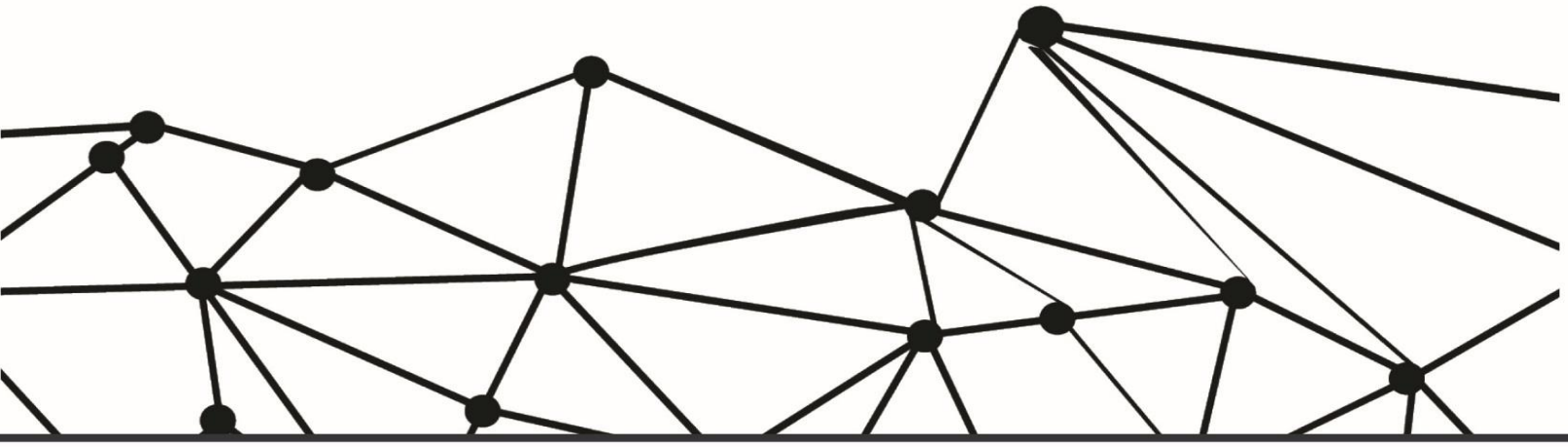
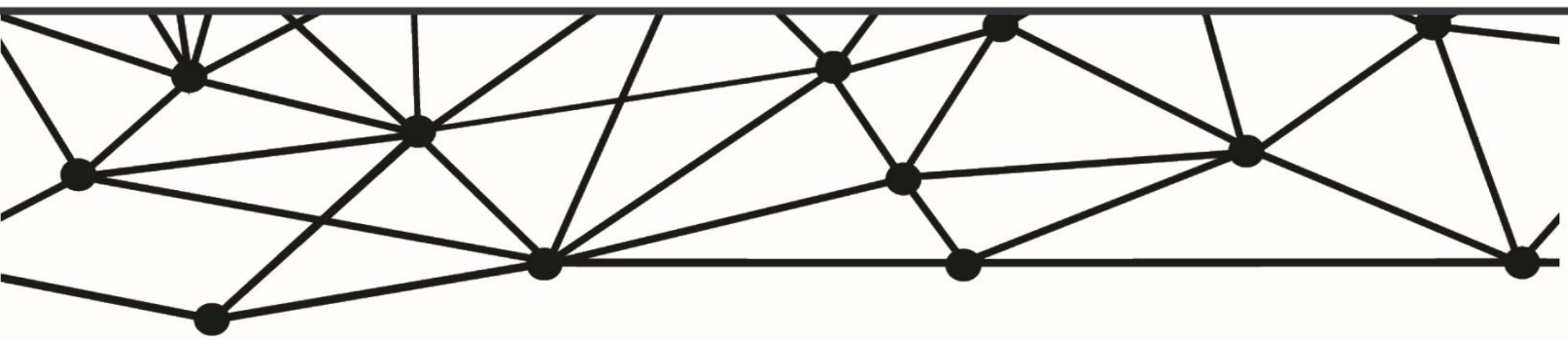


NSF INCLUDES

WATCH US: Women Achieving Through Community Hubs in the United States

Recruitment and Retention for Women and Historically Underrepresented Groups in Advanced Mathematics

Methodology Report
Prepared for the WATCH US Stakeholder Meeting
June 8th – June 10th 2017
University of Nebraska - Lincoln



Acknowledgements

This grant was funded by the National Science Foundation, Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) Design and Development Launch Pilot 2016-2018 (HRD-1649365). Primary Investigators: Ruth Haas, Deanna Haunspauger, Ami Radunskaya and Judy Walker.

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Table of Contents

Introduction 4
The Carleton College Summer Mathematics Program for Women (SMP) 5
The Nebraska Conference for Undergraduate Women in Mathematics (NCUWM) 5
The EDGE (Enhancing Diversity in Graduate Education) program 5
The post-baccalaureate program in Mathematics at Smith College (CWM) 6
The Women and Mathematics program (WAM) at the Institute for Advanced Study, Princeton, ... 6
The Infinite Possibilities Conference (IPC) 6
Research Questions 7
The WATCH US Research Study Methods and Sample Frame 9
Analytic Strategy 10
Qualitative Interviews 10
Quantitative Survey 12
Appendix I. WATCH US National Advisory Board Members and Organizations 14
Appendix II. Qualitative Interview Protocol 15
Appendix III. WATCH US Quantitative Survey Instrument 23

Introduction

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.

The WATCH US grant is funded by NSF INCLUDES Design and Development Launch Pilot (10/1/2016 – 9/30/2018) (HRD-1649365). The WATCH US partnership focuses nationwide on increasing the percentage of women who attain PhDs in the mathematical sciences. The PI team consists of four mathematicians who have led successful programs aimed at increasing the number of women with advanced mathematics degrees. The WATCH US Leadership Team is shown in Table 1.

Table 1. WATCH US Collaborative

Role	Project Team Member	Institution	Program Affiliation
PI	Ruth Haas	Smith College	Smith Post-Baccalaureate Program
PI	Deanna Haunsperger	Carleton College	Carleton SMP (Summer Mathematics Program)
PI	Ami Radunskaya	Pomona College	EDGE: Enhancing Diversity in Graduate Education
PI	Judy Walker	University of Nebraska	NCUWM: Nebraska Conference for Undergraduate Women in Mathematics
Sr. Pers.	Trish Wonch Hill	University of Nebraska	Department of Sociology
Evaluator	Mindy Anderson-Knott	University of Nebraska	Social and Behavioral Sciences Research Consortium

WATCH US Collaborating Programs

The social science research includes both a quantitative and qualitative study of participants who have participated in the four successful programs lead by the PI's on this grant, as well as two additional programs identified after the award was received.

The primary goal of these six programs is similar: to increase the number of women from majority and historically underrepresented groups with PhDs in the mathematical sciences. Programs vary, however, in participants targeted (education level), format, structure, size, and duration. Some aspects are similar across programs however: challenging mathematics research and curriculum, engaging plenary speakers and panels of diverse and inspiring men and women mathematicians, professional programs providing practical guidance (grad school prep, GRE's, etc.), and social gatherings aimed at broadening peer and mentor social networks. Program descriptions for each of the six programs included in this research study are below:

The Carleton College Summer Mathematics Program for Women (SMP) started as a one-month enrichment and mentoring summer program in 1995 for eighteen first- and second-year undergraduate women to encourage these women to pursue an advanced degree in mathematics and to provide them with a network of support if they did choose to go on. This summer program, funded by NSF (originally jointly with NSA), ran for 18 of the next 20 summers, with the last summer program in 2014. The summer program featured two challenging courses, recreational problem solving, panel discussions about making the most of their undergraduate math majors and how to be successful in graduate school, and woven throughout were opportunities for the participants to build an esprit de corps so that when they needed a support group later in their education, they had one. There have been 329 participants in the summer program and an additional 14 undergraduate teaching assistants, for a total of 343 participants in our community. Over the years the program has grown to support these women at different stages of their careers with advice and mentoring through 1) a one-day annual Graduate Education Mentoring Workshop which ran 2010-2017, providing intense mentoring and talk preparation advice for a total of 112 participants, and 2) a three day symposium celebrating women who had been through the program and finished their PhDs which ran 2005-2015 (except 2006), with a total of 160 participants.

The Nebraska Conference for Undergraduate Women in Mathematics (NCUWM) aims to encourage undergraduate women mathematics majors to attend graduate school, to increase their success in graduate school, and to help them identify possible careers using mathematics. Held annually since 1999, the conference is funded by the National Science Foundation and the National Security Agency. The number of undergraduate participants per year has grown from 43 to roughly 250, and the total over the past 19 years is over 3600. Two plenary talks given by successful women mathematicians showcase different kinds of mathematics and different careers made possible by a mathematical education. Three panel discussions and a variety of small group discussions provide information on a variety of topics involving graduate school and career options. Undergraduate students present their own research in 48 talk slots and two poster sessions. There are also a variety of networking activities that help participants connect with peers and mentors.

The EDGE (Enhancing Diversity in Graduate Education) program supports women getting PhDs in the mathematical sciences. The program is in its 19th year, with the first program held in 1998 at Bryn Mawr College. Participants enter the program in the summer before the start graduate school, when they attend a 4 week immersive program that prepares them for mathematical and cultural challenges that they may face in graduate school. Participants return the following summer for a two-day Reunion Symposium, and participate in follow-up activities such as local clusters and special sessions at national meetings. Each year's cohort typically consists of 14 new graduate students, 3 peer mentors who are in

their third, fourth or fifth year of graduate school and 4 workshop facilitators who organize two-week-long workshops in analysis and algebra. As of June, 2017, the EDGE program will have served 264 women graduate students. The program has been funded primarily by the National Science Foundation, with other funding from the Henry Luce Foundation, the Sylvia Bozeman and Rhonda Hughes EDGE Foundation, Institutional sponsors and, in the early years of the program, the Mellon Foundation.

The post-baccalaureate program in Mathematics at Smith College (CWM) was designed to serve women who discover their love of mathematics late and need more preparation to continue to graduate school in the mathematical sciences. This program intervenes at a critical point, the transition to graduate student. Students come to Smith two semesters (sometimes just one) and then apply to graduate program. In addition to comprehensive mentoring and a rich curriculum, students do research with faculty and present at national meetings. The program has been funded by two NSF workforce grants DMS-0602110 and DMS-1143716 (2006-2018). Funding has been used to pay postbac tuition and give them a stipend as well as pay for programmatic activities. Several students have attended without receiving funding (but with a tuition discount from Smith College). A total of 102 women have completed the post-baccalaureate program (roughly 10 each year . Of these, 88 went to (or will start) graduate programs in the mathematical sciences.

The Women and Mathematics program (WAM) at the Institute for Advanced Study, Princeton, started in 1994 under the auspices of the National Science Foundation, the Institute for Advanced Study and Princeton University with a mission to recruit and retain more women in mathematics. The annual program in May is held at IAS with one day at Princeton University, and is organized around a mathematical topic of current research interest. There are daily problem workshops, a (new) afternoon computer workshop, colloquia by distinguished female mathematicians and evening discussions and panels on various mentoring topics. Each year about 45-60 women participate, very roughly a quarter undergraduates, half graduate students, and a quarter postdocs and more senior faculty. Altogether there have been over 1100 participants. The program is run by a steering committee consisting of faculty who (mostly) come from institutions near Princeton. Some outreach activities are arranged with local schools, and they plan to start an WAM ambassador program to encourage participants to participate in and develop a variety of mentoring activities in their home institutions.

The Infinite Possibilities Conference (IPC) is a national conference designed to promote, educate, encourage, and support underrepresented women in the mathematical sciences, as a step towards addressing the lack of African Americans, Latinas, Native Americans, and Pacific Islanders in these fields. Participants include undergraduates, graduate students, postdocs, faculty, and industry professionals. The conference has been funded primarily through the NSF, with past support from the NSA and host campuses. Held every two to three years, the conference has grown from 150 participants in its first year (at Spelman College in 2005) to around 200-250 in more recent years, with five conferences and over 1000 participants thus far. Activities include plenary sessions and panels by prominent women who can share personal experiences in addition to their research, shorter research talks and a poster session, workshops and advice sessions for those at various stages of their mathematical trajectories, and presentation of the Dr. Etta Z. Falconer Award for Mentoring and Commitment to Diversity. IPC aims to fulfill a need for role models and community-building; provide greater access to information and resources for success in graduate school and beyond; and raise awareness of factors that can support or impede underrepresented women in the mathematical sciences.

Research Questions

The demographics of mathematics Ph.D. recipients in the United States fails to reflect the demographics of the country. Women, first generation college students, individuals who belong to racial/ethnic minority groups, with disabilities, and from rural areas, are underrepresented in graduate degrees earned, postdoctoral fellowships received, and tenured academic positions in the mathematical sciences. Percentages decrease at each successive level; thus role models for women and underrepresented groups are scarce.

Mathematics is the foundation of many STEM fields, and success in mathematics is a catalyst for success in other scientific disciplines. Increasing the participation of women and other underrepresented groups in the mathematics profession builds human capital that produces a diverse pool of problem solvers in business and industry, research mathematicians, faculty at all levels, and role models for the next generation.

Existing support and enrichment programs have targeted women in mathematics at different stages in their undergraduate and graduate education, with different strategies to building community, creating a sense of belonging, and promoting a growth mind set. These strategies challenge some of the most common individual, interactional and societal/structural level obstacles to success including; social isolation, stereotype threat, not committing to mathematics early enough, and imposter syndrome, while acknowledging the diversity among women in terms of socio-economic background and educational background.

In order to increase the representation of women in the mathematical sciences, it is imperative for funders, evaluators, and social science researchers to work together to better understand how mentoring and academic programs impact long-term STEM persistence across the life course and across multiple programs and institutions. This problem requires a national collaborative effort to leverage and combine resources and expertise from leaders in the mathematical sciences to create institutional change within the mathematical sciences. The urgency of this problem cannot be overstated. Funders will no longer invest in expensive programs without solid evidence that these programs result in increased persistence in mathematics, particularly for women and for students from groups traditionally underrepresented in mathematics.

Although there is some qualitative retrospective evidence from participants at the program evaluation level that these programs made a critical difference and are highly valued, many of the evaluations lack rigorous methods due to small sample sizes, lack of a control group, or little funding to follow up long-term with participants over time. The counterfactual, is that program participants are a self-selected group that likely would have persisted in math regardless of program participation. More rigorous research needs done in this area.

This project proposes to examine the effectiveness of these programs through the lens of two primary questions: Which elements of these programs are most critical in the success of women, as a function of their position along these distinct diversity axes? And, which features of these programs are most effective as a function of the stage of the participants' careers?

These broad questions are guided by the rationale that a better understanding of social and structural processes can broaden pathways into mathematics for historically underrepresented groups.

Through these efforts, we hope to bring together the broad mathematics community to take ownership over broadening participation efforts in the mathematical sciences in the United States, and to work together to more fully understand:

1. How do programs work to facilitate the persistence of women in the advanced mathematical sciences?

2. Are there program elements that are key to persistence for women?

3. Do programs work differently for women of color or for first generation women than for majority women?

4. What barriers to persistence do women perceive in the mathematical sciences?

5. What supporting or inhibiting factors are most influential when women decide whether to pursue a doctorate in mathematics?

6. What supporting or inhibiting factors are most influential during a woman's pursuit of a doctorate in mathematics, leading her to earn a graduate degree or to drop out without an advanced degree?

7. What features of projects like EDGE, SMP, Smith Post-baccalaureate program, NCUWM, WAM, and IPC are most effective at supporting women in their pursuit of, and success in, graduate-level mathematics?

8. What common metrics can be used to measure the effectiveness of programs and activities that support women in mathematics?

9. What are the characteristics of undergraduate programs that most effectively prepare women to pursue graduate study in mathematics, and to succeed in that pursuit?

10. What are the characteristics of mathematics graduate programs in which women are most likely to succeed?

11. Which of these identified factors can best be cost-effectively scaled up?

The WATCH US Research Study Methods and Sample Frame

In order to answer these research questions within the timeframe and scope of a two-year Design and Development Launch pilot, we utilized the resources most readily available. Together, we collated program undergraduate and graduate student participant lists from the six aforementioned large scale, multi-year programs and conferences in order to collectively survey and interview women about their cumulative experiences participating in these six target programs, and similar programs throughout their life course. While the research began with the intent to study the initial four programs led by WATCH US PI's, two additional programs were included through collaborative processes and via suggestions from the WATCH US Advisory Board (See Appendix I). This is a mixed methods research study: a combination of quantitative and qualitative data was collected concurrently from two samples drawn from the same list of participants from February-March 2017.

The six programs studied target women at different stages in their postsecondary education. Two programs focus primarily on undergraduate students (SMP and NCUWM). Two programs focus on the transition from undergraduate schools to graduate schools; one includes participants who are late in their undergraduate career and are applying to PhD programs in the mathematical sciences, or have completed their first year in a PhD program in the mathematical sciences (EDGE), the other on post-baccalaureate training for those who didn't obtain an undergraduate degree in the mathematical sciences but who want to attend graduate school in the mathematical sciences (CWM). The final two programs include a combination of graduate and undergraduate student participants (IAS, IPC). These latter two programs also included a combination of high school students, postdocs, and early career faculty, but we excluded these participants from the analysis. Table 2 shows the six programs and the number of undergraduate and post-baccalaureate and graduate women in the mathematical sciences included in the sample frame for each.

Table 2. 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

These programs collectively served over 5,000 participants across 20 years. We chose to narrow the sample frame to approximately 4-5 years for programs that served primarily undergraduates or graduate students, and larger time frames for programs that included participants at both levels. We included years based on the participant level of education in order to simultaneously obtain the most recent participants available, while also allowing for enough time for participants to have reasonably completed a PhD in the mathematical sciences since the time they attended/participated in the program.

The program years selected for inclusion for each program are shown in Table 2. Sample sizes ranged from 51 total participants for smaller more intensive programs (CWM) to 937 for the large scale shorter conferences (NCUWM). Based on these inclusion criteria, our final sample frame included 1,531 women who had previously participated in at least one of the six identified programs. Institutional Review Board approval was obtained through the University of Nebraska – Lincoln (IRB Approval #: 20160816371EX), and consent to participate was obtained for the quantitative study and qualitative study when women were contacted.

Analytic Strategy

Results of quantitative surveys and qualitative interviews were analyzed holistically and are reported together. Generally, bivariate associations and patterns will be presented from the quantitative survey data and then elucidated via the qualitative interviews in the research report. Quantitative data was assessed using SPSS statistical software version 22. Qualitative data was analyzed using Nvivo version 11. Descriptive statistics of each sample and demographics for each sample are below:

Qualitative Interviews

A total of 55 interviews were conducted in January-April 2017 (See Appendix II). For the qualitative study, in order to obtain a sample of participants who attended programs and who did not persist to receive an advanced mathematics degree, and conversely, women who persisted and later received an advanced mathematics degree, we used stratified sampling, when program outcome data was known (whether they received a PhD in the mathematical sciences), and quota sampling once interviews were completed to ensure a diverse sample. Similarly, we used data on racial/ethnic minority status when available to ensure a diverse sample of women from historically underrepresented groups (racial/ethnic minorities).[1]

The intent of the interviews was not to get a representative sample of program participants, but instead, to ensure we had a diverse sample of participants from each program with a multitude of educational outcomes to assess differences between those who persisted to advanced mathematics degrees and those who took other paths.

Table 3 shows the number of participants interviewed by primary program sample frame. We initially set out to conduct interviews with 10 participants for each program but given the large number who had participated in more than one of the six programs (25% of the total sample), we stopped at 55 interviews. In addition to answering a series of questions about the primary program they participated in, participants were also asked about their participation in the other programs with the same set of program specific questions as with their primary program. In total, 12 participants had attended two programs, and an additional 2 respondents had participated in 3 of the 6 program (25%).[2] [3]

Ten respondents were first generation college attendees (neither parent had graduated college with a four year degree). Eighteen participants were women of color (African American, Black, Latina, Native American, or Pacific Islander). Four of the women of color were also first generation college attendees.

[1] As might be expected, the programs with larger groups of participants, and that were shorter duration, tended to have less participant data than smaller, longer duration programs. Only participant contact information (First name, Last name, and email) were available for two programs (NCUWM and IAS). Other programs varied to the degree they collected demographic and follow-up data from participants by year and participant (SMP, EDGE, IPC).

[2] It was particularly difficult to find primary respondents to interview from NCUWM (4) although many participants in other programs cited NCUWM as a secondary or tertiary program. Likely this is due to many people with NCUWM learning of the other programs at the conference due to past collaborations among the program leaders.

[3] An important note is that interviewees from the first five programs were not asked about their involvement in IPC. This is because IPC came onto the project after the interviews for the first 5 programs were completed. One participant mentioned their participation in IPC in passing, and this is counted in the total, although IPC specific program questions were not asked of this respondent. Thus, there may actually be respondents who participated in the first five programs and IPC, but were not asked about IPC participation formally.

A total of 26 of the 55 respondents had completed a PhD in the mathematical sciences, and another 8 were in the process of finishing their degree, most identified 2017 as their anticipated graduation year. Four had either never attended (3) or dropped out of graduate school (1). Seventeen had completed a BS or MS degree in mathematics and or STEM, but did not pursue a PhD in the mathematical sciences.

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*	-
First Generation College Attendee	0	1	2	1	2	4	10	18%
Women 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*

Quantitative Survey

A short 5-7 minute survey was sent via email to all of the 1,531 program participants in the sample frame in April and May of 2017 (See Appendix III). Program participant contact information (Name, email) was relatively was from 2003-2012, and so was approximately ranged from five years old to 14 years old. Because it was gathered during the time of program participation, in many cases last names and emails may have changed. This is evident in the number of emails that bounced by year. For respondents who participated in a program from 2003-2008, the proportion of total emails bounced back is 67%, for those who participated in 2009 or later, only 20% of emails bounced back. This is particularly problematic for undergraduate students who were sampled from earlier participant lists, and were also more likely to lose institutional affiliation from undergraduate programs. Participants who were already graduate students when they participated are also more likely to be those who persisted to receive an advanced degree, and thus are likely overrepresented as survey respondents in the email surveys.

Table 4 shows the response rate by program. Response rates are calculated subtracting the number of total bounced emails from total number of participants. NCUWM had the largest proportion of bounced emails compared to the other five programs. The two conferences had the lowest response rates (NCUWM, IPC). The programs with smaller cohort and programs with longer duration had the highest response rates (SMP, CWM). Total response rate for this internet survey is 19%. This response rate is comparable to other internet surveys, however, the comparisons are with more recent data from the general population. This indicates that program participants are more likely to respond to emails about program participation than the general population as a whole.

Table 4. WATCH US Survey Response Rate by Program

	SMP	**NCUWM**	**EDGE**	**CWM**	**WAM**	**IPC**	Total
	2004-2008	2003-2008	2006-2011	2008-2012	2004-2008/ 2008-2011	2005, 2007/ 2010, 2012	
Total Participants	**67**	**937**	**69**	**51**	**148**	**259**	1531
Bounced emails	8	375	9	4	34	63	493
Percent bounced	12%	40%	13%	8%	23%	24%	32%
Total Survey Respondents	33	66	22	23	38	16	198
Response Rate	56%	12%	37%	49%	33%	8%	19%

Survey Respondent Demographics

Table 5 shows the demographic and educational outcome data from the survey respondents by program. A total of 198 women responded to the survey. Of those 19% were from historically underrepresented racial/ethnic minority groups (Latina, African American, Native American, Pacific Islander).

Twenty one percent were first generation college students (range from 6% at SMP to 38% at IPC). A large proportion of NCUWM respondents identified as first generation college students. The average participant age was 32, 66% reported they were currently married or cohabiting, 66% of those married had a spouse or partner with PhD (dual career), and 28% of the total sample had at least one child. In general, EDGE and CWM respondents were less likely to have a partner in general, and were also less likely to have one with PhD. Respondents from EDGE and WAM had the highest proportion of dual career partners. NCUWM respondents and IPC respondents were more likely to report having at least one child.

Table 2. WATCH US Survey Respondent Demographics by Program

	SMP	NCUWM	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
Non-PhD (BA/BS, MA/MS, MD, JD, other)	0	7	0	1	0	2	10
Non-Students	33	66	22	23	38	16	198
Degree							

Appendix I. WATCH US National Advisory Board Members and Organizations

National Advisory Board Members and Organizations	
Hélène Barcelo	Mathematical Sciences Research Institute
Edray Goins	National Association of Mathematicians
Helen Grundman	American Mathematical Society
Brit Kirwin	Conference Board of the Mathematical Sciences
Rachel Levy	Society for Industrial and Applied Mathematics
Dusa McDuff	Institute for Advanced Study
Francis Su	Mathematical Association of America
Jessica Utts	American Statistical Association
Cristina Villalobos	Society for Advancement of Chicanos/Hispanics and Native Americans in Science
Talitha Washington	Association for Women in Mathematics

Appendix II. Qualitative Interview Protocol

Mathematics Program Participant Questionnaire

Program Key:
Carleton College Summer Mathematics Program for Women **(SMP)**
Nebraska Conference for Undergraduate Women in Mathematics **(NCUWM)**
The EDGE Foundation Summer Residential Program (California) **(EDGE)**
Smith College Center for Women In Mathematics Post-baccalaureate program **(CWM)**
Institute for Advanced Study Program for Women in Mathematics **(IAS WAM)**
The Infinite Possibilities Conference **(IPC)**

Thank you so much for agreeing to speak with us about your experiences participating in <insert program name EDGE, SMP, CWM, NCUWM, IAS, IPC> and about your general experiences with any other mathematics related enrichment programs or conferences. The purpose of this project is to assess the effectiveness of mathematics enrichment programs, mathematics conferences, and undergraduate and graduate mathematics departments impact on recruiting and retaining women seeking an advanced degree in the mathematical sciences.

Before we discuss your experiences in mathematics enrichment programs and mathematics conferences, we first want to learn more about any degrees you have attained or plan to attain in the future.

PRE1: Are you currently attending school?

If YES:

a) *In what discipline?*
b) *What degree will you receive when you are finished? (BS/MS/PHD) (IF in undergraduate ->Group 1)*
c) *What will be your specialization?*
d) *Would you say your degree will be in the Mathematical Sciences?*
e) *When do you anticipate graduating?*

SKIP TO PRE4

If NO: Pre2

PRE2: Have you ever earned an MS or PhD? (MS/PhD or both)

If YES:

a) *What was your area of specialization?*
b) *IF MS: Would you say your MS is in the Mathematical Sciences?*
c) *IF PHD: Would you say your PhD is in the Mathematical Sciences?*
d) *What years did you receive your degree(s)?*
e) *From which institution(s) did you receive your degree(s)?*

SKIP TO PRE4

If NO: PRE3

PRE3: Have you ever attended graduate school?

If YES:

a) *What did you study in graduate school?*
b) *Did you intend to earn a degree in the Mathematical Sciences?*
c) *Did you leave school without completing you degree? (Confirm left without completion)*

SKIP TO PRE4

Group 1) In undergraduate school
Group 2) In graduate school (Math)
Group 3) In graduate school (No Math)
Group 4) Attended graduate school (Math) – left without completion
Group 5) Attended graduate school (No math) – left without completion
Group 6) Attended graduate school – Received PhD NOT IN MATH
Group 7) Attended Graduate School (Math) – Received only an MA in Mathematics
Group 8) Attended Graduate School (Math) – Received a PhD in Mathematics

PRE4: Are you currently employed in a mathematics related field?
IF YES:

a) What is your job title?
b) What is the name of the company/business/Institution that you work for?
c) What year did you first begin working there? (YEAR)

SECTION A (Specific Program Experiences) ALL GROUPS
1. First, please tell us about your experience with <insert program name>

2. How do you think participating in <this program> made a difference, if at all, for where you are today? *Probe: Did it impact your confidence, motivation, perseverance, or mathematical skills*

3. How did <this program> affect, if at all, your interest in pursuing the mathematical sciences?

4. Did you form any relationships, such as friendships, mentorships, role models, or other relationships, through participation in <insert program name>? ***YES/NO***

If yes, please explain the relationships you developed.

5. Did you have peers from <this program> that you have kept in touch with after the conclusion of this program? ***YES/NO***
If yes, please explain

6. Do you have any mentors from <this program> that you have kept in touch with after the conclusion of this program? ***YES/NO***
If yes please explain

7. Which formal programmatic elements were particularly important to you?
Prompts: (For example . . . see program specifics below)

***IF SMP**: Coursework, Colloquia, Panel discussions, the SMPosium*

***IF NCUWM**: plenary lectures, panel discussions, breakout sessions, student presentations*

***IF EDGE:** Two-week courses, mini courses, Difficult Dialogues session, required problem sessions, Reunion panel*
Reunion math lecture, Reunion keynote speaker(s), Reunion Talent Show

***IF CWM:** Math courses, Research project, Dialogues in Math course, Advising.*

***IF IAS WAM:** lecture courses, problem session, colloquium, research seminar, women in science seminar, Princeton University Day lectures, evening*

***IF IPC:** Short course in Mathematics, Panels/Plenary Talks, Roundtables, Poster Session, Sessions on Grad School/Professional Development)*

7. Which informal social activities were particularly important?
Prompts: (such as organized lunches, field trips, social gatherings))

***IF SMP**: DeannaChats, Group dinners, Colloquia, Group dinners, Deanna Chat, SMPosium day at the park and Buca dinner, Informal conversations with Mathematicians in Residence*

***IF NCUWM**: banquet, pizza dinner*

***IF EDGE:** Field trips, informal discussions at meals, reunion banquet, informal program sessions*

***IF CWM:** networking, meeting other women in math, attending conferences*

***IF IAS WAM:** introductions meeting, interaction with participants over meals and tea at IAS, opening dinner, closing banquet, self-organized group events, Princeton University Visit day events*

IF IPC: Dr. Etta Z. Falconer banquet, other informal gatherings

8. In what ways was <this program> meaningful to you?

9. I'm going to ask you about some other programs that you may or may not have participated in. Please tell me if you have participated in the following programs:

LEAVE OUT CURRENT PROGRAM
*Carleton College Summer Mathematics Program for Women **(SMP) YES/NO***
*Nebraska Conference for Undergraduate Women in Mathematics **(NCUWM) YES/NO***
*The EDGE Foundation Summer Residential Program (California) **(EDGE) YES/NO***

*Smith College Center for Women In Mathematics Post-baccalaureate program **(CWM) YES/NO***
*Institute for Advanced Study Program for Women in Mathematics **(IAS) YES/NO***

For each Program attended repeat SECTION A

SECTION B (Other Math Enrichment Experiences) GROUPS All GROUPS
1. Have you attended or participated in any other Mathematics enrichment programs besides the ones we have already asked about? ***YES/NO***
Prompts: This could've been a mathematics enrichment opportunity or residential program/camp or conference that you participated in High School, college, or as a graduate student. Some examples might be: Infinite Possibilities, Field of Dreams, or SACNAS.

If NO other experience Follow up: Thinking back to your experience(s) of <insert program(s) from section A>, is there anything else you want to say about your experience in <Insert Program>?

If yes Follow up:

1. Thinking, back to your very first mathematics enrichment experience or mathematics conference, when was it, and where were you in your education (middle school, HS, undergraduate or graduate?)

2. Please describe. *(If your first one was SMP/CWM/EDGE/NCUWM/IAS please discuss the second one here the mathematics enrichment experience you had after that.*

3. How, if at all, did <this program> affect your interest in math or science?

4. What types of relationships did you form at this program?
Prompts: did you make friends, meet mentors, or find significant role models?

5. How many participants were there?

   (10, 10-19, 20-49, 50-99, 100 or more?)

6. Was this program limited to a specific group, such as gender or another group?"

7. Besides this experience and the other experiences we've already discussed, have you participated in any other types of mathematics oenrichment programs or conferences? YES/NO

If yes, what other types of math enrichment programs have you participated in?

Prompts: These might be summer camps, conferences, competitions, residential programs, or any anything else.

8. Thinking across all of your experiences with mathematics enrichment programs and conferences, how many programs do you think you have participated in over your lifetime?

9. Do you think the characteristics of the participants of the programs you've been in made a difference in your interest in mathematics? Does it matter if the participants are all girls or coed? Does it matter what their racial/ethnic background is?

10. How do you think the characteristics of the participants made a difference?

11. **Thinking back to all of your experiences participating in math or science enrichment programs and conferences, can you think of any specific attributes of these programs that made a difference for you?**

SECTION C Groups 3, 4, 5 and 6

1. How likely do you think you are to go back to receive an advanced degree in Mathematics?

If Unlikely, what factors contributed to your decision to not to further pursue and advanced degree in the mathematical sciences?

2. What other types of programs or supports might have lead you to pursue/continue toward an advanced degree in mathematics?

SECTION D (Graduate School in Mathematics) If Group 2, 4, 7 & 8
Now we are going to switch gears and talk about graduate programs.

1. How many mathematics graduate programs did you apply to? (If none, skip section)

2. When you applied to and chose a graduate school did you think about the school's success rate for people "like you" (from similar institutions, race, gender, etc)? Please explain.

3. What do you think graduate programs could do better to recruit women in mathematics?

4. Thinking about the graduate program you attended, were there any aspects that were especially good in terms of support for women who are pursuing an advanced degree in mathematics?

5. Were there any aspects of your graduate program that you felt were bad or not supportive of women who are pursuing advanced degrees in mathematics?

GROUP 4 ONLY Attended graduate school in math, left without completion.

5. Why did you stop pursuing an advanced degree in Mathematics? INTERVIEW CLOSE

GROUP 2 ONLY

6. Do you intend to finish school with a PhD in mathematics?
If NO: why not?
IF YES: Skip ASK SECTION E

GROUP 7 ONLY

6. Do you intend to go back to school receive a PhD in mathematics?
If NO: why not?
IF YES: Skip ASK SECTION E

SECTION E (Went to graduate school in STEM NOT Math) Groups 3, 5 and 6

1. What made you choose to pursue a graduate degree outside of the Mathematical Sciences?

2. Are there any supports you could have received through Mathematics Enrichment programs like <Insert program Name> that might have made you pursue a degree within the Mathematical Sciences?

3. Are there any supports you could have received as an undergraduate or graduate student that might have made you pursue a degree within the Mathematical Sciences?

4. Are there ways that your experiences in mathematics enrichment programs or conferences helped you to attain your PhD outside of the Mathematic Sciences?

SECTION F (Recieved a PhD or expected PhD) GROUP 8

FOR THOSE WHO Received (or are still currently pursuing) a PhD in Mathematics:

1. Do you think you would have stayed in mathematics without your experience(s) in

mathematics enrichment programs or conferences?

2. Is there any one element of mathematics enrichment programs or conferences that was critical to your persistence in mathematics?

3. Please describe that/those element(s).

4. Why do you think they were key to your persistence in Mathematics?

Demographics:

1. **Do you consider yourself to be Hispanic or Latino/a?**

Yes
No

2. **What race or races do you consider yourself to be?** ***(Check all that apply)***

White (Caucasian)
Black or African American
Asian
American Indian or Alaska Native
Native Hawaiian or Other Pacific Islander
Other specify:

3. **How old were you on your last birthday?**

4. **What is your current relationship status?**
   Married, living together
   Married, living apart
   Not married, but living with a partner (cohabiting)
   Never married
   Divorced
   Widowed
   Separated

   If married or cohabiting
   4a. Does your partner have a PhD?

   If yes, **4b. In what discipline or field?**

5. **How many children do you have?**

   If greater than zero/none -> **6a. what are their ages?**

6. **Did at least one of your parents/guardians graduate college with a 4 year degree?**
   Yes_____ No_____

INTERVIEW CLOSE

Thank you so much for your time and for sharing your perspectives and letting us follow up with you after your participation in <insert program name>.

Appendix III. WATCH US Quantitative Survey Instrument

NSF INCLUDES WATCH US Survey

NSF INCLUDES WATCH:US Survey

Q1 Thank you for agreeing to fill out this short survey. The purpose of this survey is to learn more about your education and employment after attending the ${e://Field/ProgramFull}. This survey will take you approximately 5-7 minutes to complete.

Q2 First, we would like to ask you about your experiences in higher education. Are you currently attending school?

- ❍ Yes
- ❍ No

Condition: Yes Is Selected. Skip To: What degree are you currently seeking?.Condition: No Is Selected. Skip To: End of Block.

Q3 What degree are you currently seeking?

- ❍ A Bachelor's Degree
- ❍ A Master's Degree
- ❍ A Doctoral Degree
- ❍ Other, please explain _____

Condition: A Bachelor's Degree Is Selected. Skip To: Are you planning on applying to gradu....Condition: A Master's Degree Is Selected. Skip To: What terminal degree do you hope to a....Condition: A Doctoral Degree Is Selected. Skip To: Will your degree be in . . . . .Condition: Other, please explain Is Not Empty. Skip To: What terminal degree do you hope to a....

Q4 Do you plan on applying to graduate school in Mathematics?

- ❍ Yes
- ❍ Maybe
- ❍ No

Q5 What is the highest degree do you hope to attain?

- ❍ MA/MS
- ❍ PhD
- ❍ Ed.D
- ❍ MD
- ❍ JD
- ❍ other, please explain _____

Q6 Which discipline will your degree be in . . . .

- ❍ Mathematics or Applied Mathematics
- ❍ Statistics
- ❍ Data Science
- ❍ K-12 Mathematics Education
- ❍ Computer Science
- ❍ Engineering
- ❍ Social Sciences
- ❍ Medicine
- ❍ Other, please explain _____

Q7 What type of job do you hope to have after you complete all of your schooling?

- ❍ Higher Education (primarily research)
- ❍ Higher Education (primarily teaching)
- ❍ K-12 Teaching
- ❍ Private Industry
- ❍ Government or non-profit
- ❍ Practice Law or Medicine
- ❍ other, please explain _____

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q8 What is the highest degree you have attained?

- ❍ A Bachelor's Degree
- ❍ A Master's Degree
- ❍ A Doctoral Degree
- ❍ Other, please explain _____

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q9 Is your Degree in the Mathematical Sciences?

- ❍ Yes
- ❍ No
- ❍ I don't Know, please explain _____

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q10 What best describes your area of expertise?

- ❍ Mathematics or Applied Mathematics
- ❍ Statistics
- ❍ Data Science
- ❍ K-12 Mathematics Education
- ❍ Computer Science
- ❍ Engineering
- ❍ Social Sciences
- ❍ Medicine
- ❍ Other, please explain _____

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q11 What year did you attain your last degree?

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q12 Do you think you may ever return to school in the future to pursue an advanced degree in Mathematics or in another discipline?

- ❍ Yes
- ❍ No
- ❍ Maybe
- ❍ I don't know

Condition: No Is Selected. Skip To: End of Block.

Display This Question:

If First, we would like to ask you about your experiences in higher education. Are you currently at... No Is Selected

Q13 If you returned to school, what advanced degree would you pursue?

Q14 How did your overall experience in the ${e://Field/ProgramFull} influence your likelihood to pursue an advanced degree in the Mathematical Sciences?

- ❍ Greatly Increased the likelihood
- ❍ Increased the likelihood
- ❍ No effect
- ❍ Decreased the likelihood
- ❍ Greatly Decreased likelihood

Q15 How important were your peer interactions at ${e://Field/Program} in influencing you to pursue an advanced degree in the Mathematical Sciences?

- ❍ Very Important
- ❍ Important
- ❍ Somewhat Important
- ❍ Not at all important
- ❍ Not Applicable

Q16 How important were the mentors that you made at ${e://Field/Program} in influencing you to pursue an advanced degree in the Mathematical Sciences?

- ❍ Very Important
- ❍ Important
- ❍ Somewhat Important
- ❍ Not at all important
- ❍ Not Applicable

Q17 How did the mathematics content at ${e://Field/Program} increase your confidence in your mathematics ability?

- ❍ Greatly increased my confidence.
- ❍ Increased my confidence.
- ❍ No Effect
- ❍ Decreased my confidence.
- ❍ Greatly decreased my confidence.

Q18 Are you currently employed?

If What degree are you currently seeking? A Master's Degree Is Selected Or What degree are you currently seeking? A Doctoral Degree Is Selected

- ❍ Yes, as part of my graduate school funding
- ❍ Yes, full-time
- ❍ Yes, part-time
- ❍ No

Condition: No Is Selected. Skip To: End of Block.Condition: Yes, as part of my graduate... Is Selected. Skip To: End of Block.

Q19 How would you describe your current job?

- ❍ Higher Education (primarily research)
- ❍ Higher Education (primarily teaching)
- ❍ K-12 Teaching
- ❍ Private Industry
- ❍ Government or non-profit agency
- ❍ Practice Law or Medicine
- ❍ other, please explain _____

Q20 What has been your experience applying to Graduate Schools in the Mathematical Sciences?

- ❍ I have never applied to graduate school in the Mathematical Sciences
- ❍ I applied to graduate school in Mathematical Sciences but did not attend
- ❍ I applied, and attended graduate school in the Mathematical Sciences, but I did not graduate
- ❍ I applied to, attended, and graduated from a graduate program in the Mathematical Sciences
- ❍ other, please explain _____

Condition: I have never applied to gra... Is Selected. Skip To: End of Block.

Q21 How many graduate schools in Mathematics did you apply for?

- ❍ 1
- ❍ 2-3
- ❍ 4-5
- ❍ 6-9
- ❍ 10+

Q22 How did your experiences in ${e://Field/Program} influence the graduate school application process?

- ❍ It made the graduate school application process much easier
- ❍ It made the graduate school application process somewhat easier
- ❍ it had no effect
- ❍ It made the graduate school application process somewhat harder
- ❍ It made the graduate school application process much harder

Display This Question:

If What has been your experience applying to Graduate Schools in the Mathematical Sciences? I applied to, attended, and graduated from a graduate program in the Mathematical Sciences Is Selected

Or What has been your experience applying to Graduate Schools in the Mathematical Sciences? I applied, and attended graduate school in the Mathematical Sciences, but I did not graduate Is Selected

Q23 Did the content that you learned in ${e://Field/Program} help you in graduate school?

- ❍ The content I learned help me a lot
- ❍ The content I learned help me a little
- ❍ The content I learned didn't help me at all
- ❍ Not Applicable

Display This Question:

If What has been your experience applying to Graduate Schools in Mathematics? I applied to, and attended, graduate school in the Mathematical Science Is Selected

Q24 What was the effect of participating in ${e://Field/Program} in preparing you for success in graduate school in the Mathematical Sciences?

- ❍ It had a strong positive impact
- ❍ It had some positive impact
- ❍ It had no impact
- ❍ It had some negative impact
- ❍ It had a strong negative impact

Q25 What is your year of birth?

Q26 Are you Spanish, Hispanic, or Latino?

- ❍ Yes
- ❍ No

Q27 Choose one or more races that you consider yourself to be:

- ❑ White
- ❑ Black or African American
- ❑ American Indian or Alaska Native
- ❑ Asian
- ❑ Native Hawaiian or Pacific Islander
- ❑ Other _____

Q28 What Best Describes your Gender?

- ❍ Male
- ❍ Female
- ❍ other _____

Q29 What is your sexual orientation?

- ❍ asexual
- ❍ gay/lesbian
- ❍ heterosexual/straight
- ❍ queer
- ❍ other _____

Q30 What is your current ZIP code?

Q31 Are you now married, widowed, divorced, separated or never married?

- ❍ Married (living together)
- ❍ Married (living apart)
- ❍ Not married, but living with a partner (Cohabiting)
- ❍ Widowed
- ❍ Divorced
- ❍ Separated
- ❍ Never Married

Condition: Widowed Is Selected. Skip To: Do you have any children?.Condition: Divorced Is Selected. Skip To: Do you have any children?.Condition: Separated Is Selected. Skip To: Do you have any children?.Condition: Never Married Is Selected. Skip To: Do you have any children?.

Q32 Does your spouse or current partner have a PhD?

- ❍ Yes
- ❍ No
- ❍ Other, please explain _____

Condition: Other, please explain Is Selected. Skip To: Do you have any biological children?.Condition: No Is Selected. Skip To: Do you have any biological children?.

Q33 In what field?

Q34 Do you have any children?

- ❍ Yes
- ❍ No

Q35 Did one or both of your parents complete a four year college degree?

- ❍ No
- ❍ One parent
- ❍ Both parents
- ❍ other, please explain _____