Teaching Math* in the 21st Century

*mathematical sciences = math / stats / data sciences

Tara . Holm @ Cornell . edu

Transforming Post-Secondary Education in Mathematics

2 August 2016
Outline

- Introduction – curriculum vitae brevis
- The Secret Question
- Change is coming
- TPSE Math Strategic Priorities
- TPSE Math Graduate Education
- Finale
Introduction

- Pennsylvania / Dartmouth / BSM / MIT
- Berkeley / UConn / Cornell
- AWM / AMS / Common Vision / TPSE Math / PMA
- Public Voices Op-Ed Project
- HOW: with the encouragement of mentors!!
Leadership

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IAS

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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.
The Secret Question

How many of you feel, deep down in your most private thoughts, that you aren’t actually any good at math? That by some miracle, you’ve managed to fake your way to this point, but you’re always at least a little worried that your secret will be revealed? That you’ll be found out?

Growth versus Fixed Mindset

- Can mathematical success be achieved through hard work, or only with innate talent?
- “Smart” label can reinforce fixed mindset.
- Factor by which a white public school students is more likely than a black student to be labeled “gifted”? 2.4

Harper's Index, May 2016.
Growth versus Fixed Mindset

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Harper's Index, May 2016.
Growth versus Fixed Mindset

... and how it relates to you
... and how it relates to your students

- We are coaches and mentors, not just teachers
- Practice, practice, practice !!!
- Ownership of ideas
Change is coming
Change is coming …

1887 Cornell entrance exam

- Extract $\sqrt[3]{5}$ to five places of decimals.
- Define: a convergent and a divergent series, a harmonic progression and a geometric progression, a continued fraction, an incomensurable number, and undetermined coefficients.
- Find the angle at which the side of a pyramid is inclined to the base, the sides being equilateral triangles and the base a square; thence find the diedral angle of a regular octaedron.

Source: Taimina, Daina, “How it was to study and to teach mathematics in Cornell at the end of 19th century”, preprint, http://tinyurl.com/j9qkewr
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.

Mathematician are beginning to use this research to inform how they teach.
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 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 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
Key Activities

- Regional meetings
- Strategic planning
- Inaugural MAG meeting
- Organizational set-up
- Chairs+1 Meeting – 6-8 October 2016
Narrow the gap between today’s mathematics and the mathematics students study in college.

Make each mathematics departments essential partners in improving quantitative education in all disciplines.

Ensure that post-secondary mathematics education gives all students a platform for success (toward college completion and achieving aspirations).
TPSEMath 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.
“The United States is the pre-eminent hub for academic training.”

(Senior policy analyst Neil G. Ruiz of the Brookings Institution in *The Geography of Foreign Students in US Higher Education*)

**Doctoral Degrees Awarded**

**Figure A.2: New PhDs Awarded by Group**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Doctoral Degrees Awarded</th>
<th>Doctoral Mathematics Combined</th>
<th>Statistics &amp; Biostatistics Combined</th>
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<td>519*</td>
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</tbody>
</table>

**Figure E.2: US Employed by Type of Employer**

- Business & Industry: 409 (23%)
- Government: 77 (5%)
- Master’s, Bachelor’s, & 2-Year Colleges: 238 (14%)
- All Mathematics*: 362 (20%)
- Statistics & Biostatistics: 72 (5%)
- Other Academic & Research Institutes**: 234 (17%)

*Includes all Math Public, Math Private, and Applied Math departments.
**Other Academic consists of departments outside the mathematical sciences including numerous medical-related units.
Graduate Education
Graduate Education
Graduate Education

What was something outstanding (good or bad) about your co-curricular experience in grad school?

- Make a note on a **YELLOW** sheet
- Discuss with your table
- Report out – any commonalities?
Finale – What can YOU do?

- Find like-minded colleagues and build community
- Share your findings and materials
- Apply for NSF funding to improve undergraduate courses and programs
- Take a sabbatical with aim to enrich your undergraduate teaching
- Continue to engage with Project NExT, MAA, TPSE
Let’s work together ..... 

Thank you!!

http://www.tpsemath.org/

@tpsemath

Send me a postcard!