Collaborations in post-secondary Mathematics Education

A field report from one large public university
First, about the scale and nature of the enterprise

- 1,100 undergraduate majors, up from 800 three years ago
- 22,000 student classes in 2013-2014 (77,000 student credit hours)
- Enrollment up 28% since 2007
- Undergraduates in College of Engineering up 45% since 2007

Example: applied linear algebra
- 1,100 in 2010—2011
- 1,200 in 2011—2012
- 1,400 in 2012—2013
- 1,700 in 2013—2014

Example: multivariable calculus (“Calculus 3”)
- 1,900 in 2007—2008
- 2,600 in 2010—2011
- 2,700 in 2011—2012
- 2,900 in 2012—2013
- 3,000 in 2013—2014
Undergraduate mathematics is interdisciplinary

- 1,100 undergraduate majors
- 22,000 student classes in 2013-2014 (77,000 student credit hours)
- Enrollment up 25% since 2007
- Undergraduates in College of Engineering up 40% since 2007
- 90% of enrollment is undergraduates
- 80% of enrollment is to majors of departments other than Mathematics
- 60% of enrollment is colleges other than Liberal Arts & Sciences
- Each year more than 40% of undergraduates take a Mathematics or Statistics course, and 85% of undergraduates take at least one at some time

- PCAST report calls for “college mathematics teaching and curricula developed and taught by faculty from mathematics-intensive disciplines other than mathematics, including physics, engineering, and computer science” We are doing a version of that, collaborating productively with colleagues in many disciplines
Projects

- Engineering calculus project
- Active learning in large courses
- First-year math for life sciences
- Merit program
- Illinois Geometry Lab
- Interdisciplinary internships
- New initiatives
Collaboration with College of Engineering
1 CoE faculty member, 2 Mathematics faculty
Additional funding to reduce size of discussion sections
2/3 of TAs from Math, 1/3 from CoE
Enrollment has grown from 400 students in 2007 to 600 students in 2014
Under development since 2006; at least 14 tenure-code faculty have participated include at least 10 from Mathematics
Engineering calculus: substance

• “Once students have been exposed to calculus, they’re immune” (J. McClure)
• 1 semester course covers usual 2 semesters
• Start with Taylor series and incorporate them throughout
• In each discussion section (2 times/week), students work in groups of 4 on a worksheet
• Worksheets are developed collaboratively by the engineering and mathematics faculty
• Faculty members rotate through discussion sections
Engineering calculus: lessons

- Collaboration is valuable
- Collaboration is time-consuming
- Sustained faculty commitment
- TAs need training, mentoring, and supervision
- Discussion section size
- How to welcome underrepresented populations
- Plan for evaluation
Active learning in large calculus courses

- First, second, and third semesters
- Roughly 7,500 students per year
- Taught by teams including at least one experienced faculty member
- Incentives for faculty result in sustained attention
- Discussion sections small enough for group work
Introductory Mathematics for Life Sciences

- Developed collaboratively by mathematics and biology faculty
- Initially, biology faculty member will lecture once per week
- Active learning discussion sections
- Also involves statistics faculty and statistics course
- Second try: first attempt squashed by upper administration in 2007
Merit program

- [http://merit.illinois.edu](http://merit.illinois.edu)
- Support students with high potential from traditionally underrepresented populations
- Since 1989
- Uri Treisman’s collaborative learning model
  - Merit students attend same labs and lectures and take the same exams
  - Merit workshops replace regular discussion section
  - Students work in groups on worksheet or activity
- Extra 2 hours a week
- Additional advising from Merit Director and Merit TAs
## URM outcomes, Calculus, F2007-F2010

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>All Students (2152)</th>
<th>Merit URM (137)</th>
<th>Non-Merit URM (215)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>519 (24.12%)</td>
<td>32 (23.36%)</td>
<td>32 (14.88%)</td>
</tr>
<tr>
<td>B</td>
<td>626 (29.09%)</td>
<td>51 (37.23%)</td>
<td>39 (18.14%)</td>
</tr>
<tr>
<td>C</td>
<td>538 (25.00%)</td>
<td>26 (18.98%)</td>
<td>56 (26.05%)</td>
</tr>
<tr>
<td>D</td>
<td>263 (12.22%)</td>
<td>16 (11.68%)</td>
<td>45 (20.93%)</td>
</tr>
<tr>
<td>F</td>
<td>157 (7.30%)</td>
<td>8 (5.84%)</td>
<td>33 (15.35%)</td>
</tr>
<tr>
<td>CR</td>
<td>8 (0.37%)</td>
<td>2 (1.46%)</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>25 (1.16%)</td>
<td>2 (1.46%)</td>
<td>5 (2.33%)</td>
</tr>
<tr>
<td>AB</td>
<td>15 (0.70%)</td>
<td></td>
<td>5 (2.33%)</td>
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</table>

| A/B          | 1145 (53.21%)       | 83 (60.58%)     | 71 (33.02%)         |
| D/F/NC       | 445 (20.68%)        | 26 (18.98%)     | 83 (38.60%)         |

| Course GPA   | 2.51                | 2.62            | 1.94                |
| Math ACT     | 29.26               | 26.99           | 26.6                |
| Comp ACT     | 27.86               | 25.66           | 25.5                |
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MIST: Use Merit to increase STEM Degree Declarations

Undeclared Merit students declare STEM majors at a significantly higher rate than non-Merit students.

(Data collected before much of cohort 3 declared)
Illinois Geometry Lab — Research

- [http://math.uiuc.edu/igl/](http://math.uiuc.edu/igl/)
- Teams of 2-4 undergraduates, a graduate leader, and faculty mentor, work on semester-long research projects
- 37 undergraduates, 12 graduate students, and 12 faculty working on 12 projects this semester
Illinois Geometry Lab — Outreach

• Outreach activities to local schools and community groups
• Local schools, farmer’s market
• AAAS in Chicago
• ChiPrep
• PRIMES-USA
• Reached thousands of students in just three years
• Internships
• Sponsored projects
Illinois Geometry Lab — Lessons and challenges

• Enormous potential for outreach: need personnel
• How to scale to our math major (~180 students/year not including actuarial science)
• Need ideas and mentors for projects
• Remove requirements from major?
• Postdocs?
• Corporate sponsors?
Graduate program

- PI4 (https://pi4.math.illinois.edu)
  - Internships
  - Embeddings
  - Boot camp
New initiatives

• Revise applied linear algebra course
  – Active learning
  – Big matrices
  – Collaboration with CoE
• Brief videos for large calculus courses (incorporated into Webassign)
• Concept inventory and pre- and post-testing
• Undergraduate research for actuarial science
• Careers and internships
Acknowledgments and comments

Projects here represent huge amount of work and dedication by U of I personnel

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- Jennifer McNeilly
- Lee DeVille, Zoi Rapti, James O'Dwyer
- Philipp Hieronymi, Luke Olson, Matthew West
- Alison Reddy
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• Projects here represent huge amount of work and dedication by U of I personnel
• We are not unusual
• Many, indeed many of you, are ahead of us on many of these projects and themes
Thank you!

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