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The SUNY Potsdam-Clarkson University REU Program

Joel Foisy

1. History and Structure of the Program

The SUNY Potsdam-Clarkson University REU program began, with support from NSF, in the summer of 1997 with Kazem Mahdavi (algebra, SUNY Potsdam), David Powers (graph theory, Clarkson University) and Joel Foisy (geometry/topology, SUNY Potsdam) involved as faculty advisors. Professor Mahdavi had for several summers before that led individual SUNY Potsdam students in various research projects, with financial support from SUNY Potsdam. In 1996, the author was a new PhD, but he had spent two very positive summers working as a student in the Williams College SMALL program. We were all delighted to begin the program. In 1998, we did not have a summer program, but for every summer since 1999, we have had a summer program, with financial support from NSF and NSA. We have had some changes in the faculty members involved each year, but the overall structure of the program has changed little. We have typically had between 3 and 5 different research groups each summer. This past summer, our faculty advisors were Joel Foisy (graph theory, SUNY Potsdam), Chrisino Tamon (applied graph theory, Clarkson) and Blair Madore (ergodic theory, SUNY Potsdam).

For eight weeks, students work daily in groups of 3 or 4 with an advisor on an original research problem in mathematics. We have ambitious goals for our students. We would like to help them build their confidence in their ability to do research independently, and to help them build their appreciation and understanding of the vast field of mathematics. We also want to help them to improve their oral and written communication skills. Each group presents their results to the other students, at least twice during the eight weeks. Students are encouraged to present their results at a national meeting. Each group also uses LaTeX to prepare a paper on their work. We also try to expand our students' mathematical horizons through hosting a weekly guest speaker, followed by lunch.

In order to encourage student-student interaction, we house the students in a cluster of on-campus apartments. We also organize a couple of outings for the students, including a day-trip to Ottawa, and a hike in the Adirondacks. We have also hosted barbeques at the beginning and endings of the program.

Students are assigned to their team before the program begins. We believe this allows them to start focusing in on a specific problem on the first day they

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arrive. Though there will be differences among the different teams, each day is structured fairly rigorously. A typical group might meet in the morning to discuss background, brain-storm on possible theorems and counter-examples, and to check proofs. Lunches are informal, except on days we have a guest speaker. In the afternoons, in a spirit of helping our participants become independent researchers, students generally work individually or in groups, without the faculty advisor. The faculty advisor would be available for consultation and help. If the situation demands, the entire group may arrange to meet.

The faculty members provide support for the students by helping them get started on a problem, and directing them to relevant background sources. The students and the faculty members check each other's work, and ideally we jointly develop publishable mathematics. At the later stages of the program, the faculty members help the students communicate their results both orally and in writing. In our experience, we have found that small groups of students working on a research problem is a successful paradigm. Brain-storming in a small team setting is useful for both experienced and less experienced participants. Explaining their ideas, both orally and in writing, to their peers is excellent for both the explainer and for the one who is trying to understand what the other is trying to say.

In choosing research problems for the students, we have several requirements in mind. First of all, problems should be approachable by good undergraduate math majors of varying backgrounds and talents. Second, they should require very little start-up time so those students can begin engaging in real research as soon as possible (eight weeks is a short amount of time!). Finally, it should be possible to obtain substantive results with enough time for writing up these results.

We feel we have been successful in finding such problems for our students in past summers. Having said that, finding good problems is probably the most difficult job for the faculty advisor. Where do we find good problems? We use a variety of approaches: looking through journals (MathSciNet is very useful for finding potential sources of inspiration), talking to research mathematicians, talking to mathematicians active in research but who primarily teach undergraduates, attending conferences, and attending MAA and Pi Mu Epsilon student talks at Mathfest are just some of the ways we find inspiration for problems. Often a good problem from one summer can be modified into another good problem for the next summer.

2. Recruitment

We recruit nationally, though we find comfort in knowing that a wide pool of qualified students can be found at numerous universities and colleges within three hundred miles of Potsdam. We recruit students in their junior (or in exceptional cases: sophomore) year, and we expect they will continue their undergraduate studies in the following Fall. All should have completed three semesters of calculus, one semester of linear algebra, and at least one more advanced mathematics course.

We will ask students to send the following material as part of their applications: (1) A letter describing mathematical background and interests, with an indication of topic preference. (2) A transcript. (3) Two letters of recommendation from mathematics faculty members, addressing mathematical aptitude, enthusiasm for the subject, and the ability of the student to work within a group. (4) A resume.

We feel that the two biggest recruitment tools are our web-page and word of mouth. In the fall of 2005, we improved our program's web-page, so that it now has links to descriptions of our various projects, as well as links to local attractions in the Potsdam area. We feel that this improvement has helped to increase the volume and quality of our applicants. In terms of word of mouth, we plan to continue to e-mail colleagues and the Project NExT list-serves to advertise our program, as we have done in the past. Our previous year's web page is located at:

http://www.clarkson.edu/mcs/reu.html

We do hope to attract students from under-represented groups to our program. The Principal Investigator has a history of working with SUNY Potsdam's CSTEP (Collegiate Science and Technology Entry Program) program. The purpose of CSTEP is to increase the number of historically underrepresented students who enroll in and complete undergraduate and graduate programs leading to professional licensure or to careers in mathematics, science, technology (MST), and health related fields. In our 2006 program, CSTEP and SUNY Potsdam provided funding for one Native American math major from SUNY Potsdam to take part in our program.

3. Project Evaluation and Results from Prior Support

In addition to giving numerous talks and posters at the local, regional and national level (several were award-winning), our groups have published several papers in journals ranging from the Pi Mu Epsilon Journal on up to standard professional journals.

We track our students after they leave the program. If we have not heard from a student in a while, it is quite easy to do a web search to determine if our former student is in graduate school. We administer pre and post-project surveys. Our surveys ask students questions that relate to their career plans, how well they liked their research topic, how well they interacted with other students and faculty in the program, the facilities, how they learned about our program, and what they perceived to be general strength and weaknesses of our program. Our surveying has shown our students to feel very positive about mathematics and the program. This was not surprising. We have learned other useful information, however, from the surveys. For example, in our 2006 surveys, we learned that several of the students were disappointed that we did not have any female guest speakers. This was an important piece of information that we will try to address in our 2007 program, should we be lucky enough to receive funding.

We have had an NSF supported REU program every summer since 1997, with the exception of 1998. According to our records, from 1997-2005, we have had 105 different students (31 women) participate in our REU program (some more than once), 9 of them participated in two different summers, and one student managed to participate for 3 summers. We have had 70 student positions from NSF funding, 18 from NSA, 15 from SUNY Potsdam, 8 from Clarkson University, and the remaining positions were funded from outside universities. We know about all but 15 of those 105 different participants. A total of 9 of these students have completed their Ph.D.s and are employed either in post-doc or tenure-track positions in mathematics. Forty-six of these students are currently in graduate programs in the mathematical sciences (one of these in physics, one in biostatistics, one in

computer science and one in engineering). Nine of our former students are teaching or are preparing to teach at the K-12 level. Ten are still undergraduates. Thirteen are engaged in various occupations. One is working for the department of defense, and yet another is a peace activist. We also have a former student in a graduate program in music technology at McGill University. Yet another is teaching at a Community College. One recently completed her Ph.D. in statistics and is working in industry.

Our post-doctoral REU participants have been recently employed at the following institutions: Rice University, the University of Chicago, University of Arkansas Fort Smith, California State East Bay, University of Kansas, Cleveland State, Texas A & M, and University of Colorado at Boulder.

4. Conclusion

The most important aspect of our program is that the students and the faculty both enjoy immensely working on mathematical problems together. We are grateful for the support NSF, NSA, SUNY Potsdam and Clarkson have provided over the years, and we look forward to next summer's program.

Department of Mathematics, SUNY Potsdam, Potsdam, NY 13676
E-mail address: foisyjs@potsdam.edu