Mentoring and student success

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November 15, 2014
Mentoring and Community Building are important tools to help underrepresented students succeed in graduate school.

- The alliance of "doctoral studies the mathematical sciences" has built an extensive constantly growing community and excels in this.
- Has helped to place students in the right graduate programs where they could exceed.
- Problem: Mentoring alone is not enough to help underprepared students succeed. They often get burned out from taking (catchup) courses too long and leave with a masters degree.
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Goal and Observations

Goal: Promote Mathematics as a career choice for American students, especially underrepresented groups, and help them succeed.

Observations:
- American students don’t specialize early. Only the most dedicated choose math early enough to be noticed compared to foreign students.
- Studies have shown that especially women and minorities decide late in their undergraduate studies to become math majors. Consequently, they often lag behind.
- Plenty of other talented American students are out there. We need a way to bring them to our programs and get them up to speed.
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Main Ideas

- Motivate students with potential.
- Get and maintain student excitement about mathematics.
- Build a community of mathematicians.
- Retention.
- Modernize Curriculum!
- Attract and retain good US students (perhaps initially on paper not the "best" students, but students with the same potential as those that are better prepared).
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- **REU**: Modeling and Industrial Applied Mathematics (funded by NSF and NSA)
- **REU+**: Research and enrichment experience for under-represented undergraduate students (funded by NSF and NSA)
- **REG**: Research Experience for Early Graduate Students (funded by NSF)
- Summer Research Experience for Early NCSU Graduate Students (some participate in projects of the REU program).

Academic year programs:
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Post-baccalaureate program (REG+):

- REG+ enables students to catch up, build confidence and become part of a community.
- 100% of REG+ students became PhD students and are making good progress towards their PhD.
- All participants underrepresented students (women and URM) whom would otherwise not have pursued graduate education in math.

Research Scholars Program

- Provides students with less preparation a cohort, extra time (reduced TA duties) and mentoring until they pass the qualifying exams.
- Get at least one early research experience (often two). Applied students get co-mentors from industry or national labs.
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Data from 2014 Summer program

- Total: 78 students participating in summer research institute (48 students in the combined REU/REU+/REG and 30 NCSU first year grad students)

  - Mentors for REU/REU+/REG: 14 NCSU Faculty, 14 senior graduate students, 2 faculty from HBCU’s, 1 counselor.

  - Mentors for Summer Research Experience for Early NCSU Graduate Students: 21 NCSU Faculty.

  - 12 African American Students from partner HBCU’s and 1 Hispanic, student

  - 50+% women each year

  - 22.5% were planning or in grad school before program, 98% planned grad school after program.
Details and Data

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Key features of all programs

- Give the students the experience and excitement of doing real mathematical research.
- Build a community of mathematicians. Both peers and vertical. (live together, friendly accessible faculty/grad students, events, activities)
  - A cohort for peer support throughout their careers.
  - Students not that far above them/ below them to inspire and aspire.
- Supportive environment.
- Grad students learn to be mentors, they improve their own ability as researchers by having to think about helping others. (Like learning calculus by teaching it)
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2014 REU Projects

- Mathematical Phylogenetics and the Space of Trees
- Computational Modeling for OCT Imaging of the Human Eye
- Multiple Beam, Permanent Magnet Focused Klystrons for the Next Generation of High Energy Accelerators
- Physiologically Based Pharmacokinetic Modeling for Acetone: How Much Do We Really Breathe In?
- Generalized Symmetric Spaces and Their Applications
- Counting the Number of Real Roots of Random Polynomials
- Mean-Variance Portfolio Optimization and Black-Litterman Model
- Geometric Flows of Plane Curves
- Parameter Selection and Model Reduction Techniques for Uncertainty Quantification in Large-Scale Models
- Data and Cluster Analytics
- Modeling the Interaction Between Autonomic Neural Regulation and Inflammation Using Pre- and Postoperative Data from Hip and Knee Replacement Surgery
- Computational Modeling of the Thyroid Hormones Hemostasis and its
Examples of REG Projects for NCSU first year grad students

- A Comparison of Nonlinear Filtering Approaches in the Context of an HIV Model
- Inverse problems for cell proliferation models using noisy data
- L-infinity Structures
- The Hopf Algebra of Twisted Baxter Permutations
- Numerical Modeling of a Resonant Tunneling Diode
- Models of Drug Epidemic and Prevention
- Stability of Relative Equilibria of LR Systems
- Symbolic-numeric Solution of Polynomial Systems
- Model of the Female Reproductive System
- Hamel Equations and Hamilton-Pontryagin Principle
- Decomposition of Positive Definite Matrices
- Optimal Pipe Sizes and Water Treatment Plant Expansion: Public Utilities
Specific features for minority students (REU+)

- Accept capable though underprepared underrepresented students.
- 2 week ramp up course before the project begins.
- HBCU mentors participate in ramp up program.
- Totally integrated into regular REU program.
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Specific benefits for early graduate students

Grads doing early research:

- Early grad students doing research early reminds them why they went to grad school, gives them a chance to test out areas/faculty.
- A more social research experience
- Leads to earlier advisor selection, shorter time to degree (ave. 5.1 years), better overall retention (96% for students participating in REG)
- Builds confidence that they can do research and should be mathematicians.
- Strengthens ties between current cohort of early graduate students (community building)
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More than 90% American students.
- Recruit from REU, smaller colleges and universities, take capable though underprepared students.
- Make undergraduate classes available without stigma
- Variable time to qualifying exams
- Good mentoring

Community building.

Early research experiences

Modern curriculum and flexible qualifying exams. (15 possible, must take 3)
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207 graduate students, of whom 142 are PhD (131 US), 65 MS (mostly Financial Math. Professional Masters Degree).

83 TA lines, remaining PhD funded by RA or fellowship. Guarantee 5 years funding, (more as needed).

56 tenure track faculty.

50+% women PhD students admitted for at least the last 9 years.

Currently 19 African American PhD students and 2 Hispanic. Each year since 2004, 1-3 African Americans earned a PhD in Math at NCSU. (This is 12% of all AA PhD's at group 1 or 2 universities).

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Retention rate at 3 years was 72%
Current rate 96%
5 year completion rate was 56%
Current rate 83%
6 year completion was 65%
Current rate 93%
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207 graduate students, of whom 142 are PhD (131 US), 65 MS (mostly Financial Math. Professional Masters Degree).

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Costs and Obstacles

- **New admissions profile.**
  - Additional attention needed by faculty towards students. (REU mentors, REG mentors, more interaction with early grad students, more POSITIVE interaction)

- Faculty buy in.
  - Students seem to need support and encouragement, but when we give it they excell!

- Need key faculty on board to help convince others. The results are apparent.

- These new interactions with students are fun!

- Easier than supervising an individual grad student (teams help each other).

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