   C: 12%

Women in Engineering:

A or B: 4%   C: 19%

Men in Engineering

A or B: 2%   C: 7%

Source: CSPCC

Reason for switching	Gender	Students earning A or B	Students earning C
Too many other courses I need to take	Women	43%	33%
	Men	42%	16%
Have changed major	Women	40%	43%
	Men	33%	39%
Takes too much time and effort	Women	33%	25%
	Men	29%	26%
Bad experience in Calculus I	Women	18%	53%
	Men	19%	35%
Don’t understand calculus well enough	Women	18%	38%
	Men	4%	26%
Grade was not good enough	Women	7%	15%
	Men	0%	13%

Students could select more than one response.

Source: CSPCC

PLOS | ONE

RESEARCH ARTICLE

Women 1.5 Times More Likely to Leave STEM Pipeline after Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit

Jessica Ellis[1]*, Bailey K. Fosdick[2], Chris Rasmussen[3]

1 Department of Mathematics, Colorado State University, Fort Collins, Colorado, United States of America, **2** Department of Statistics, Colorado State University, Fort Collins, Colorado, United States of America, **3** Department of Mathematics and Statistics, San Diego State University, San Diego, California, United States of America

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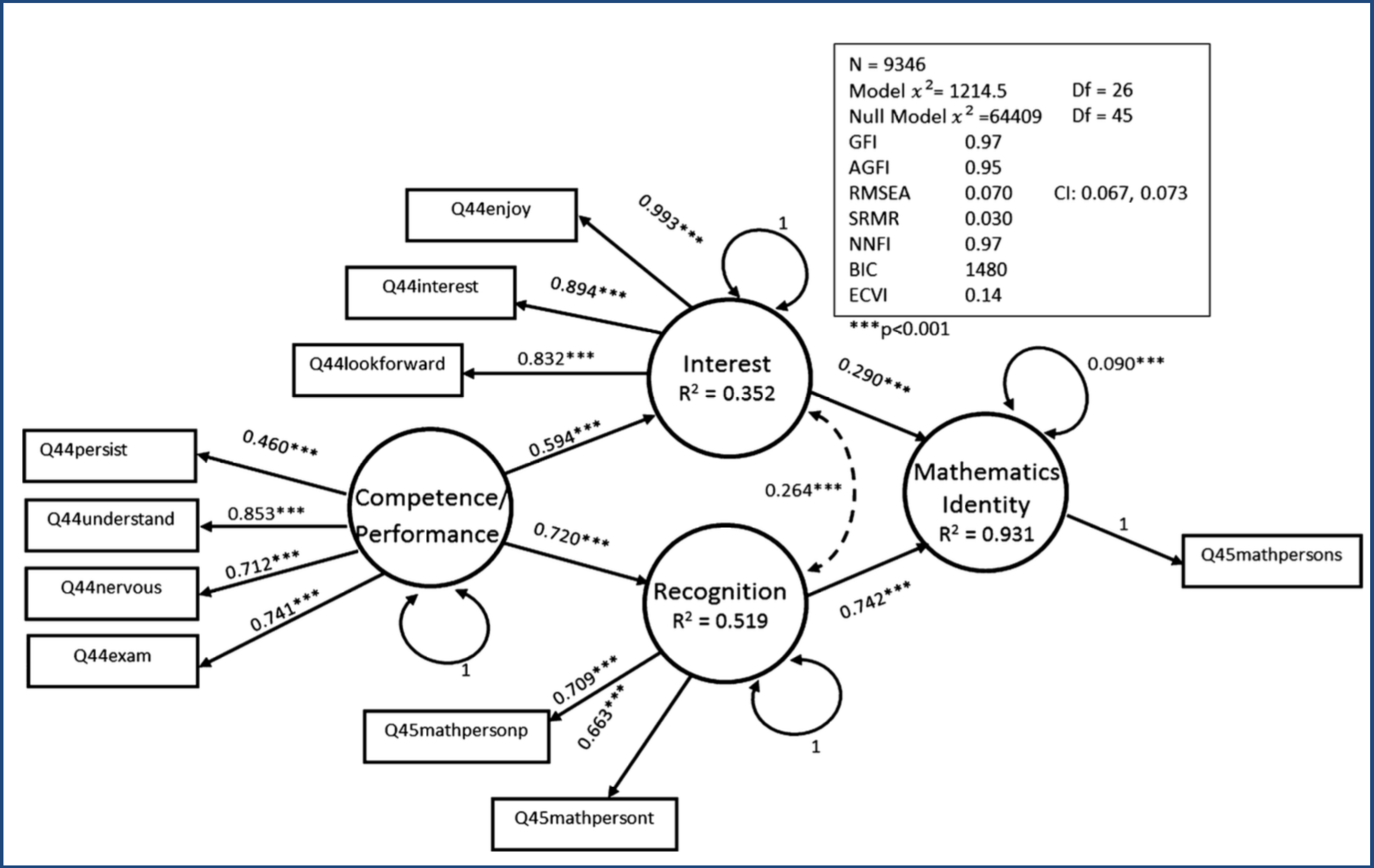
Student Attitudes toward Mathematics

Structural Equation Model for Math Identity of College Calculus Students



Cribbs, J., Hazari, Z., Sonnert, G., & Sadler, P. (2015). Establishing an Explanatory Framework for Mathematics Identity, *Child Development*, *86*(4), 1048-1062.

Effect of Calculus I at PhD-granting universities on

Desire to continue the study of mathematics — Down 1/6 of a standard deviation

Enjoyment of doing mathematics — Down 1/3 of a standard deviation

Confidence in mathematical abilities — Down half a standard deviation

Source: CSPCC

“Good Teaching” (in order of significance)

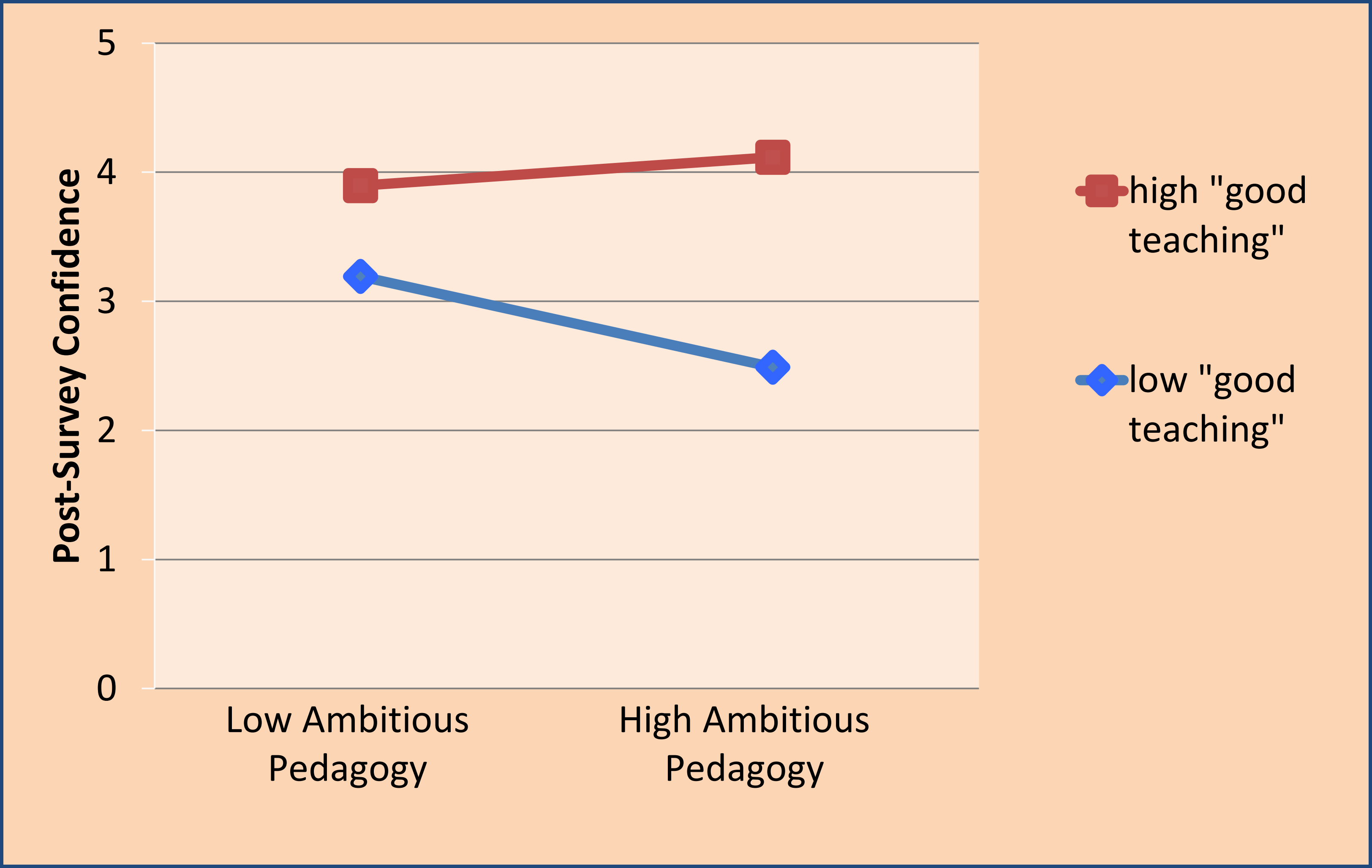
My Calculus Instructor:

1. provided explanations that were understandable
2. helped me become a better problem solver
3. allowed time for me to understand difficult ideas
4. made me feel comfortable in asking questions during class
5. presented more than one method for solving problems
6. made class interesting
7. asked questions to determine if I understood what was being discussed

“Ambitious Pedagogy” (in order of significance)

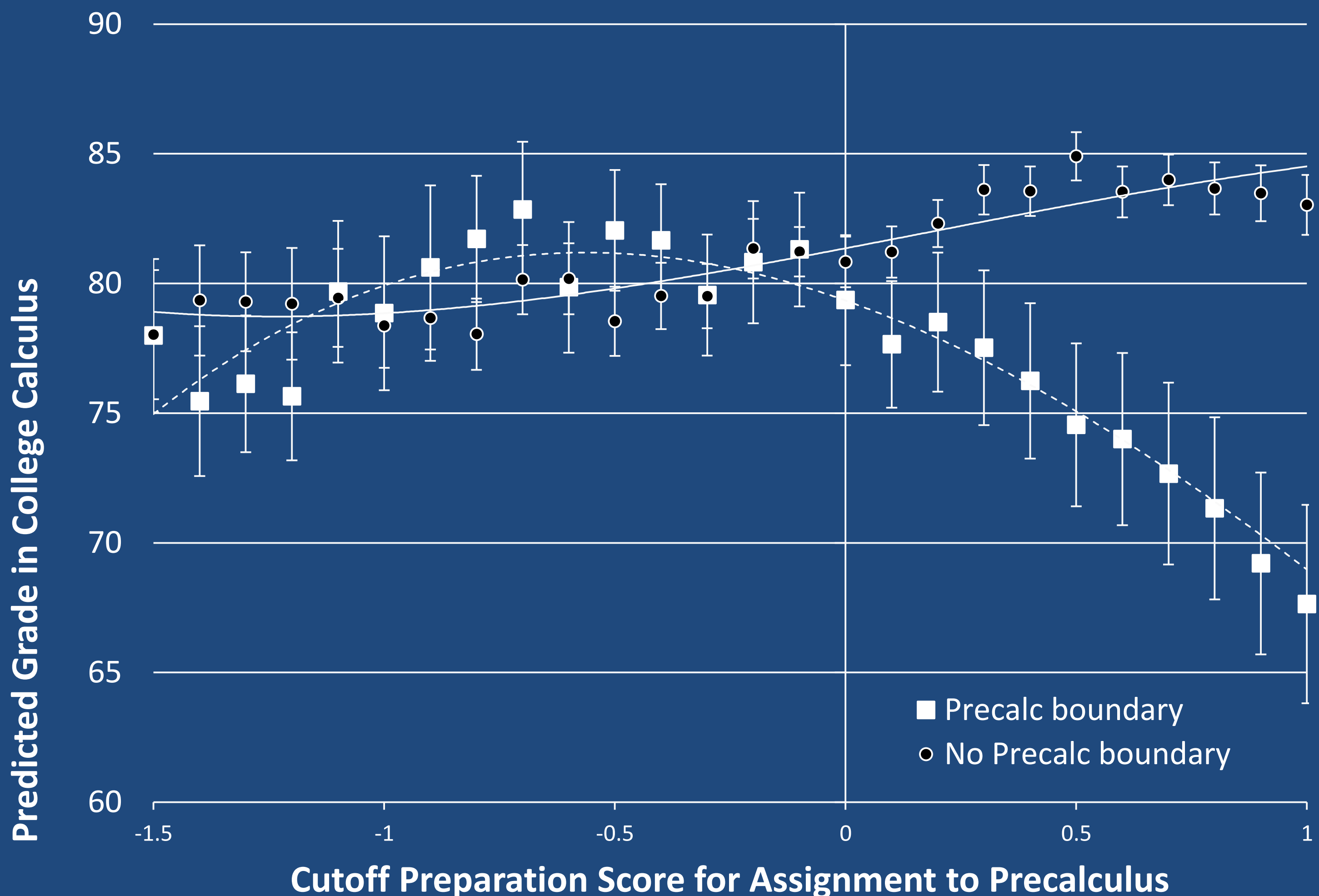
1. Instructor had students work with one another
2. Assignments were submitted as group projects
3. Exam questions included word problems
4. Assignments included word problems
5. Assignments required explanation of thinking
6. Assignments included problems unlike those done in class or in the book
7. Instructor held whole-class discussion

Interaction on student confidence



Source: CSPCC

Departmental Efforts and Culture



Source: Sonnert, G., & Sadler, P. M. (2014). The impact of taking a college precalculus course on students' college calculus performance. *International Journal of Mathematical Education in Science and Technology*, *45*(8), 1188-1207

Variation	PhD (133)	MA (89)
Stretched out Calculus I	13	7
Calculus infused with precalculus	7	4
Stretched out Calculus I & II	6	1
Precalc contemporaneous with calculus	2	1

Source: PtC

Spring 2015, surveys on the precalculus through single variable calculus sequence sent to all 330 US math departments offering a graduate degree in mathematics.

Response rates:

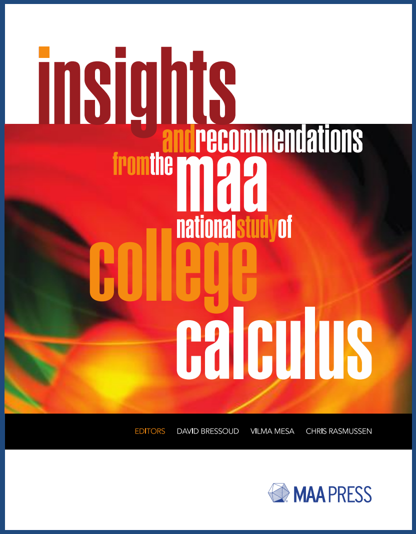
- PhD departments: 134/178 = 75%
- MA departments: 89/152 = 59%
- Overall: 223/330 = 68%

Available at MAA.org/PtC

PROGRESS THROUGH CALCULUS:
CENSUS SURVEY
TECHNICAL REPORT

Report prepared by:
Naneh Apkarian & Dana Kirin

Progress through Calculus leadership team:
David Bressoud, Chris Rasmussen, Sean Larsen, Jessica Ellis, Doug Ensley, & Estrella Johnson



Bressoud, Mesa, & Rasmussen (eds.). 2015. *Insights and Recommendations from the MAA National Study of College Calculus*.

Chapters describing best practices in

- Placement
- Student support
- Pedagogy
- Departmental dynamics
- Preparation for teaching for graduate students

Available at MAA.org/PtC

Characteristics of Successful Programs in College Calculus, NSF #0910240

7 or 8 Features of Successful Calculus Programs

1- Attention to placement issues

2- Attention to local data

3- Support for active learning

4a- Coordination of courses

4b- Regular meetings of course instructors

5- Solid GTA professional development

6- Strong student support services

7- Rigorous courses

Use of local data

Does your department have access to data to help inform decisions about your undergraduate program?

	PhD (131)	MA (84)
No	5%	5%
Yes, but not readily available	48%	52%
Yes, readily available	47%	43%

N (131 or 84) is number of departments

Source: PtC

Use of local data

Which types of data does your department review on a regular basis to inform decisions about your undergraduate program?

	PhD (123)	MA (79)
Student performance (e.g., grades)	89%	86%
Student evaluations	87%	76%
Correlation with previous performance	49%	43%
Adherence to placement recommendations	45%	41%
Student persistence onto the next course	41%	41%
Student exit interviews	19%	17%
Communication with client disciplines	5%	4%

Source: PtC

Collaboration and uniformity

For those terms in which more than one section of this course is offered, what aspects of the course are intended to be uniform across all sections?

When several instructors are teaching this course in the same term, how often do they typically meet as a group to discuss the course?

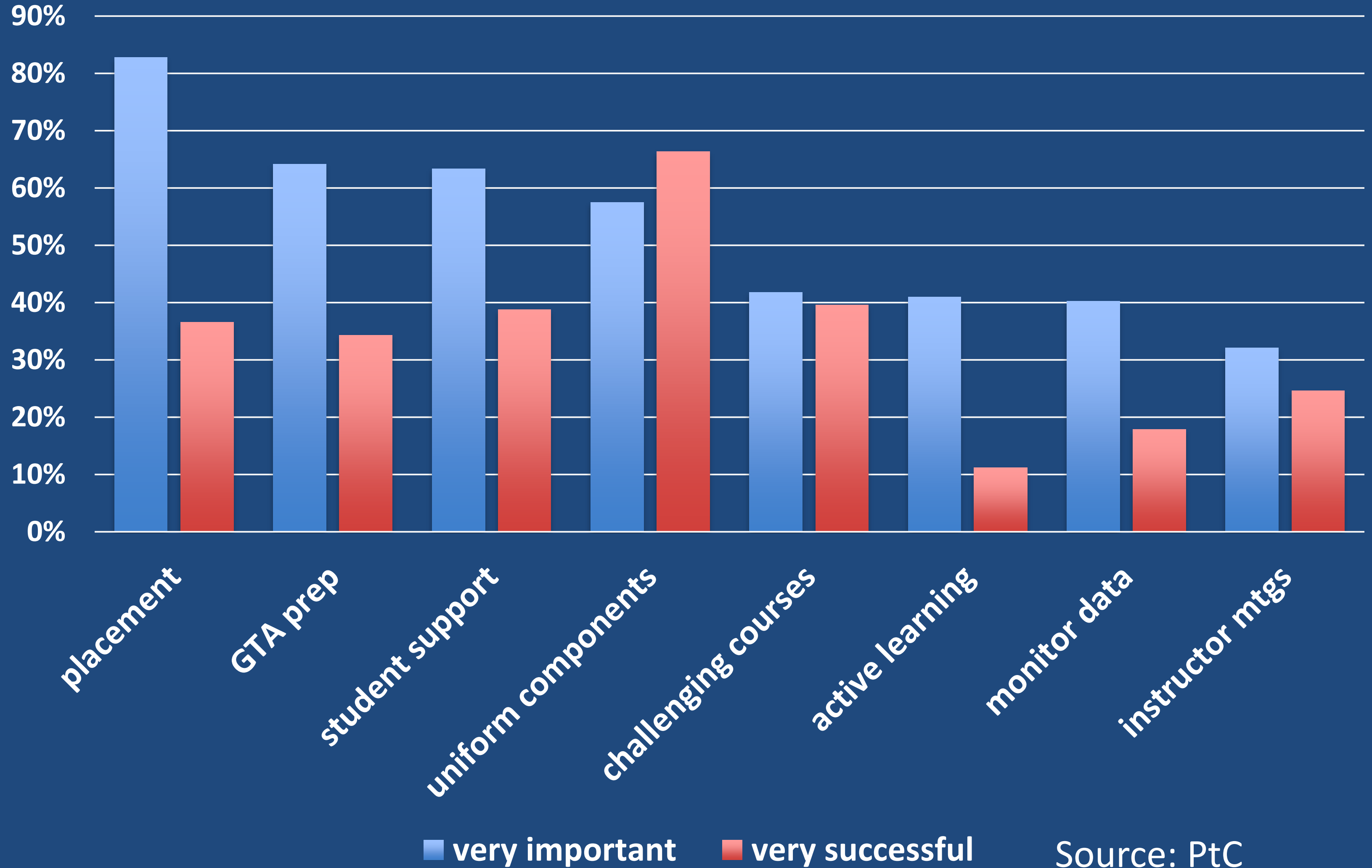
Common Elements of Calculus I	PhD	MA
Textbook	91%	90%
Topics to be covered	90%	93%
Schedule of when topics are covered	60%	20%
Midterms	44%	8%
Final exams	60%	22%
Online homework	45%	17%
Written homework	28%	4%
Quizzes	18%	1%
Course grading	49%	8%
Exam grading	50%	8%
Instructional approach	23%	5%

Source: PtC

How frequently do instructors for the same course meet?	PhD	MA
Weekly	22%	6%
Biweekly	8%	2%
2-4 times per term	21%	26%
Once per term	21%	24%
Never	28%	43%

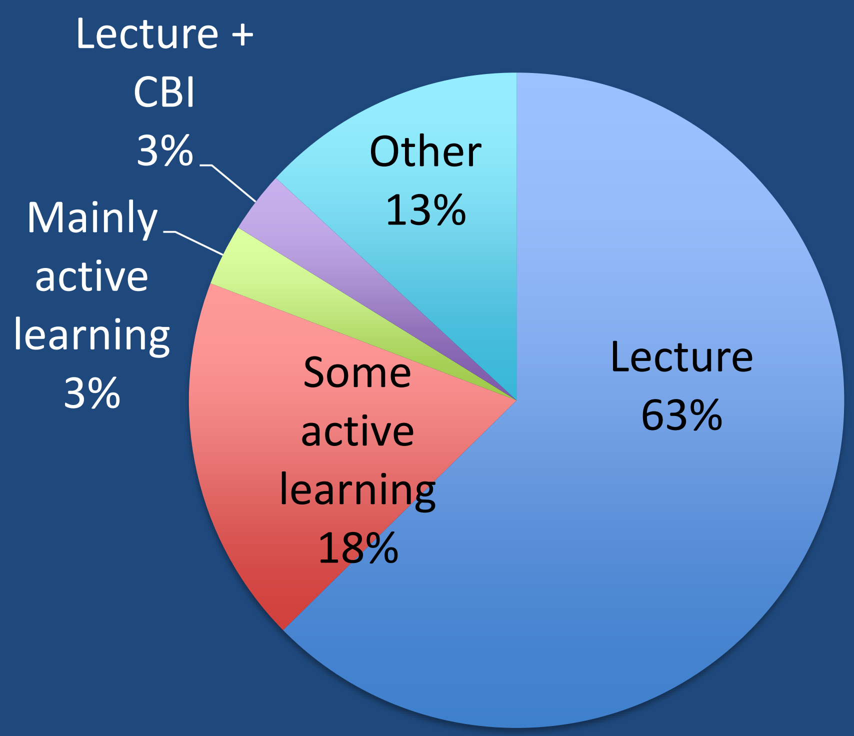
Source: PtC

What is important vs where they are successful PhD programs



Source: PtC

Primary style of instruction for Mainstream Calculus



35% of surveyed universities are using active learning in at least some sections

Some active learning (e.g. clickers), mostly lecture
Mainly active learning (e.g. flipped classes), minimal lecture
CBI = Computer based instruction
"Other" includes too much variation to specify one style

Source: PtC

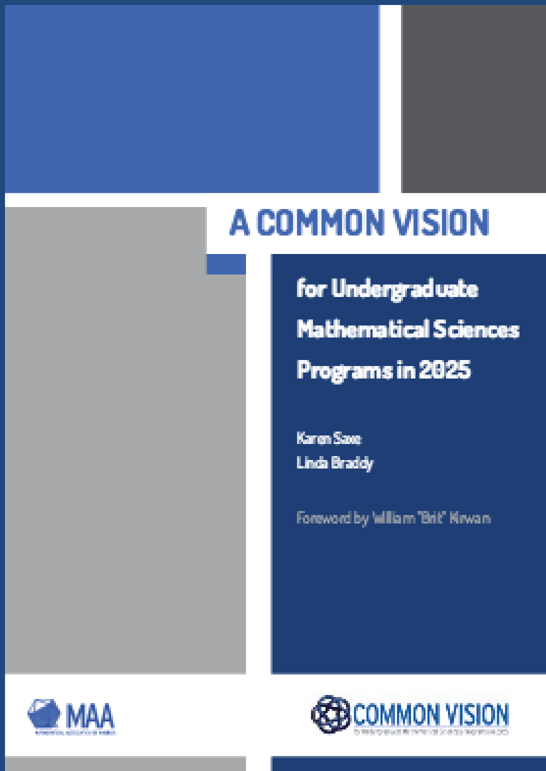
TPSEMath

Transforming Post-Secondary Education in Mathematics

Mission: TPSE Math will facilitate an inclusive movement to strengthen post-secondary education in mathematics by working closely with--and mobilizing when necessary--faculty leaders, university administrations, membership associations, and relevant disciplinary societies in the pursuit of mathematically rich and relevant education for all students, whatever their chosen field of study. TPSE Math will identify innovative practices where they exist, advocate for innovation where they do not, and work with and through partners to implement and scale effective practices.

Sponsored by Carnegie Corporation of New York, the Alfred P. Sloan Foundation, and the National Science Foundation

www.tpsemath.org



Saxe, K., & Braddy, L. 2016. *A Common Vision for Undergraduate Mathematical Science Programs in 2025*. Joint report of AMATYC, AMS, ASA, MAA, SIAM.

Search for Common Vision at maa.org

CBMS
Conference Board of the Mathematical Sciences

PDF file of these slides available at
www.macalester.edu/~bressoud/talks

Active Learning in Post-Secondary Mathematics Education
15 July 2016

> "We call on institutions of higher education, mathematics departments and the mathematics faculty, public policy-makers, and funding agencies to invest time and resources to ensure that effective active learning is incorporated into post-secondary mathematics classrooms."

Full statement at CBMSWEB.org.
Signed by presidents of AMATYC, AMS, ASA, MAA, SIAM and 10 other societies