NSF INCLUDES: WATCH US

Women Achieving through Community Hubs

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WATCH US is a nationwide Design & Development Launch Pilot focused on understanding and scaling programs that successfully broaden participation of women in the mathematical sciences.

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WOMEN ACHIEVING THROUGH COMMUNITY HUBS IN THE US

SOCIAL SCIENCE RESEARCH PARTNERS

University of Nebraska – Lincoln

Department of Sociology
http://soc.unl.edu/

Social and Behavioral Sciences Research Consortium (SBSRC)
http://sbsrc.unl.edu/

Bureau of Sociological Research
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Research Question

1) Which elements of enrichment programs/conferences in mathematics are critical to the success?
2) Do programs work differently for women of color or for first generation women than for majority women?

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The Study

To better understand how programs work to recruit and retain women into advanced degrees in the mathematical sciences, we compiled and collaborated with six successful conferences and programs who have collectively served more than 5,000 participants over the span of 20 years. The six pograms are:

1. Carleton College Summer Mathematics Program for Women (SMP)
2. Nebraska Conference for Undergraduate Women in Mathematics (NCUWM)
3. The EDGE (Enhancing Diversity in Graduate Education) Program
4. Smith College Center for Women In Mathematics Post-baccalaureate program (CWM)
5. The Women and Mathematics program (WAM) at the Institute for Advanced Study
6. The Infinite Possibilities Conference (IPC)

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Mixed Methods Research

For the WATCH US research study, both an internet survey and in-depth interviews were conducted in February – May 2017

Concurrent Triangulation

Characterized by: Two or more methods used to confirm, cross-validate, or corroborate findings within a study. Data collection is concurrent.

Purpose: Generally, both methods are used to overcome a weakness in using one method with the strengths of another.

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Sample Frame

Table 1. Six Program Program Sample Frame for Quantitative and Qualitative Study

	SMP	NCUWM	EDGE	CWM	WAM	IPC	
Years	'04-'08	'03-'08	'06-'11	'08-'12	'04-'08/ '08-'11	'05, '07/ '10, '12	Total
Sample Program Participants	**67**	**937**	**69**	**51**	**148**	**259**	1531
Post-Bacc/Grad School	0	0	69	51	71	54	245
Undergraduate	66	937	0	0	77	51	1131

- A total of 1531 past program participants were identified
- Programs varied in size, duration, and target population education level.

**A detailed methodology report on is available @ WomenDoMath.org*
https://www.womendomath.org/wp-content/uploads/2017/06/INCLUDES-WATCH-US-Methodology-Report-Final.pdf

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Quantitative Survey Respondents

Table 2. WATCH US Survey Respondent Demographics by Program							
	SMP	**NCUW**	**EDGE**	**CWM**	**WAM**	**IPC**	**Total**
Total Participants	**33**	**66**	**22**	**23**	**38**	**16**	**198**
Demographics							
% Race/Ethnic Minority	3%	11%	23%	17%	13%	94%	19%
% First Generation College	6%	30%	9%	17%	21%	38%	21%
Average Current Age	31	33	30	31	33	36	32
Degree							
PhD Mathematical Sciences	18	21	11	13	26	7	96
MS Mathematical Sciences	4	8	4	3	3	2	24
Total	**22**	**29**	**15**	**16**	**29**	**9**	**120**

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Qualitative Interview Respondents

Table 3. Program Participation Interview Sample

	SMP	NCUWM	EDGE	CWM	IAS	IPC	Total	Percent
Primary Program Interview	10	4	11	8	11	11	55	-
*Secondary Programs**							*12(2)*	25%
SMP		*3*		*1*	*1*		*5*	-
NCUWM					*1*	*1*	*2*	-
EDGE		*2*			*1*		*3*	-
CWM						*1*	*1*	-
IAS	*1*	*2*				*1*	*4*	-
IPC		*1*	*2*		*1*		*4*	-
Total Program Participants with duplicates	*11*	*12*	*13*	*9*	*15*	*14*	*74*	-
Underrepresented Minority								
First Generation College Attendee	0	1	2	1	2	4	10	18%
Woman of Color	1	1	2	2	1	11	18	33%
Educational Outcomes by Program	SMP	NCUWM	EDGE	CWM	IAS	IPC	Total	Percent
Never attended or Dropped out of Graduate School in Mathematics	2	0	0	1	1	0	4	7%
Math or STEM, MA Terminal Degree	3	3	2	1	4	4	17	31%
Math PhD Student	1	0	2	4	0	1	8	15%
Math Phd	4	1	7	2	6	6	26	47%

**2 participants attended 3 programs. Primary program was SMP and IPC, both also attend IAS and NCUWM*

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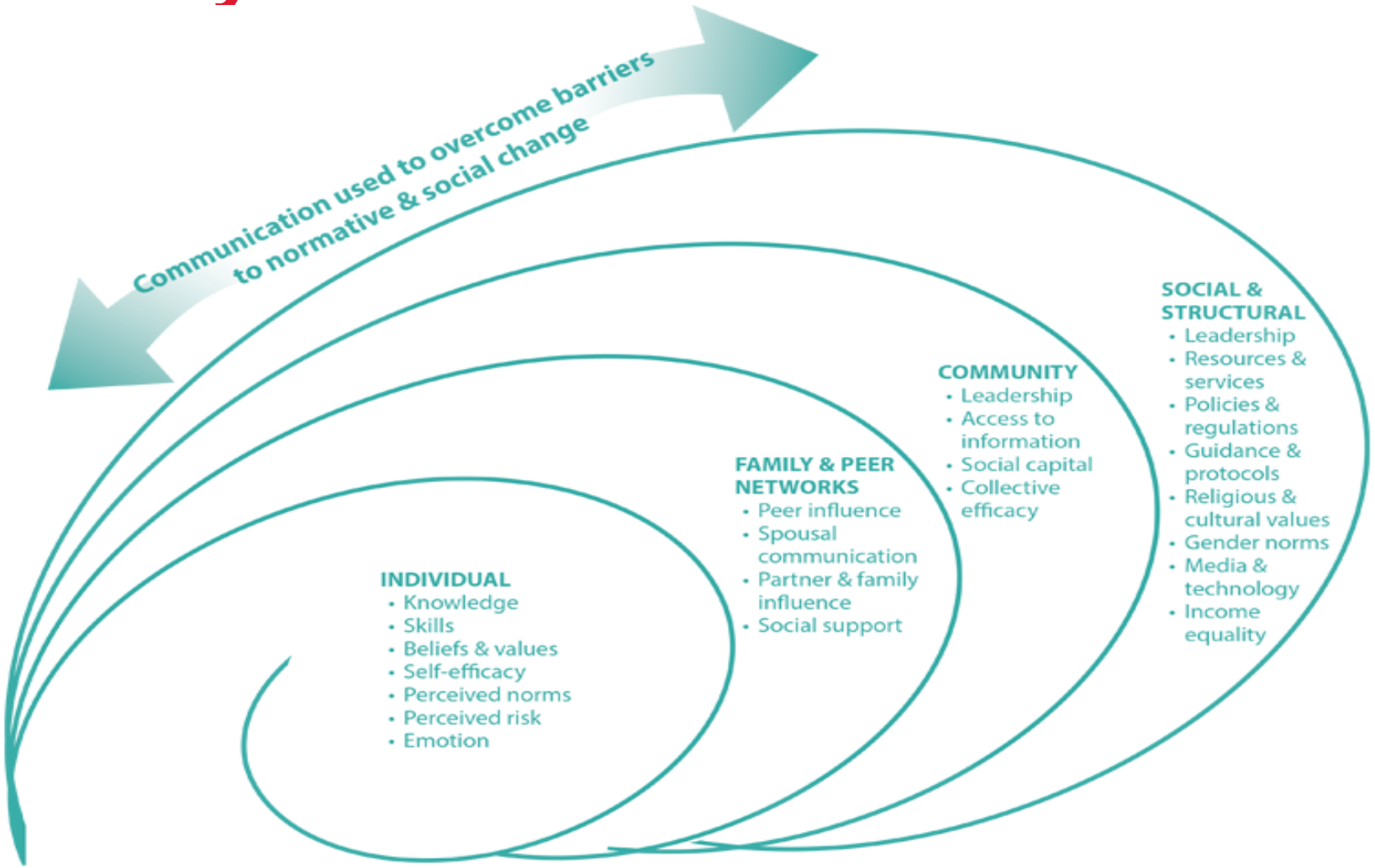
Theory: Gender as Social Structure



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Gender as Structure – Multiple Levels

Level	Mechanism
Individual	Confidence gap Biased self assessments
Interactional/ Interpersonal	Friendship networks Mentorship Discrimination Social isolation Implicit Bias
Social and Structural	Organization Policies Procedures Culture Organization

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RESULTS

Level	Social Process	Program Results
Individual	Confidence gap Biased self assessments	???
Interactional/ Interpersonal	Friendship networks Mentorship Discrimination Social isolation Implicit Bias	???

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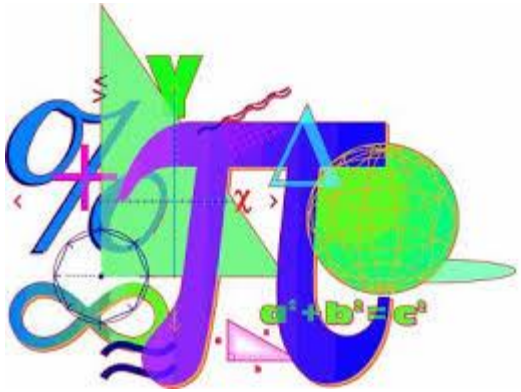
Survey Results



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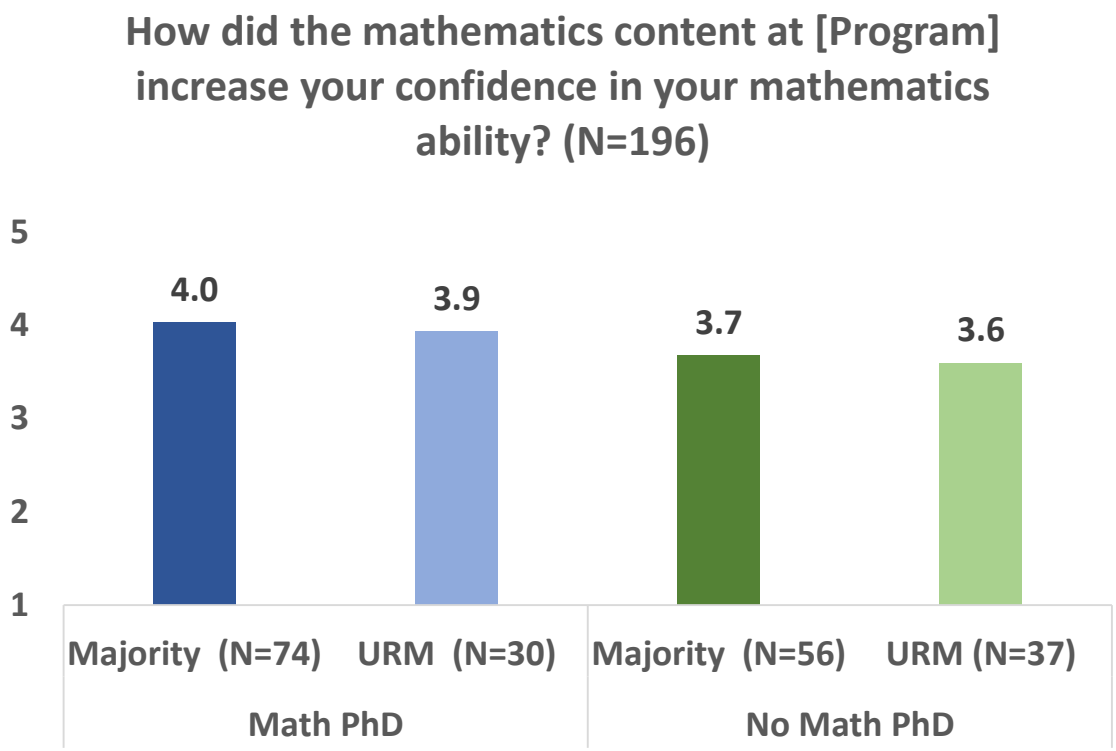
Confidence is associated with increased persistence towards an advanced degree in the mathematical sciences



1-5 = Greatly decreased the likelihood - Greatly increased the likelihood.

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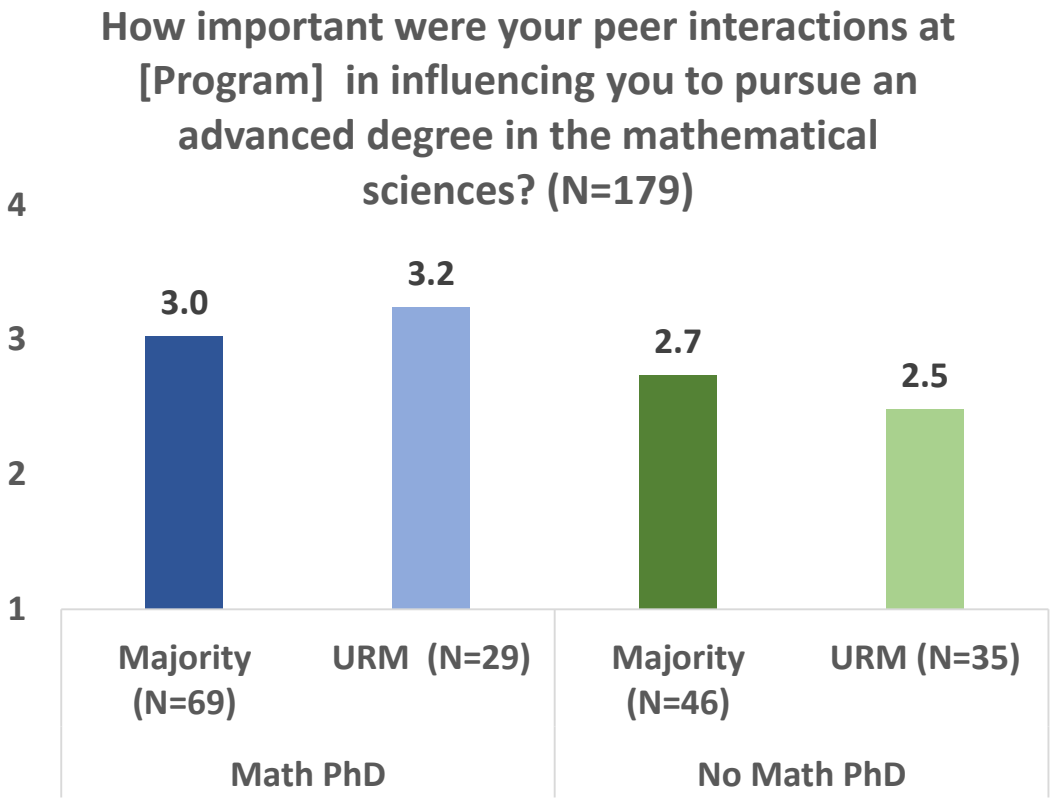
Peer interactions within programs and conferences are associated with persistence towards an advanced degree in the mathematical sciences, and are particularly crucial for URM women.



1- 4 = Not Very Important - Very Important

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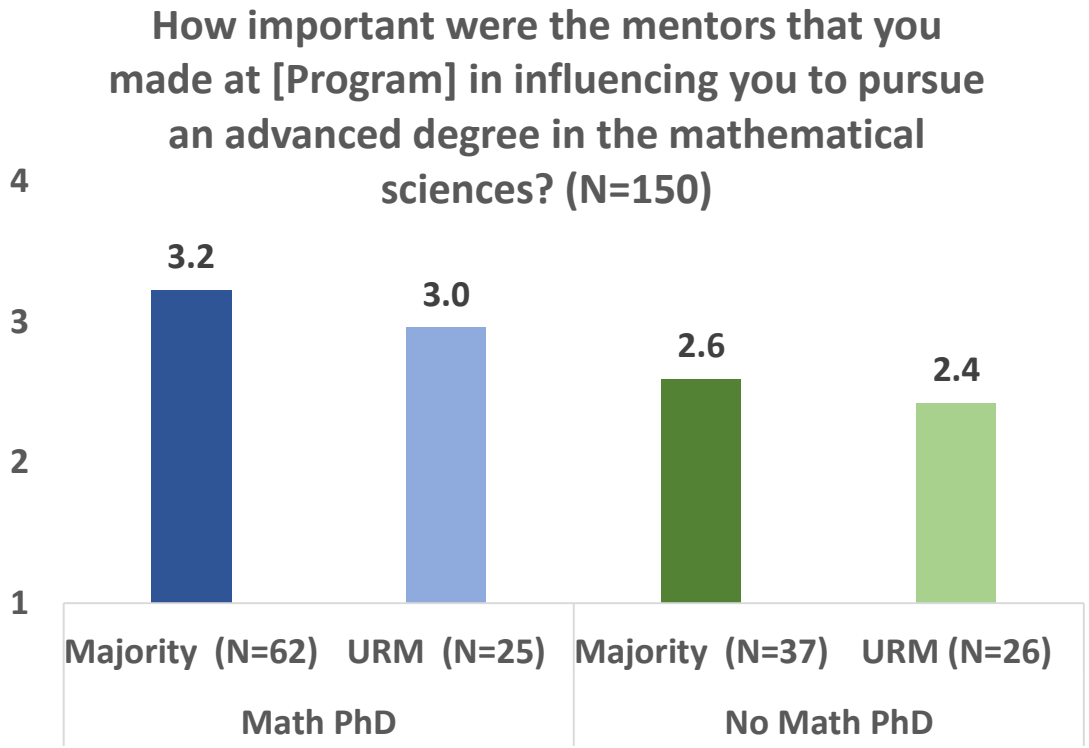
Mentors were key to persistence toward and advanced degree in the mathematical sciences, this is where the largest difference was between those who persisted to a PhD in the mathematical sciences and those who did not.



1- 4 = Not Very Important - Very Important

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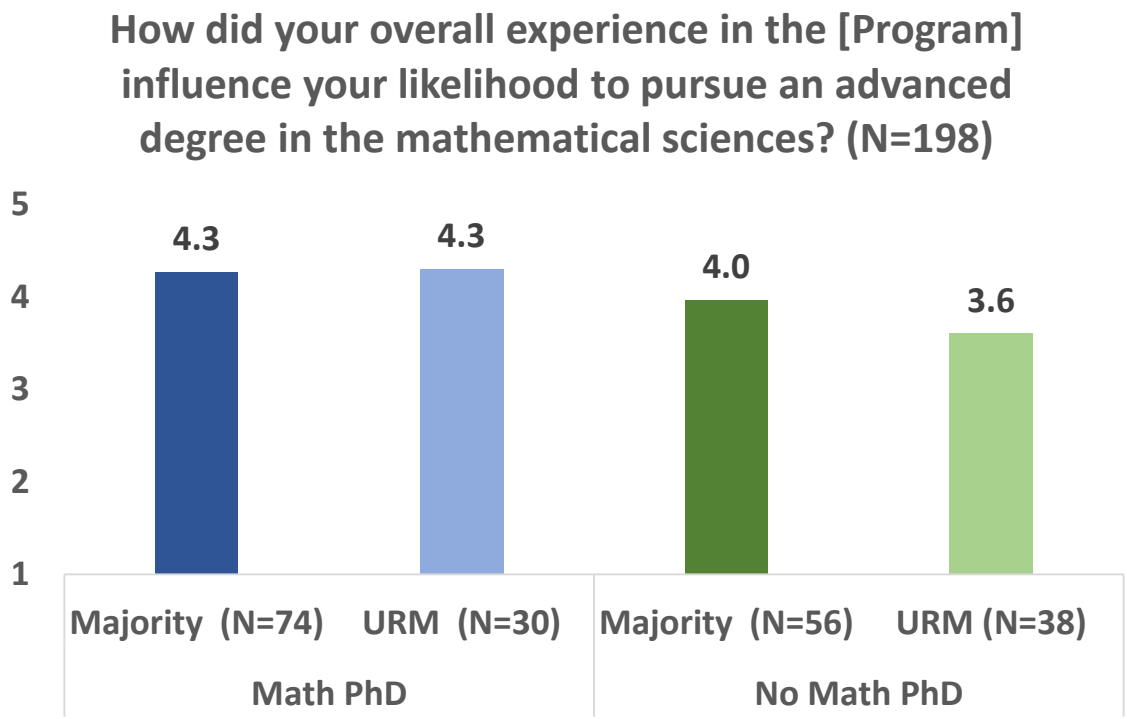
Enrichment programs and conferences for women in the mathematical sciences work.



1-5 = Greatly decreased the likelihood - Greatly increased the likelihood.

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Interviews revealed that programs work simultaneously at the individual and interactional levels.

At the Individual level – Programs and conferences provide access to mathematical content and cutting edge research that:

- challenges and rewards participants resulting in increased confidence.
- broadens views of mathematics research and how it is relevant to their future. and to peoples' lives.
- allows participants to explore and envision new career paths.

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Programs and conferences provide access to mathematical content and cutting edge research that:

Challenges and rewards participants resulting in increased confidence

"[The program] impacted my confidence and led me to pursue a research experience for undergraduates and all of those extra activities . . . that helped me stand out after undergrad. It definitely improved my confidence and perseverance because it was so challenging and I had to work very hard and that continued in other courses that I was taking later on."

"It was kind of my very first conference in a sense. I had never attended anything like that before and it made me feel important to go to a conference and it boosted my confidence and made me excited to go to more conferences and events like that."

"It was a really big deal for me. It was inspiring to be around amazing people. I definitely came back to school excited and motivated. It put me ahead in terms of course work. big confidence booster and I learned a lot. Most of all, the excitement and motivation to learn more in depth about things I was excited and interested in. Helped me figure out what I want to do after undergrad.

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Programs and conferences provide access to mathematical content and cutting edge research that:

Helped women find an area of research that interested them

"[The Program] made a huge difference. I didn't know which area of math I wanted to be a part of. After the conference, I knew I wanted to have an emphasis in statistics. It was an eye opener to see all the paths you can choose. I saw the ability to use skills in math to help people. Having a close network of women who look like you and who are doing the same things as you. It broadened my mind about all the possibilities of what you can do with math."

"It made it more attractive than before because I was introduced to new fields that were more interesting and I got to meet more mathematicians and their careers looked interesting for my future."

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Programs and conferences provide access to mathematical content and cutting edge research that:

Helped women find a mathematics identity, a place where they felt they fit into the broader mathematics community.

“I've always been fairly nerdy and I mean that in the best possible way and my experience in all of the programs was that it was really an environment that I fit in, I found my peers.”

“Because having a vison of the future that's personal is really motivating and it's especially motivating when things are really hard. To know it's possible and any kind of degree in math is really hard, there's no way around that.”

“It helped me see that there are other women doing this and that I'm not alone and they were really excited that I wanted to do it to and so that's the biggest impact, like wow, people wanted me to be here. I had no idea.”

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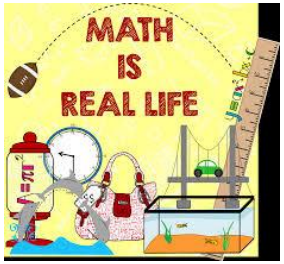
Programs and conferences provide access to mathematical content and cutting edge research that:

Broadens views of mathematics, mathematicians and the social relevance and importance of research

" . . . it completely sort of rebranded the idea of a mathematician for me. Who is a mathematician, you don't have to be a weirdo, there's different ways to be successful as a mathematician besides math class and research (i.e. math & origami, math and art) experiencing math from many different angles and feeling like math is more than a textbook."

"It helps to see someone like you, to show what you can do with a degree in mathematics. It is important to show how you can have an impact on society with a math degree."



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Interviews revealed that programs work simultaneously at the individual and interactional levels.

At the Interactional level – Programs and conferences provide opportunities to interact with peers, mentors, and role models that provide recognition and encouragement.

- Collaborative problem solving is key
- Formal Presentations and Panels provide a sense of mastery and recognition
- Informal social gatherings spark lifelong friendships
- Peers and mentors are key source of social support outside of their home institutions at multiple stages

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Programs and conferences provide opportunities to interact with peers, mentors, and role models that provide recognition and encouragement.

Collaborating with peers on coursework is key

"The coursework was very important. Not so much the material but the way it's designed to work in groups. I felt math was a isolated activity previously. Group work opened eyes and saw how fun that could be, to collaborate with other mathematicians."

"The social experiences that were the most vibrant were for me was when I was with other women in small groups and working on math together. At [my college] some of the guys were faster than me or didn't take me seriously and so I hadn't thought of math being a collaborative event until I worked with the women as a group. It gave me a different perspective when I got back to [my college] and I had more confidence and I was willing to take more risks."

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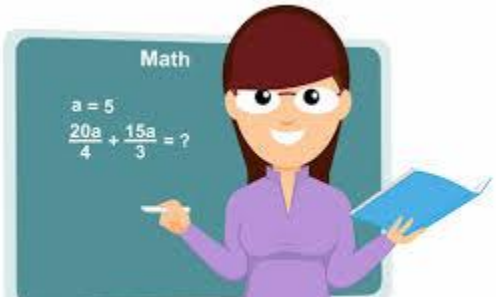
Programs and conferences provide opportunities to interact with peers, mentors, and role models that provide recognition and encouragement.

Formal Presentations and Panels provide a sense of mastery and recognition

"In 2012 I presented poster and talking to the judges and professors and sharing my work it was well received and I liked the feedback I got, it was a chance to present on a topic I was passionate about and get feedback. Professors encouraged me to continue in the field and that was really valuable. At the end I won an award and got a chance to go to a conference. The whole experience was really helpful."

"It was my first experience presenting research at a conference. It made me feel a part of the research community and identify as a mathematics researcher."



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Programs and conferences provide opportunities to interact with peers, mentors, and role models that provide recognition and encouragement.

Informal social gatherings spark lifelong friendships and sense of community

". . . meals were great opportunities to have casual conversations and I think the openness and flexibility to talk about multiple things and having the opportunity to grab a coffee, go for a walk, all great ways to build more community. One year there was this spoken word performance event and it had a super amazing impact on me to see how they had other talents and to see how it related to mathematics. That was a great thing."

"I've been to like five of them over the years and I look forward to it so much because there aren't a ton of women mathematicians and this is a space where you see all different kinds of women and in different areas . . . And it is nice to let your hair down and not have a care in the world. It helps build a community."

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Programs and conferences provide opportunities to interact with peers, mentors, and role models that provide recognition and encouragement.

Role models inspired participants to achieve their dreams

"Seeing women with families and careers and they were really happy and envisioning that in the future, and also just the access to the wonderful network of the alumni -that has been valuable for me."

"One of the biggest impacts was getting to see a lot of women of color who sounded strong, spoke with passion about what they were interested in, felt like role models to pave the way for someone like myself to continue on with math and academia and especially being someone who has dealt with a lot of people's own opinions about whether I'm doing the thing I should be doing, so it felt like a lot of encouragement and motivation there."

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RESULTS

Level	Social Process	Program Results
Individual	Confidence gap Biased self assessments	- Increase confidence - Normalized struggle - Provided peer group reference point
Interactional/ Interpersonal	Friendship networks Mentorship Discrimination Social isolation Implicit Bias	- Role Models - Encouragement - Community of "People Like Me"

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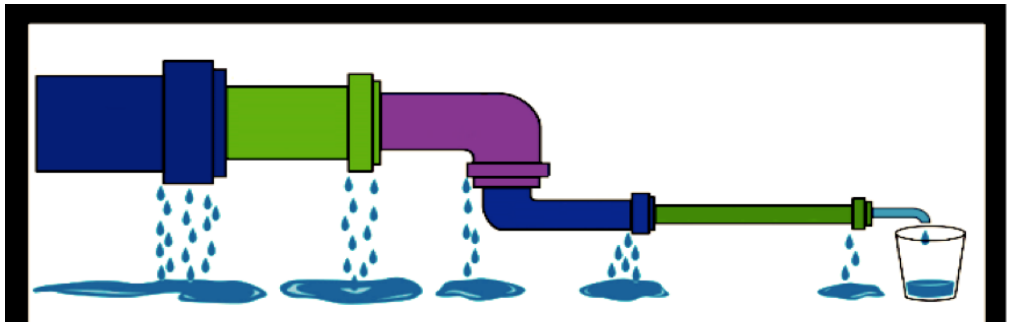
Social and Structural Barriers

According to the National Science Board Science and Engineering Indicators, in 2007 there were approximately 15,500 undergraduates majoring the mathematical sciences, 43.9% were women. Six years later, 1,800 had earned PhD's in the mathematical sciences, 28% were women. Based on these numbers:

- **7% of women** undergraduates majoring the mathematical sciences go on to receive a Phd compared to **15% of men** undergraduate mathematical majors.



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BREAK

DISCUSS :

Forty-eight percent of survey respondents in our study persisted to graduate school, what phenomenon can explain this?

In what ways might individual and interactional level interventions help women navigate the transition into and through graduate school in the mathematical sciences?

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Social and Structural Level

Level	Social Process	Program Results
Individual	Confidence gap Biased self assessments	- Increase confidence - Normalized struggle - Provided peer group reference point
Interactional/ Interpersonal	Friendship networks Mentorship Discrimination Social isolation Implicit Bias	- Role Models - Encouragement - Community of “People Like Me”
Social and Structural	Organization Policies Procedures Culture	? ? ?

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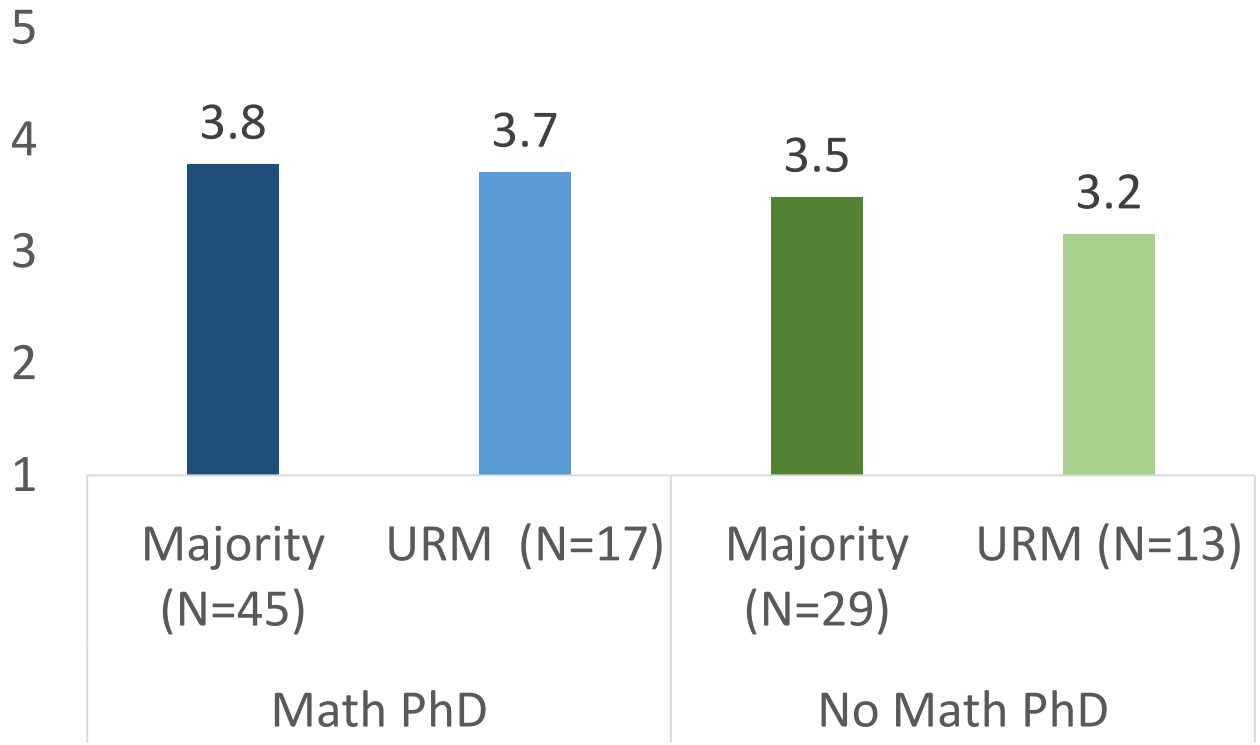
How did your experience in [Program] influence the graduate school application process? (N=104)



1-5 = Made process harder - Made process easier

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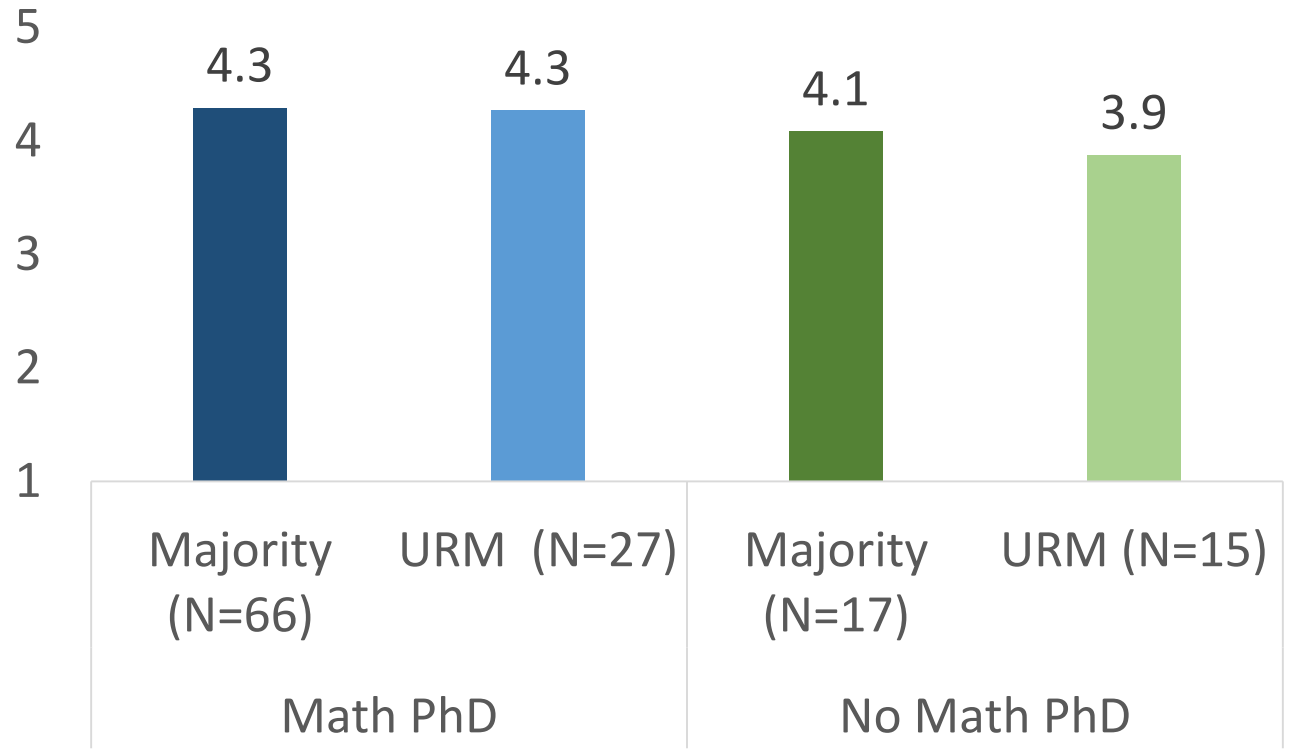
What was the effect of participating in [Program] on your success in graduate school in the mathematical sciences? (N=125)



1-5 = Decreased success- Increased success

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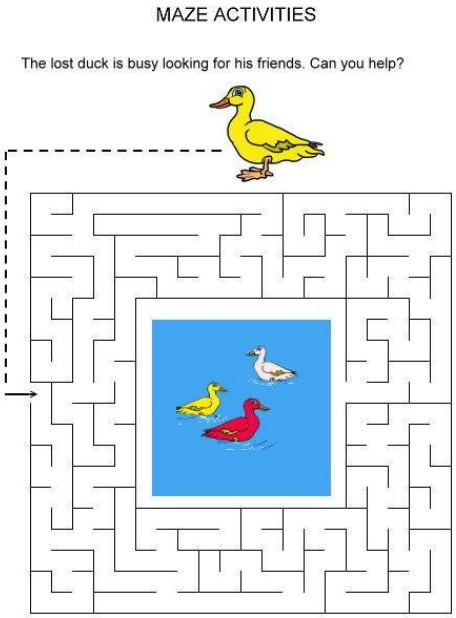
Interviews suggest that the confidence gained and social support and connections helped participants navigate future institutional barriers:



<u>At the Institutional level</u> – The relationships formed at programs and conferences proved to be a valuable resources in:

- Navigating the maze of formal institutions.
- Providing insider knowledge on institutional processes that are often invisible to outsiders.
- Creating peer social support when women encounter barriers.
- Accumulating social capital necessary to advance, including letters of recommendation and research collaboration opportunities.

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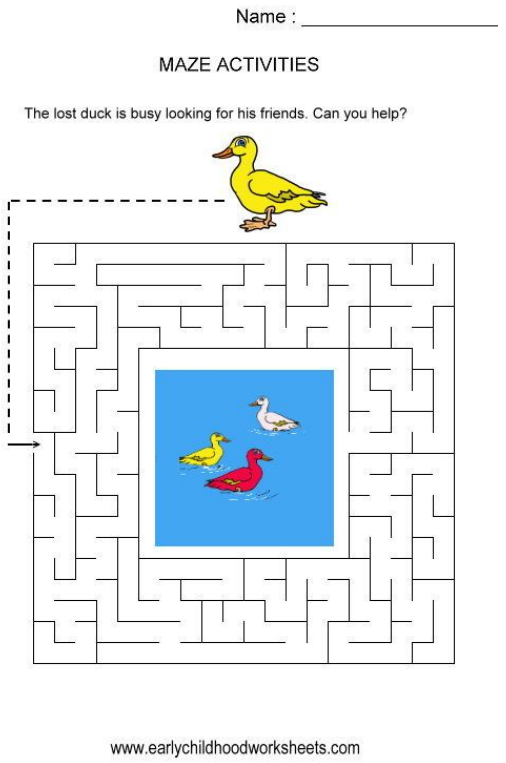
Interviews suggest that the confidence gained and social support and connections helped participants navigate future institutional barriers:

<u>At the Institutional level</u> – The relationships formed at programs and conferences proved to be a valuable resource in:

- Navigating formal institutions
- Providing insider knowledge on institutional processes that are often invisible to outsiders
- Provide social support when women encounter barriers
- Provide social capital necessary to advance including letters of recommendation and research collaboration opportunities.



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The relationships formed at programs and conferences proved to be a valuable resource in:

Navigating formal institutions & providing insider knowledge on institutional processes that are often invisible to outsiders

“It was probably the first experience that I had in undergrad that made me realize that mathematics was a viable career option and later on when I became interested in pursuing a career, I had poor support at my undergraduate institution. No one was very well informed of the programs I needed to apply for so that's when this program became indispensable to me in helping me to just navigating the programs and requirements. This holds true for a lot of women that were in the program with me. We are strongly tied and this has been a very valuable thing to me in the program.”

“Without these programs, I wouldn't have known about the opportunities, would not have been able to know what to write in my essays, wouldn't have known what resources to look into to strengthen my technical abilities.”

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The relationships formed at programs and conferences proved to be a valuable resource in:

Providing social support when women encounter barriers through graduate school and beyond.

"In the long-term, it gave me support in different areas. As a grad student it's about surviving and learning math but later on looking for a job and having someone who knows you and how to ask for things and who to call in certain situations. For example, two years ago I had a baby and I talked to one of my mentors who gave me her maternity clothes, but she also helped me to navigate this where 10 yrs. ago I wasn't concerned about that. How do you negotiate to get maternity leave and things like that? So as life changes it helps me deal with it."

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The relationships formed at programs and conferences proved to be a valuable resource in:

Accessing social capital necessary to advance, including letters of recommendation, and research collaboration opportunities.

“I kept in touch with several people from the [Program], one who continued to do math. They told me about job opportunities. One of the best relationships I made was a person who wrote recommendation letters. He was a great mentor. He made me feel capable.”

“I've kept in touch with the co-directors, one I see a lot and, one another, I collaborated on a research project with.”

“One of the mentors I met has regularly given me advice on how to manage grad school and how to prepare for my career and because I'm graduating from the same grad school that he went to. He helps me navigate the academic environment that I'm in.”

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Of 34 women interviewed who were in school to, or who had received, a PhD in the mathematical sciences responded to the question, "Do you think you would have stayed in mathematics without your experiences in enrichment programs/conferences in mathematics?

- 22 simply said "No"
- 5 were unsure
- 3 unsure, but said they would have been less successful
- 4 said "Yes"

"[Program} is the reason I went on into math. I can trace my successes back to that. My professors gave me letters, network, advice, helped us in grad school, reunion dinners helped and workshops to help us navigate through grad school. After I was working full time I called up my professor and talked to her about industry or academia and she helped me figure that out."

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For, some barriers too great to overcome . . .

Risk of Social Isolation

“I never really made an extremely strong connection with anybody so that may have been one of the reasons I didn't fully pursue further education in mathematics. I just felt like I loved research, loved the findings, interesting and empowering. I felt like my connections with people were a little limited.”

“It's easy when you're working on your research it's easy to get isolated because it doesn't involve interacting with other people at all so it's easy to start thinking that any difficulty you are having in your research it's easy to feel like you're the only one experiencing those things”

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Lack of family leave policies

“The program I chose had 50% women and I knew that it would include a critical mass of women and that my work would too, there was surprising very little formal protections in place including things like maternity leave and what happened is we went to the director of grad studies and asked for a different teaching assignment or something like that and it worked out. It would be more welcoming if there were actual policies in place including maternity leave.”

“The family medical leave act and doesn't cover half time TAs. That could have gone a lot better. I only had 2 weeks off as a TA so I asked for a different assignment and I wasn't sure my graduate stipend would continue going.”

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Lack of mentorship

“Very unlikely. I grew to really hate grad school. I did four years of grad school and then I dropped out. I felt very isolated . . . My advisor was very hands off and I only saw him once a week. I was doing this research all by myself and I hated doing it. It was really stressful. . . . Maybe I might have done better at a bigger school where there were more advisors?”

“It was really hard for me the last 2 years, it was very isolating, felt like I didn't have any help, my phd advisor didn't understand why it was difficult and didn't know how to mentor, I sought out others. I was generally chided for going to my phd advisor and I'm not willing to put myself through the same process.”

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Chilly climate/culture

“I always liked the math. It was never the thing that made me stressed out. Even in classes that I hated where the professor was sexist, I never hated the math, just the feeling in that class.”

“The community in the programs provided the other piece I was looking for. I hate the sense of being isolated or being on display.”

“It is the culture. People say math is hard but that's not it. Other subjects are just as difficult. The culture makes it stifling. The culture makes it not conducive to participating. Culture is not inviting because it is male dominated. Not a nurturing environment. The assumption that if you're here then you are smart enough, but then you can't ask questions.”

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Dismissing the problem, hostility towards women

“Basically their position was gender doesn't matter . . . dismissed it when I brought it up-like the national average, narrowing like the whole pipe-line thing. The whole like trying to sweep it under the rug. Because of the attitude combined with the fact that not many women ahead of me. But when there's only one, and that woman fails out, it makes it look like the stereotype sas. Then when you fall back on these achievement standards of who can be here, it looks like the women are leaving because they're not good enough.”

“In my first year of grad school I went to professor's hours and he said you're dumb and you can't do that. He was just a very unpleasant person. That was my first experience and I was turned off to the discipline. He didn't care about what we were doing, you're invading my time, like just go away. I had the feeling that everyone was having this experience. Especially the girls from this professor.”

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Institutions resistant to diversity and change

"The faculty were not supporting of the diversity project that the grad vice chair led. He was really good about selecting students who showed promise. A lot of women got accepted but there was no professor who would work with them. Some faculty even tried to undermine the diversity project. You need the whole department working together to be successful. I was really discouraged because they never hired women in math. They never selected the women candidates for faculty. It gave the message that it doesn't matter how good you are, you will never get a job at a place like this. The cohort was not supportive of me. First year of grad school, the mostly male graduate students formed study group without me. It was a very isolating, lonely experience. And the program didn't get involved in a thing like that, they let grad students do their thing. Males were just going to work with each other. It was a really traumatizing time. **Now I've done better than all of them.**

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Solutions

“There could be more programs like mentoring programs, learning groups of women that know each other and have some kind of interaction. There could be more outreach to women at younger ages even into the high schools-explain it to them what it is like research and make it visual in a way that young students want to work for NASA or something like that but in math. Culturally make it more interesting. Like movies and such like Hidden Figures. Outreach at two year and four year schools.”

“Having a prominent female faculty or if they have only one or two female professors making sure they are there for question and answer sessions for students who are interest and making sure they at they are visible on the website, so having a diverse faculty.”

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Solutions continued . . .

“Have like a mentorship program. That would have been particularly helpful to me or just some sort of support. They talked about mentorship but it wasn't really connected, maybe I wasn't savvy enough to join in. You had to kind of seek it out yourself. Maybe the steps on how to go about building a relationship with a mentor. The first semester is especially difficult but if you could sit down with someone really dedicated like the check in kind of thing. That might have been really helpful. Kind of connecting with the faculty.”

“I think grad programs are not retaining women, I think that's an issue, grad programs have women who are interested but are not as prepared - they get admitted and they drop out and leave. Other recruiting could happen at undergraduate level and not grad admissions level. Retention: culture thing, the way that mathematical programs are currently structured-it's very apprenticeship, one advisor who can make or break your program for men or women. Trying to find outside support can be quite difficult if you are dependent on your advisor to determine whether it's going to go on or if you can finish. Culture, too that coming into grad school that maybe they don't have as complete a background as some of their peers and they might not be as well versed in the language or culture and that can get worse as they continue to their dissertation.

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Next steps for change

Mathematics Enrichment Programs and Conferences

Institutional Change

Future Research

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