

# Carleton and St. Olaf Colleges' Summer Mathematics Program<sup>1,2</sup>

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Several years ago, Amy, a student of ours, came back from the Mills Summer Mathematics Institute bubbling with enthusiasm and ready to begin applying to graduate school in math. We talked to Amy about the experience, and she couldn't say enough good things about the wonderfully inspiring, nurturing environment. She confessed to just one regret: she had learned so much about how to prepare for graduate school, and she only had a year left as an undergraduate—she wished that she could have gone when she was younger.

The next year, when we saw a notice in the AWM newsletter about the formation of a Consortium to Advance Women in Mathematics and a call for proposals for programs for women, we remembered Amy's words. We enlisted the aid of our colleagues Laura Chihara and Kay Smith from St. Olaf and Gail Nelson from Carleton and started planning a program for students finishing their first or second year of college.<sup>3</sup> This, we felt, was a crucial time to catch young women, a time when they are making difficult, perhaps irrevocable, decisions about their futures. And they are making these decisions without a lot of accurate information—every year dozens of young women apply to our program and tell us “I love math, but I really don't want to teach—that's why I'm double-majoring in biology (or chemistry, or business).” During our time at St. Olaf and Carleton we have learned that a word or two of encouragement can make an enormous difference to a first- or second-year student, especially an insecure, unconfident student; and having a critical mass of students together studying math, going to colloquia and socializing builds an incredibly strong sense of community. We thought that we could use some of what we had learned to affect a group of young women and

<sup>1</sup>See our web page at:

<http://www.mathcs.carleton.edu/smp>.

<sup>2</sup>The directors would like to express their great appreciation to the National Science Foundation and the National Security Agency for funding.

<sup>3</sup>The current directors are Laura Chihara, Deanna Haunsperger, Stephen Kennedy, and Gail Nelson.

give them some tools and, more than anything else, the desire and self-confidence to continue in math.

## What we do

The heart of the program is, of course, the coursework. The women take two classes which meet 8:30 to noon, Monday through Friday morning (one class meets MWF, the other TuThF). We have been extremely fortunate in our choice of instructors, each of whom has thrown herself fully into the program and given much more than we expected. We always have one instructor from a research university and one from either Carleton or St. Olaf (each aided by a female teaching assistant from St. Olaf or Carleton). In the first year, Judy Kennedy of the University of Delaware led a Moore-method seminar in point-set topology and a computer-experiment-driven course in dynamical systems. These were woven together at the end when she explained how the strange and beautiful, almost Baroque, abstract point-set theory becomes useful when trying to understand the strange and beautiful unexpected behavior of some dynamical systems; this connection, of course, is the focus of most of her research program of the past decade. The students were stretched and challenged in a way they could never have been in a regular college class—and they rose to the challenge. By the end of the program 17 of the 18 women had solved and presented to the class their solution to at least one of the problems on The List. The rigors of Judy's class were well-complemented by a more leisurely tour through knot theory led by Gail Nelson of Carleton.

In the second year the demands of the two classes were more balanced as Tami Olson of Michigan Tech taught applied functional analysis and Laura Chihara of St. Olaf taught algebraic coding theory. In both years, the students reported in post-program evaluations that they had been asked to do things they did not believe they could do, but with the support of the faculty and of their peers, they had struggled to accomplish something difficult and meaningful. This year Laura Chihara will repeat her coding theory course, and Karen Brucks of the University of Wisconsin at Milwaukee will teach a course in low-dimensional dynamical systems.

We keep the students very busy—in addition to the coursework there is a twice-weekly colloquium series. Highlights have included Mary Ellen Rudin's visit (A History of Women in Mathematics), an introduction to Clifford Algebras by Marge Murray of Virginia

Tech, and our annual visit from Joe Gallian (University of Minnesota, Duluth) who not only gives a lovely colloquium, but also tells the students about the opportunities available to them in REUs. We always have talks by several local faculty, and we try to bring in a speaker or two from outside academia (each year we have invited a speaker from the National Security Agency and last year an epidemiologist from the Minnesota Department of Health). We do usually have one or two male speakers, but we try to have a preponderance of females.

In addition to the colloquium series, there are weekly panel discussions. The topics are: completing a math major; careers that use mathematics; applying to and succeeding in graduate school; and women in science. One afternoon a week the students have a three-hour session in a computer lab learning Mathematica, LaTeX, html, or Java. One evening per week we have recreational problem-solving.

Around and through it all, we weave mathematical outings and social activities: a tour of the Minnesota Geometry Center, at least one picnic per week, movie nights, canoe trips, hikes, even the Mall of America. Every weekend features at least one organized excursion. One night per week Deanna visits the dorm lounge for "Deanna chat," a time for her and the students to check that everything is going smoothly. The program closes with a banquet celebrating success and honoring the participants; farewells are difficult for the women, many of whom found long-sought-after sisters in mathematics.

## The Outcome

Our 18 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 they will need to succeed in a mathematical career; and to connect them to a network of fellow female mathematicians. The 1995 and 1996 Carleton-St. Olaf Summer Mathematics Programs (SMP), as measured by the participants' post-program evaluations, were successful in achieving all of these goals.

The students, faculty, teaching assistants, and directors all confess to being profoundly influenced by the

program. Every faculty member has reported that this was the most rewarding teaching experience of her life. The following quotes are culled from post-program evaluations:

This experience has revived my mathematical soul and charged me up.

Thank you for an awesome experience. It is something I will remember for the rest of my life.

This has been, by far, the most exciting and fun experience in math I've ever had.

The program has certainly confirmed my desire to major in math at the undergraduate level, and it has revealed more options than I previously expected for graduate study and an eventual career.

But the more I listen and learn of myself, I know that I can't stop after college and I won't stop until I feel that I've learned enough. And when I come to your grad school panel in a few years I'm gonna tell some really good stories.

To learn about other womens' experiences, to be encouraged, supported, to have so many people believe in me, and to connect with such brilliant and fun women was awesome!

I found it inspiring and informative to be around so many knowledgeable people with whom I could easily connect and communicate. The information and contacts that I have gained are invaluable. Everyone should have something like this at some point (sooner rather than later).

The students return to their home institutions eager to plunge into their studies. They have a clearer idea of what mathematics is and how to organize their future plans. Their increased awareness of various topics within mathematics have led many to give talks in their home departments on the mathematics that they learned in the summer program. Most have already, or intend to, participate in REUs, the Budapest Semester, or other enrichment programs.

All who have done so acknowledge being much better prepared to succeed at, and benefit from, those programs than they otherwise would have been. Perhaps more important than the knowledge and renewed excitement for mathematics, each of the students has gained confidence in her ability to do mathematics.

It challenged me, but I was able to work through the proof, I really put my heart into it—and I loved it. It was not only good for me alone, but it was so special to have a class full of people who could handle this level of self-motivated, rigorous learning.

But now, given this opportunity, I'm excited for school to start in the fall and I'm excited that I am a smart and intelligent math student. Really I am. And most of all, I don't need to prove it to anyone—just to myself.

[Studying mathematics in a group of women students] is the best! People explained things so that others would understand, and people kept telling each other, "Good call," "great idea," or "you're brilliant." You don't hear that studying with guys. It is very reassuring to discover that almost everyone else has the same insecurities and self-doubts and when you realize everyone else's are unfounded, it starts to chip away at your own. A very positive experience.

Most of all the program has given me the confidence that I can succeed in math, both as a student and as a woman.

I have proved things which I had doubted I could.

The satisfaction one derived from finally completing that proof they had been working on for a week was tremendous. It taught you that you could do things on your own.

The [SMP] has given me the confidence, the mathematical foundation, and the desire to propel myself through advanced studies of mathematics. It has been

an immense force driving all of us on to higher plains of mathematics. The courses and people contributed to an environment which has nourished and developed our mathematical souls.

This confidence building is central to the mission of this program. All of these students, and most of the other 100 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 which we hope 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.

## Who are the participants?

The program is advertised each year through a mass-mailing to all bachelor's and advanced degree-granting mathematics departments throughout the country. Also, advertisements are placed in the AWM Newsletter, FOCUS, Math Horizons, and several electronic newsletters. Participants have been first- and second-year undergraduates from regional and national liberal arts colleges and universities throughout the country. The "typical" student has had three semesters of Calculus, a Linear Algebra course, and one to three other math courses. She has a GPA of 3.85, she works in the campus tutoring service, and she plays the French horn. The directors attempt to choose the participants so that their academic backgrounds are somewhat balanced—we have, however, on occasion admitted women whose preparation didn't match up but whose apparent talent was such that we thought they could handle whatever we threw at them. We have also erred—each year there have been a couple of students who see the passion and commitment of their peers for mathematics and decide that mathematics is not that important to them.

## Conclusions

One of the things that most surprised us about these young women is that, by and large, they themselves

do not believe that their gender has had an impact on their education. In fact, many adamantly maintain that they have never been the victim of gender-based inequity. And yet, in their applications, many students do mention a desire to study mathematics with other women, and many applicants do notice the gender imbalance in their math and physics classes. At the close of the program, they maintain that studying in this all-female group was the most supportive, enriching, and joyous intellectual experience of their lives. They don't, or many don't, ask themselves why all of their schooling could not be this nurturing and exciting. Of course, there are other factors at work besides the all-female environment, e.g., the intensity and richness of the program which would be difficult to duplicate in an ordinary classroom. Nonetheless, we believe that many of these young women speak out and take chances here in a way that would not happen in a coed environment.

Every year we are forced to reject over 100 young women—most of whom would benefit from an experience like this. There are many fabulously talented young women at small two- or four-year colleges whose chances to obtain an advanced mathematics degree would be greatly enhanced by an experience like what we offer. We see room for several more programs, each aimed at a slightly different group of these students. In particular, we have carved out a sort of middle level of necessary preparation: we choose mostly students who have only one or two theoretical courses after Linear Algebra. It would be easy to fill up two more programs like ours: one for women who have come to mathematics too slowly and have yet to get beyond Linear Algebra; and another for women who approached mathematics too greedily and have too much experience in upper-level classes to fit in well here.

The young women who apply to our program seem to be very concerned about getting a leg up on establishing a career—most don't know what kind of career, but they are worrying about it already. It seems to us this might in part explain why so many of them, while clearly possessing the ability and love of mathematics that would ensure success in graduate school, choose not to pursue advanced degrees. Perhaps young men in college, for whom the existence of a career seems virtually assured in our society, feel they can afford the luxury of indulging their intellectual curiosity more than young women do?

It is clear to us that 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 impetus we give sustains them in the face of adversity. In any case, we are operating with very small numbers; the few programs like ours will not by themselves even out the gender imbalance in our profession. We do believe that we are making a difference though: just today, Suzanne (SMP '95) sent e-mail to tell us that she had been accepted for graduate study in mathematics at Berkeley and that she was considering accepting; she felt strong enough and smart enough. Go Suzanne!