Serendipity and Inadvertence in the Building of Community

Deanna Haunsperger and Steve Kennedy

We're not sure when it happened. It probably wasn't between the minestrone and the Caesar salad, though it may have been. In fact it must have been there all along, growing stronger, but we didn't notice until it hit us with full force at dinner one night in January 2005 at the Joint Mathematics Meetings in Atlanta, Georgia.

We had planned a reunion of the former participants from the first nine years of the Carleton College Summer Mathematics Program (SMP). Participants in our selective program are young women finishing their first or second years at a U.S. college or university who are interested in, and have shown talent in, mathematics. Our program was designed as an intense mathematical experience to give them the impetus they need, along with the support and encouragement, to go on to advanced degrees in mathematics. It's a four-week summer program, and we encourage the participants to keep in touch with each other via e-mail after they leave. We had had small reunions at the Joint Meetings before—four or five of us gathered after the day's talks for conversation over drinks. That January, though, there were going to be 25 former participants and nine former instructors and teaching assistants at the meeting, so we planned a nice dinner out, not as nine individual SMP class reunions from the nine summer programs we'd run, but as one big group.

When we arrived, most of the SMPers were already there, and the natural thing was happening. They were talking to each other. Women at different points in their careers, from different parts of the country, from colleges and

DEANNA HAUNSPERGER, associate professor of mathematics, joined the Carleton faculty in 1994. She earned her B.A. degree at Simpson College and her M.A. and PhD degrees at Northwestern University. STEVE KENNEDY, professor of mathematics, earned his B.A. degree at Boston University and his M.A. and PhD degrees at Northwestern University. He joined the Carleton faculty in 1994.

from universities, some undergraduates, some graduate students, some professors. What they had in common was a love of mathematics and a summer spent in a rural Midwestern town, but that was enough. We didn't need to do any introductions; in fact, we couldn't have because no one could talk over the roar of conversation. The hubbub washed over us—we heard them talking about choosing graduate schools, choosing advisors, doing research, figuring out how to fit a family into a career, and whether to choose a sauvignon blanc or a nice pinot grigio with the grilled shrimp.

Over the years we've heard from SMP graduates who have attended a conference or visited a graduate school and bumped into an SMP graduate from a different year. They have enjoyed the "small world" phenomenon and dropped us a line to report. We had not fully realized, until this dinner in Atlanta, that over the years what we had actually built was an incipient community ready to interact, ready to support itself, and it just needed a tiny push to get it going full strength.

FEWER WOMEN IN MATHEMATICS

The numbers are familiar to everyone in mathematics: Each year nearly 50% of the bachelor's degrees in mathematics awarded by U.S. colleges and universities go to women. However, only about 30% of the PhDs in mathematics go to women.[1] The rate at which qualified women advance to graduate school and the rate at which they persist in graduate school are both lower than the comparable rates for qualified men.

Why do so few women (relative to men) pursue and achieve advanced degrees in mathematics? Although definitive studies on this problem have not yet been done, anecdotal evidence points to several causes. Often, talented women who are drawn to mathematics find it difficult to believe that they can have effective careers in the field. Few of their professors are women. The male students in the class seem to get more attention from the instructor and, for whatever reason, seem to dominate the classroom discussions with their questions and responses. Most students demonstrate a lack of awareness about women mathematicians. Thus, women studying mathematics often have to deal not only with the difficulties inherent in the subject itself, but with the psychological and emotional problems caused by studying in such an environment.

OUR SUMMER MATHEMATICS PROGRAM

Each summer 18 first- or second-year undergraduate math majors, selected from the 100-120 who apply, come to Carleton for four weeks. During that time they spend 3½ hours a day in a classroom setting learning mathematics they would not normally see as an undergraduate (such as Morse theory, coding theory, game theory, fuzzy logic, low-dimensional dynamics, knots and topology) from outstanding instructors, chosen for their ability to inspire in the classroom and engage the students outside the classroom. Each instructor has her own teaching assistant who is a former SMPer either heading off to graduate school or in the middle of a graduate program. The students do homework, take exams, and make presentations, but not for a grade; they do it for the joy of deeply understanding some interesting mathematics.

The students are, by design, kept very busy: Beyond the classroom instruction, the students attend twice-weekly colloquia on a variety of mathematics subjects to give them a peek into the wider world of mathematics. They also participate in three panel discussions. The first is "Making the Most of Your Mathematics Major" (including information on research experiences for undergraduates, the study abroad programs in mathematics, courses they should be sure to take before applying to graduate school, math meetings they could attend, organizations they should join). The second is "Applying, Surviving, and Succeeding at Graduate School" (including information on teaching assistantships and fellowships, how to choose a graduate program, what happens at graduate school, what exams they'll be expected to take, choosing an advisor, and enjoying their graduate program). The third is "Non-Academic Careers in Mathematics" (with panelists possibly including an actuary, a high school math teacher, a biostatistician from the Mayo Clinic, an operations researcher from Northwest Airlines, an epidemiologist, and others).

On Monday nights they have an optional recreational problem-solving session during which they learn about various national and local problem-solving competitions and have several hours to sit and think about challenging problems. All of these activities are meant to give the students a view of the mathematical community that exists outside their own college and give them some avenues to follow to find where they fit into it.

One of the most important goals of the program has always been to join the women into a cohesive community so that after they leave Northfield they will still look to one another for support and encouragement. Toward that end we wind in, around, and through all the programming social opportunities for

the students to grow closer together: two picnics each week, walks around the Twin Cities, an afternoon at the Minnesota Arboretum, game night, hiking at a state park, or canoeing in a local river. Besides keeping tabs on the students' progress through the instructors and teaching assistants, we check in once each week to make sure no one is feeling overwhelmed by the intense nature of the classes.

By the time of the program-ending banquet it is clear to us that deep and abiding bonds have been formed. Facing, and conquering, difficult challenges together is the most effective way we know to form group bonds. That's why we insist that our instructors challenge the participants to the limits of their abilities. The intense and rigorous intellectual experience, combined with the supportive and enveloping social interactions, forge our students into a vibrant sisterhood of mathematics. We are very intentional about this; it is the soul of our program. We were astounded and delighted to discover in Atlanta that in fact our nine distinct communities might well be easily melded into a larger, stronger community. We started immediately after the Atlanta meeting to work on consciously constructing that larger community.

The tenth summer of the program, 2005, saw the inaugural "SMPosium," a three-day event celebrating the successes of SMP graduates who have completed their PhDs. In the summer of 2005, there were nine former participants who had finished their PhDs. Of those, seven were able to attend the symposium, and two (of three) former teaching assistants who had also earned their PhDs attended as well.

On the first day of the program, the visitors were introduced to the participants, and four of them presented 20-minute talks on their research. This was followed by a picnic for all involved for informal interaction. At the picnic, a number of participants approached the directors to say what an "inspiration" it was to have these women who've "made it" visit the program.

On the second day, the other five participants gave 20-minute talks on their research. This was followed by the panel discussion on applying, surviving, and succeeding at graduate school. The questions and answers were lively and upbeat. The panelists gave practical, honest answers to eager, thoughtful questions. These visitors weren't women on a poster designed to inspire, nor were they anecdotal evidence of women successful in mathematics passed down over generations of students; these were flesh-and-blood role models, sitting right in front of them, only a few years older than they were.

That evening was a dinner reception to which all were invited. The last

It has been an extremely busy, frustrating, exciting, empowering, four weeks, and today is the final day. I have learned so much math and so much about math it is truly amazing. The whole secret world of mathematicians is one that I never really knew about, but now want to be a part of. These four weeks

I have learned that 2+3 is not 3+2, a circle and a triangle are the same thing, a sphere is a two-dimensional object, and that the more useless the problem, the more mathematicians like it. I have also learned how to draw four-dimensional objects on paper, yet still can barely draw two-dimensional objects. My brain has been turned upside down, and I am excited to know that it will probably never be returned to its original orientation. The friends I have made here are ones I hope to never forget. It is amazing how strongly people can bond so quickly by spending hours discussing math. It is going to be hard to have to leave the people I met here, because I feel some connection to every one of them—Raena Bryant, SMP '05, quoted with permission.

day of the three-day event was reserved for hiking in the Minnesota Arboretum, during which time the participants and guests intermingled and walked and talked and made connections.

The SMPosium was an experiment. We believed that from getting together former participants who have since earned PhDs in a mathematical science only good could come. Come it did. They enjoyed talking with each other, learning of their peers' graduate experiences, hearing about job searches and two-body problems, discussing how marriage and family fit into career. The participants talked with the graduates about undergraduate and graduate institutions, enrichment opportunities, exams, advisors. The conversations flowed easily because they all have similar interests; the graduates blended in easily with the undergraduates.

On the second day, when the graduate panel started, and the nine guests took their seats at the front of the classroom, one participant in the front row looked at the guests, with whom she'd been interacting for several days about math and non-math alike, and an awakening visibly crossed her face. She realized that they're no different than she was, just a few years older. She said to herself, in a voice quite a bit louder than she had intended, "Wait, they *all* have PhDs? This is *so* cool!"

We agree; it is cool. And we are looking forward to our next reunion to bolster the young and celebrate the triumphs—to catch up with our mathematical family.

OUR RESULTS

The young women mathematicians immerse themselves in mathematics, living and working in a supportive community of women scholars (undergraduates, graduates, and faculty) who are passionate about learning and doing mathematics. Our intentions for them are threefold: to excite them about mathematics and mathematical careers, to provide them with some of the tools—psychological, emotional, and mathematical—they will need to succeed in a mathematical career, and to connect them to a network of fellow female mathematicians. We have been successful. Over the years, students have reported on their post-program evaluations being recharged and recommitted to mathematics by our program. They also intimate to us their feelings of isolation at their home institutions and the joy with which they entered into new kinships with sisters in mathematics.

Not only do the students, faculty, teaching assistants, and directors admit in their evaluations at the end of the program to being deeply influenced by what happens during SMP, but also the statistics of what the participants do after graduation from their home institutions support our claim.

As we can see from the table, of the 156 who have finished their undergraduate degrees, 29 (or 19%) of the SMP graduates are in a math-related career, most often programmer, actuary, or high school teacher, and a whopping 96 (or 62%) have or are working toward an advanced degree in a mathematical science. (Overall about 20% of female bachelor's degree holders in mathematics attempt graduate degrees.)[2]

The students return to their home institutions eager to plunge into their studies. They have a clearer idea of what mathematics is and a much clearer map of the mathematical community and a vision of what their place in it could be. Their increased awareness of various topics within mathematics has led many to give talks in their home departments on the mathematics that they learned in the summer program. Most have already participated in research experiences for undergraduates, the Budapest Semester in Mathematics, or other further-enrichment programs. All who have done so acknowledge being much better prepared to succeed at, and benefit from, those programs than they

By the Numbers: Where the SMP Graduates Are as of 2005

	95	96	97	98	99	00	01	03	04	05	TOTALS
PhD	3	2	4	7	2	--	--	--	--	--	18
Terminal Masters	4	6	5	2	3	3	1	--	--	--	24
Graduate School	--	4	3	3	7	10	10	10	8	--	55
Math-Related Career	7	3	4	3	3	2	3	4	--	--	29
Adv. Degree (Non-Math)	2	2	--	1	3	1	3	2	2	--	16
Other	2	1	--	2	--	2	2	2	3	--	14
Undergraduate	--	--	--	--	--	--	--	--	5	19	24
Total	18	18	16	18	18	18	19	18	18	19	180

otherwise would have been. More important than the knowledge and renewed excitement for mathematics, each of the students has gained confidence in her ability to do mathematics.

This confidence building is central to the mission of the program. All of these students, and most of the other one hundred who applied, are intellectually capable of achieving an advanced degree in mathematics. Something other than intellectual capacity prevents many women from pursuing one. Heightened self-confidence and a supportive network of colleagues and mentors are two factors that we hope will prevent young women from dropping out. These students return to their home institutions knowing that women can and should be doing mathematics. They will not only be supported by this knowledge, but they also will carry the message back with them to influence their peers and their teachers.

We have an impact on the lives of the young women who come to our program—we see the increased confidence, enthusiasm, knowledge, and mathematical sophistication. We see the electronic messages they post on the program's list-server to let us and each other know what is happening in their lives—mathematical and otherwise.

It is less clear to us how to measure this effect. We can never know how many would have gone on to productive mathematical careers without us—given the talent level, some certainly would. We won't know for some time how long and how far the momentum we give will sustain them in the face of adversity. We do believe that we are making a difference: At the dinner in Atlanta, many of the former students stopped to tell us about the impact SMP had on their lives as undergraduates and what a profound experience it is now, seeing women at every stage from undergraduate to full professor interacting as one big cohesive community, one big family.

FUTURE PLANS FOR THE SMP

As we plan for the future of this program, in addition to the summer program as we run it now, we are going to be more intentional in nurturing the larger community of mathematical women who are the SMP alumnae. Five years from now, we will have 270 SMP graduates, and we expect to have over 50 SMP women with PhDs and at least another 50 with PhDs in progress. There is a community here now, and we intend to take care of it.

It's unclear to us when SMP started to take off on its own; in the early years we were completely focused on each individual summer's group. We learned how to forge strong bonds within those groups but we never really looked at connecting across the groups. We made small steps: We use SMP alumnae as teaching assistants each year; we occasionally staffed the graduate school panel with an alum or two; and in recent years we've had a colloquium or two by alumnae with PhDs. All this was done as much out of convenience and affection for the alums involved as for any other reason.

But now we look up, and we see a budding community of 80 or 100 new or nascent professional mathematicians, and we see how much they could offer one another and how easy it will be to make that happen. We have inadvertently built something much larger than we initially intended, much stronger than we could have imagined. We're running alongside trying to keep up with this group of young women who will influence mathematics and each other for the next half century or so, and we couldn't be prouder of, or happier about, our serendipitous community.

ENDNOTES

[1] Data was compiled by reviewing the November issues of *Notices*, the magazine of the American Mathematical Society for the past ten years.

[2] Data from *CBMS 2000: Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States*, a report published every five years by the American Mathematical Society.