Teaching Math* in the 21st Century

*mathematical sciences = math / stats / data sciences

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Transforming Post-
Secondary Education in Mathematics

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Outline

- Change is coming
- TPSE Math Strategic Priorities
- TPSE Math Actions (Present / Future)
- Finale
TPSEMath Vision
Transforming Post-Secondary Education in Mathematics

Post-secondary education in mathematics will enable any student, regardless of his or her chosen program of study, to develop the mathematical knowledge and skills necessary for productive engagement in society and in the workplace.

We believe that a collective effort by the mathematical sciences community will be required to achieve that vision.
Change is coming

State Funding for Higher Education Remains Far Below Pre-Recession Levels in Most States
Percent change in state spending per student, inflation adjusted, 2008 - 2015

Source: CBPP calculations using data from Illinois State University’s annual Grapevine Report and the State Higher Education Finance Officers Association. These funding data is provided by the Fiscal Policy Center at Voices for Illinois Children. Because enrollment data is only available through the 2014 school year, enrollment for the 2014-15 school year is estimated using data from past years. Years are fiscal years.

Change Ahead

Active Learning

Output Content

Who

Student Debt
Change is coming … why now?

Answer 1

Discipline-based education research, which matured in the 1980s and 90s, has produced significantly new ways of understanding knowledge, thinking and learning.

Heterogeneity analyses indicated no statistically significant variation among experiments based on the STEM discipline of the course in question, with respect to either examination scores (Fig. 2A; $Q = 910.537, df = 7, P = 0.160$) or failure rates (Fig. 2B; $Q = 11.73, df = 6, P = 0.068$). In every discipline with more than 10 experiments that met the admission criteria for the meta-analysis, average effect sizes were statistically significant for either examination scores or failure rates or both (Fig. 2, Figs. S2 and S3, and Tables S1A and S2A). Thus, the data indicate that active learning increases student performance across the STEM disciplines.

For the data on examinations and other assessments, a heterogeneity analysis indicated that average effect sizes were lower when the outcome variable was an instructor-written course examination as opposed to performance on a concept inventory (Fig. 3A and Table S1B; $Q = 10.731, df = 1, P << 0.001$). Although student achievement was higher under active learning for both types of assessments, we hypothesize that the difference in gains for examinations versus concept inventories may be due to the two types of assessments testing qualitatively different cognitive skills. This explanation is consistent with previous research indicating that active learning has a greater impact on student mastery of higher- versus lower-level cognitive skills (6–9), and the recognition that most concept inventories are designed to diagnose known misconceptions, in contrast to course examinations that emphasize content mastery or the ability to solve quantitative problems (10). Most concept inventories also undergo testing for validity, reliability, and readability.

Heterogeneity analyses indicated significant variation in terms of course size, with active learning having the highest impact on courses with 50 or fewer students (Fig. 3B and Table S1C; $Q = 6.726, df = 2, P = 0.035$; Fig. S4). Effect sizes were statistically significant for all three categories of class size, however, indicating that active learning benefitted students in medium (51–110 students) or large (>110 students) class sizes as well.

When we metaanalyzed the data by course type and course level, we found no statistically significant difference in active learning’s effect sizes when comparing (i) courses for majors versus nonmajors ($Q = 0.045, df = 1, P = 0.883$; Table S1D), or (ii) introductory versus upper-division courses ($Q = 0.046, df = 1, P = 0.829$; Tables S1E and S2D).
Change is coming … why now?

Answer 2
There is renewed federal interest in higher education in general, and undergraduate STEM in particular.
Change is coming … why now?

Answer 3

It has become a question of social justice. Higher education is key to social mobility. Mathematics classrooms are among the most segregated in the United States.

“… over the entire career, the typical bachelor’s degree graduate worker earns $1.19 million, which is twice what the typical high school graduate earns …”

Some surprising statistics

- How much more likely are women than men to choose not to continue beyond Calc 1, even when Calc 2 is required for their major? about twice as likely
- What % of bachelor’s degrees in math are earned by women? 41%
- What % of PhDs in math+stats are earned by women? 32%
- What % of postdocs in math went to women? 25%
- What % of tenured faculty in doctoral math departments are women? 14%
- What % in top 50 research departments? 11%
Some surprising statistics

- # Associates degree granting institutions: 1113
- # Baccalaureate degree granting institutions: 991
- # Master’s degree granting institutions: 741
- # PhD degree granting institutions: 335
Some surprising statistics

Who here, as an undergraduate, took (math) courses at more than one institution?

- What % of undergraduate students attend 2-year colleges? 42%
- What % 4-year college students had enrolled in a 2-year college? 46%
- What % of low-income students attend a 2-year college? 44%
- What % of high-income students attend a 2-year college? 15%
Some surprising statistics

Who here, as an undergraduate, took (math) courses at more than one institution?

- What % of students attending 2-year colleges take math courses that are not credit-bearing? > 60%
- What % of those never complete a math course? > 70%

Over 40% of students who start at a 2-year college never finish simply due to the math barrier.
Strategic Priorities

- Coherent Pathways (lower division)
- Enhanced/Alternative Pathways (upper division)
- New Teaching Strategies
- Graduate Education
Multiple pathways and improved completion rates:
Dana Center, APLU/AASCU
Creating an administrative center at Maryland
Building an action network beyond the math community:
- Administrators
- Funders
- State governments and officials
- NSF / Federal agencies
- Employers and other stakeholders
Mobilizing Chairs

Mathematics Advisory Group

Chairs + 1 Meetings - October / March

Dig more deeply into Upper Division pathways

Hear from other STEM areas

Analyze the “demand side”
Strategic Priorities

- Coherent Pathways (lower division)
- Enhanced / Alternative Pathways (upper division)
- New Teaching Strategies
- Graduate Education

The challenge: Enhancements to graduate education are needed to better prepare students for careers in an evolving environment.
showed an increase in Business & Industry, and 61% of the increase was accounted for by the Statistics Group. Math departments are in postdoc positions, up from 69% last year. The number of new PhDs taking positions in Business & Industry has increased to 409 this year compared to 381 last year. All groups except Math Public Large and Biostatistics showed an increase in the number of PhDs employed in the US. The overall US unemployment rate for the new doctoral recipients is 6.2%, up from 5.7% last year. (Details on the calculations for academic training.)

Comparing PhDs awarded this year with those awarded in 2003–2004:

• PhDs awarded have increased more than 78% over the last 10 years.
• Degrees awarded by Doctoral Mathematics combined and by Statistics & Biostatistics Combined have increased 72% and 96%, respectively. Some of this latter increase is due to the increase in response rate among the Statistics & Biostatistics departments and an increase in the number of biostatistics programs included in the Annual Survey over the last 3 years.
• 63% of those still seeking employment in the US are US citizens.
• 8% (126) of the new PhDs who are employed are working at the institution which granted their degree, up from 6% last year.
• 75% (657) of non-US citizens whose employment status is known for academic training.
• 53% (755) of those who are employed in the US are US citizens, up slightly from 52% last year.

**Other Academic consists of departments outside the mathematical sciences including numerous medical-related units.**

(Senior policy analyst Neil G. Ruiz of the Brookings Institution in The Geography of Foreign Students in US Higher Education)
Graduate Education
Finale – What can TPSE do?

What additional resources would be most useful for your Department? What input from other Departments would be most helpful?

- Make a note on a TPSE sheet
- Discuss with your table
- Report out – any commonalities?
Let’s work together ..... 

Thank you!!

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