

Supporting Women and People of Color in Graduate Mathematics



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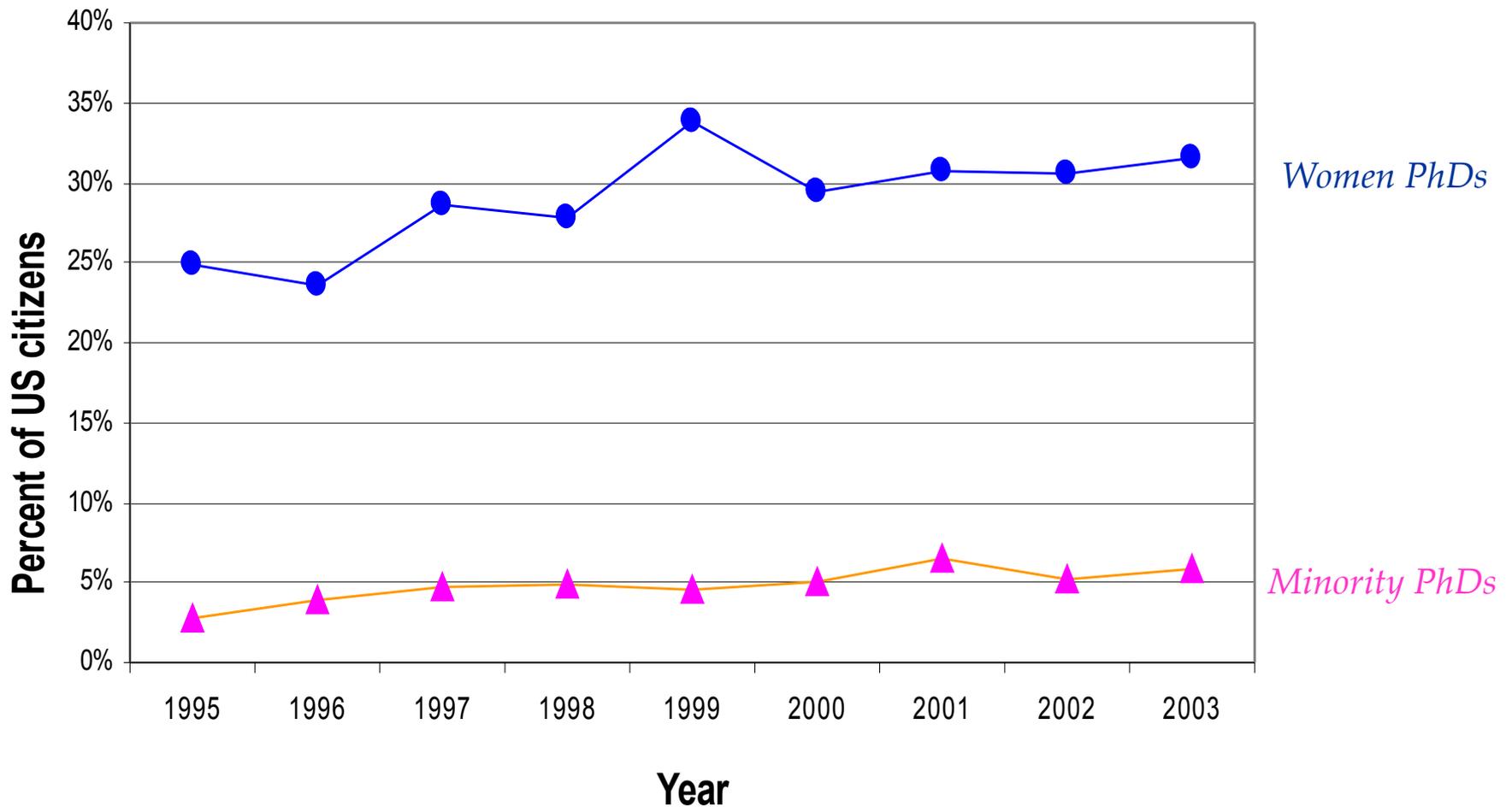


Women and people of color in mathematics

1994	Bachelors	47% women
1994	New full-time graduate students	35% women
1996	Masters	40% women
2000	Ph.D.	27% women
2000	Full-time faculty	22% women



Women and people of color in mathematics





Women and people of color in mathematics

In 2003,

- Women earned 42% of bachelors degrees and 30% of doctorates.
- Women comprised 30% of full-time graduate students, and 33% of full-time first-year graduate students.
- Women received 20% of new faculty positions (18% of tenure track positions).
- African Americans, Native Americans, and Latinos combined earned 9% of doctoral degrees awarded in mathematics.



The “problem” of gender and race

For several decades, researchers have studied the under-participation of women and students of color in all levels of mathematics,

- through investigations of the nature and extent of differences among students of different genders, races, and ethnicities,
- in terms of achievement, attitudes, strategy use, choice, and persistence.

This work has led to explanatory models and interventions. As a result,

- we better understand the complexities of issues of gender, race, and ethnicity,
- and the differences are smaller.

But the differences still remain.



The “problem” of gender and race

The risk of this work was the development of a “deficit model”:

It contributed to a discourse that “girls can’t do math” or “people of color can’t do math.”

Interventions were needed to “fix” the students.

The focus was on students and their differences, not on the social, political, institutional, economic, and other systemic forces at play in education.

Mathematics is assumed to be a meritocracy.

Talent and determination are considered to be necessary and sufficient for success in mathematics.

Mathematics is considered to be “pure”, “objective”.

This has led to a blindness to the impact of personal, social, or political factors on the learning of mathematics.



The Critical Question

Small *numbers*, together with beliefs in *talent* and *objectivity* support the notion that some people do not have “what it takes” to succeed in mathematics.

What does it take to succeed in advanced mathematics study?



Learning Graduate Mathematics

Graduate study as apprenticeship:

- Apprentices learn by participating in the **authentic** work of the craft.
- Apprentices learn through their **interactions** with the master craftspeople.

Through apprenticeship, novices:

- learn the craft.
- learn to act the part of craftspeople.
- develop a sense that they are important and active participants in the craft.

In mathematics, this means that a graduate student needs to:

- learn to do mathematics.

Think like a mathematician

- learn the norms, practices, and other tacit knowledge of the discipline.

Act like a mathematician

- develop an identity as a mathematician (or mathematician-in-training).

Feel like a mathematician

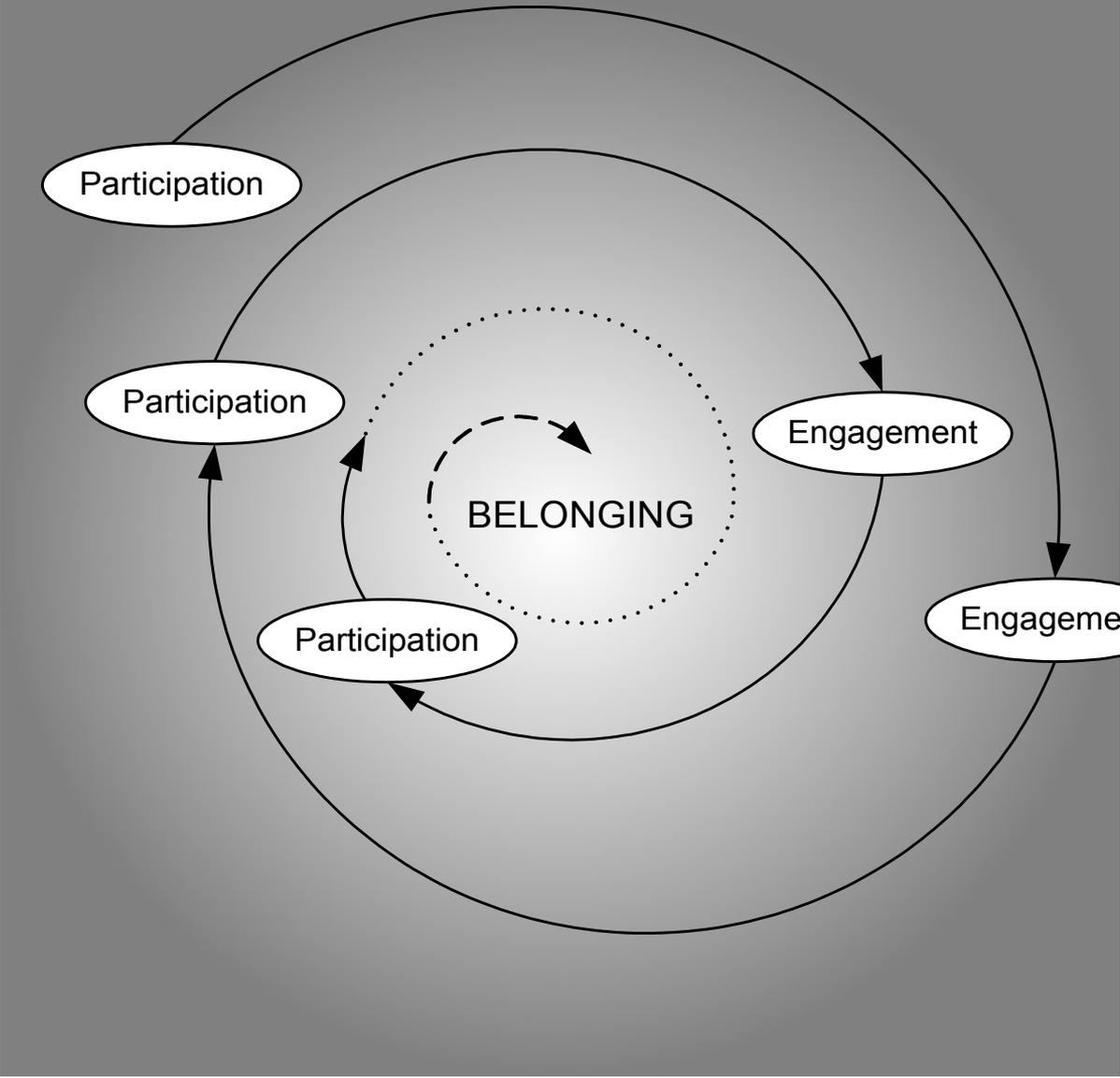


Supporting Student Learning

Learning mathematics requires more than just acquiring mathematical knowledge.

Effective graduate training entails three dimensions of learning:

- Learning mathematical content
- Participating *with more experienced mathematicians* in the practices of mathematics
- Developing a mathematical identity or sense of belonging





Thinking Like a Mathematician

Learning the content of mathematics:

- Concepts, theorems, results, methods, etc.



Acting Like a Mathematician

Participating in the *practices* of mathematics:

- Problem solving
- Accepted methods for writing and presenting results
- How to do research
- Collaborating in research
- Writing papers
- Giving talks
- Participating in conferences
- Teaching
- Applying for grants
- Preparing for tenure
- Balancing life in and out of mathematics
- Etc.



Feeling Like a Mathematician

Building students' sense of *belonging* in mathematics has been proposed as a critical feature of an equitable K-12 education.

At the doctoral level, students' involvement or *integration* into the communities of their departments is important for their persistence.

Students who have multiple avenues to develop a sense of belonging have been found to be more likely to persist.

An identity as a mathematician, a sense that "I belong here," is critical in the persistence of graduate students.



Obstacles to Belonging

Many graduate students face obstacles to belonging in mathematics:

- Harsh “weed-out” practices and competition
- Pedagogy
- Limited relationships with faculty



Obstacles to Belonging

Women and people of color face additional obstacles:

- Lack of role models
- Discrimination in finding mentors
- Being marginalized, treated as “invisible”
- Not “real” mathematicians, not “real” women
- Isolation in a (mostly-white) male-dominated environment
- Blatantly sexist and racist behavior
- Conflicting demands of family and school
- Difficulty identifying with “mathematical people”
- The burden of having to prove their worth
- Limited educational opportunities

Building Belonging

Some antidotes to these obstacles to belonging:

- Community with other students, within and across departments
- Meaningful, mentoring relationships with faculty
- Flexible scheduling and policies to accommodate the full lives of people with family, community, and other responsibilities
- Role models (e.g. women speakers)
- Zero tolerance for discriminatory behavior
- The importance of “critical mass”
- Explicit information about expectations and requirements, and equal access to resources to meet those expectations.

Many of these ideas also support the learning of mathematical content and practices.



What Others are Doing

In December 2006, the American Institute of Mathematics hosted the workshop

Finding and Keeping Graduate Students in the Mathematical Sciences

The workshop brought together experts with a record of success in recruitment and retention with teams of 2-3 leaders in graduate education from 8 mathematical sciences departments.



The Workshop

The workshop was organized around 3 general themes:

- *Recruiting* applicants, admissions policies and practices, and recruiting admitted students to enroll;
- *Supporting* students as learners and as people; and
- *Mentoring* the development of professional mathematicians.



Outcomes

Other themes identified during the workshop:

- The importance of *mentoring* and other meaningful, sustained relationships between students and faculty.
- *Building community* among graduate students and between students and faculty, to help students become integrated into the program, thus enhancing their learning and their progress.
- Involving students in *authentic mathematical activities*.



Outcomes: Recruiting and Admissions

- Exploit existing networks and develop new networks with targeted schools (in particular, minority-serving institutions) for recruiting talented undergraduates.
- Develop internal and external resources to increase stipends for offers to new students.
- Re-think reliance on the GRE and other traditional measures admissions. *Distinguish between prior performance and opportunity and future promise.*
- Involve graduate alumni, current graduate students, and faculty as recruiting ambassadors.



Outcomes: Recruiting and Admissions

- Implement a recruiting weekend for admitted students to learn about the graduate program.
- Show the range of people who participate in mathematics and the range of mathematics they do.
- Make it clear that diversity is valued.
- Establish a faculty-led Diversity Committee.
- *Keep all of these goals in mind when selecting members of faculty admissions committees.*

Outcomes: Supporting Students as Learners and as People

- *Communicate an expectation of success, rather than one of failure.*
- Provide peer and faculty mentoring to all students. Hire advanced graduate students to mentor new graduate students.
- Hire advanced graduate students, or use other means, to help students prepare for preliminary or qualifying examinations.
- Modify program requirements to correspond to educational objectives.
- Invite speakers, particularly women and people of color, to give talks that are accessible to all graduate students, and to interact with current students.

Outcomes: Supporting Students as Learners and as People

- Send students to conferences and help them prepare to present research results.
- Allow students more time, mechanisms, and support to master the basics, as appropriate.
- Provide graduate students with early research experiences, with faculty as mentors.
- Provide students with opportunities to get involved in the work of the department and mathematics community more broadly.



Outcomes: Supporting Students as Learners and as People

- Organize problem sessions for first-year graduate courses, led by faculty or advanced graduate students.
- Select instructors of first year courses carefully, and discuss expectations.
- Sponsor social events to encourage students and faculty to interact as people.
- Create a Faculty-Student Advisory Board.

Outcomes: Mentoring the Development of Mathematicians

- Interact closely with students to learn about their experiences in the program. Find out when mentoring fails and why.
- Help faculty explore the meaning of mentoring. Train advisors and mentors, and discuss expectations and strategies.
- Build an infrastructure for mentoring.
- Develop a principled (rather than random) way to match students with mentors.
- Monitor students' progress and provide feedback throughout the program, and provide mentoring and support when necessary.

Outcomes: Mentoring the Development of Mathematicians

- Create an Advising Committee for first year students.
- Select faculty carefully to be advisors and “coaches” for incoming graduate students.
- Prepare graduates to maintain a level of intellectual activity should they go to a 4-year institution, by bringing back alumni speakers who have done this.
- Provide mentoring and training for teaching. Involve students in teaching advanced undergraduate courses.
- Provide internships for students to learn about working in industry.



What Next?

- There are ample existence proofs that diversity can be built and sustained in graduate programs with high expectations of all students.
- We need to enhance communication among leaders in mathematics education, and with students, about what works and how.
- It takes commitment on the part of dedicated leaders who will not tolerate racism, sexism, or other obstacles to the development of talented mathematicians.



What Can Students Do?

Look for welcoming programs in which you are expected to succeed.

Find, build, sustain intellectual and other communities.

Learn about and take advantage of all available resources.

Learn the explicit and implicit (unstated?) expectations and requirements for success in your program.

Speak up about racism, sexism, and inappropriate behavior.

Form study groups.

Mentor and support other students when you can.

Find and sustain relationships with mentors.



What Can Faculty and Policymakers Do?

Identify institutionalized inequities and obstacles and work to remove them.

Maintain a zero-tolerance attitude toward racism, sexism, nationalism, and other forms of discriminatory behavior—overt and covert, intentional and unintentional.

Build educational channels for students of underrepresented groups across the educational pipeline, from K-12 education through the professoriate.

Examine and build *educational* models that aim to help all students learn mathematics (*content, practices, and identity*) to the best of their abilities.

Make explicit efforts to help all students feel included in the communities and practices of the department, program, and discipline.

Structure graduate study to accommodate the lives of *people* with full and complex lives and commitments.

What Can Faculty and Policymakers Do?

Attend the workshop

Finding and Keeping Graduate Students in the Mathematical Sciences

American Institute of Mathematics

August 2-5, 2009.

Check www.aimath.org for more details.

Supporting Women and People of Color

- Her job as an educational researcher is to research what educational programs, initiatives are useful to minorities and women
- Deficit theory – We use white males as the standard. We judge others by that standard. We want to raise other races and women to do everything the same way as white men, which says that there is a deficiency in those groups, not a deficiency in the problem
- The focus has been on fixing students, not fixing the broader problem
- Studies about what apprenticeships are: 1) authentic work of the craft – actually do the work, not just observe, 2) start at periphery and work way to details, 3) learn through interactions
- We don't put emphasis on "feeling" what a mathematician is like. RAUs do that. Sometimes we need to look at the pedagogy; some have teaching styles that don't excite. In large institutions, there is limited chance to interact with professors until after qualifying exams.
- Belonging- sometimes minorities and women don't have access to resources that are shared in informal communication, ie. Over a beer, over a game of basketball
- What is difference between mentor and advisor? Mentor involves sustained meaningful relationship
- In recruiting and admissions we need to build bridges between networks, especially between undergrad and graduate schools. When we have relationships between two, then letters of recommendation would come from people who know about the requirements of a specific institution and could speak to that.
- Flexibility - Importance of undergraduate involvement – RAUs, allow students to attend conferences and let them speak; give graduate students more time to complete core requirements.
- In recruiting, many times departments say that applicant pool for minorities and women are limited. Consider the athletic model. In athletics, you identify talent in the lower grades and follow them, finding ways to develop them and keep in touch.

Q&A

- AMS and AMA can disseminate information about programs that are in place that work in recruiting and keeping underrepresented students
- www.a.mathorg/gemstones - great resource