



# Helping students do mathematics

A field report from one large  
public university

UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN



[illinois.edu](http://illinois.edu)

## First, about the scale and nature of the enterprise

- 1,000 undergraduate majors
- 22,000 student classes in 2013-2014
- Enrollment up 25% since 2007
- Undergraduates in College of Engineering up 40% 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



## First, about the scale and nature of the enterprise

- 1,000 undergraduate majors
- 22,000 student classes in 2013-2014
- 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



# Projects

- Engineering calculus project
- Active learning in large courses
- Merit program
- BioMath
- Illinois Geometry Lab
- Placement
- New initiatives



## Engineering calculus: chair's eye view

- 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 8 senior faculty have participated



## 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 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





## Merit program

- <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



# Merit vs non-Merit, Calculus F2007-F2010

Letter Grade	All Students (2152)		Merit (357)		Non-Merit (1795)	
A	519	24.12%	92	25.77%	427	23.79%
B	626	29.09%	126	35.29%	500	27.86%
C	538	25.00%	82	22.97%	456	25.40%
D	263	12.22%	36	10.08%	227	12.65%
F	157	7.30%	10	2.80%	147	8.19%
CR	8	0.37%	5	1.40%	3	0.17%
NC	25	1.16%	6	1.68%	19	1.06%
AB	15	0.70%			15	0.84%
A/B	1145	53.21%	218	61.06%	927	51.64%
D/F/NC	445	20.68%	52	14.57%	393	21.89%
Course GPA	2.51		2.74		2.47	
Math ACT	29.26		28.04		29.51	
Comp ACT	27.86		27.01		28.67	



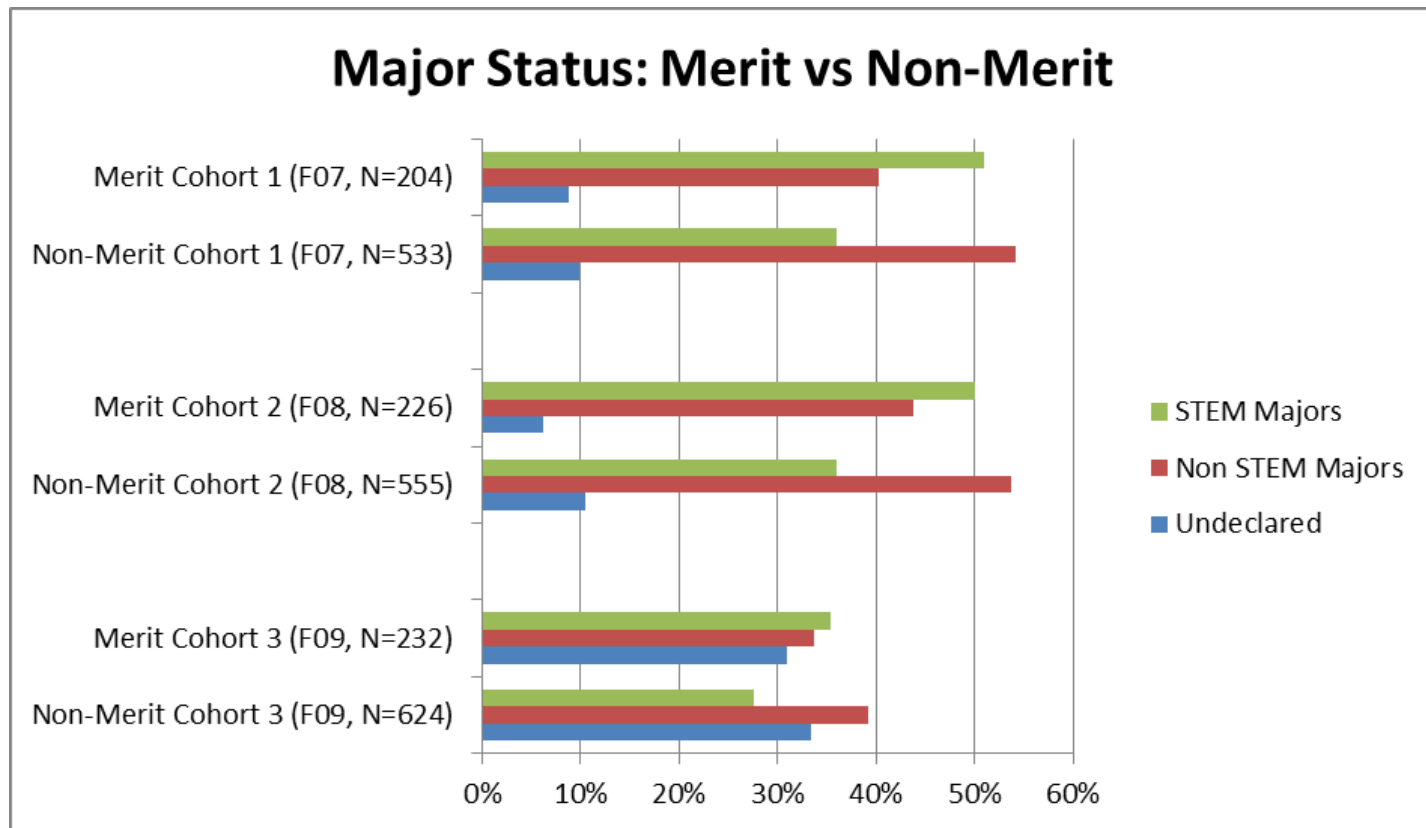
# URM outcomes, Calculus, F2007-F2010

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



# MIST: Use Merit to increase STEM Degree Declarations

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



# BioMath

- <http://www.math.uiuc.edu/biomath/>
- Collaboratively taught
- Project based
- NSF funding supports summer research (until 2015)
- Merit workshops replace regular discussion section
- Led to NSF-funded research collaboration by faculty members involved





## Illinois Geometry Lab — Research

- <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 (~160 students/year not including actuarial science)
- Need ideas and mentors for projects
- Postdocs?
- Corporate sponsors?





# Placement

- <http://www.math.illinois.edu/ALEKS/index.html>
- ALEKS to help connect students with course where they can succeed
- 70K assessments since Fall 2007
- DFW rate at 20% for Calculus I



## Graduate program

- PI4 (<https://pi4.math.illinois.edu>)
  - Internships
  - Embeddings
  - Boot camp
- Green-yellow-red



## New initiatives

- First-year mathematics and statistics courses for life science majors (with biology faculty)
- 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



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- Alison Reddy



## Acknowledgments and comments

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Thank you!

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