A Research Experience for Undergraduates

Shelly Harvey and Andrea Ritter

Every undergraduate interested in graduate school should consider attending a Research Experience for Undergraduates (REU) program. The National Science Foundation yearly sponsors approximately twenty REU programs in mathematics that are held at various universities around the country during the summer. The programs range from eight to ten weeks in length, admit anywhere from six to twelve students, and include topics ranging from algebraic geometry and computational group theory to population dynamics and topology. These programs allow an undergraduate to closely work with a faculty member on some component of the faculty's research. These situations allow students to experience graduate study firsthand very early in their careers.

The authors attended Cal Poly San Luis Obispo, a predominately teaching university. As a result of our REU experiences, we both applied to graduate programs for the fall of 1997 and each of us is now in her first year of graduate studies. Andrea is working on her Ph.D. at the University of North Carolina at Chapel Hill, Shelly is at Rice University in Houston, Texas. Ironically, we both discovered our enjoyment of mathematics during our sophomore proof-oriented mathematics course. Moreover, we were both interested in furthering our education in mathematics. With encouragement from various faculty members, we decided to explore the REU programs. What follows are our personal accounts of life in an REU program.

Andrea:

I started at Cal Poly as an architectural engineering major with a minor in mathematics, but somehow I wound up pursuing mathematics full-time. To help pay for college, I worked as a research analyst for a major trade association. My immediate supervisor was the company statistician, and thus my curiosity in statistics was aroused. After two years I had a strong interest in continuing with statistics, but was undecided as to whether I wished to pursue a graduate degree. A good friend on the Cal Poly mathematics faculty suggested attending an REU and handed me a list of programs. I chose to apply to several programs in statistics and finally wound up at the University of South Alabama in Mobile. My family and friends were against it. They all said the same thing: "Alabama is so hot and sticky. The bugs are humongous there, you know. Don't do it. It's not worth it." Everyone told me I was crazy to leave the relative comfort of the central coast of California for the heat of the Gulf Coast, but it was well worth it.

When I arrived in Mobile, I was immediately assigned a project. My adviser was a sociology professor whose interest was in the social upheaval following a technological disaster, particularly the *Exxon Valdez* oil spill. Hence my project was to design a mathematical model explaining the phenomenon sociologists refer to as The Disaster Syndrome. The work was difficult but interesting. I usually found myself working late into the night as one idea often led to another. I even enjoyed reading the literature, a rare sensation for me.

There were several other students at South—all math or statistics majors working in fields as diverse as economics, psychology, epidemiology, and theoretical statistics. Once a week we got together and discussed our progress, problems we were having, surprising results, and the like, but mostly we were on our own. Weekends were reserved for play; we often got together for a barbecue or a movie. We also had several opportunities to travel around the state. I even made it to the Olympic Games in Atlanta!

Before I arrived I expected to gain only two things: a topic for my senior project, a requirement to graduate from Cal Poly, and an idea of life as a graduate student. The program far exceeded my expectations. I left South with a senior thesis topic, new friends, several recommendations, a possible publication, a clear idea of what research at the graduate level includes, and even a little pocket money. My summer in Alabama allowed me the time to focus and to experience research without

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extraneous details like classes, tests, and tuition. It convinced me to further my education and helped me find the right path. I would recommend an REU program to anyone with a strong background and interest in any of the mathematical fields, especially ones whose future educational plans are uncertain.

Shelly:

My sophomore year was the first year that I began to understand what mathematics really was about. It was the first time that I realized mathematics wasn't about plugging and chugging, but entailed understanding the foundations of a subject. I decided that I wanted to know more about mathematics. I thought about going on to graduate school. Then one of my mathematics professors told me about a summer program called REU and suggested I try to find out more about it. This sounded intriguing, so I decided to check out the programs.

So there I was, a young female who was on a mission to find out what mathematics was about. At this point I had only taken a few proof-oriented classes and had no clue what the future held. I took a shot at what was probably the best thing I could have ever done and applied to a couple of programs based on the fields of research offered. Within a couple of months I was thrilled to be accepted to the program at Louisiana State University (LSU) in Baton Rouge. Of course, I happily accepted the offer.

Before I arrived in Louisiana I wasn't sure what the experience would be like. I assumed some of the other students and I would read through some material in knot theory and then do some research. After I arrived I found that most of the students were in the same situation as I: we were interested in mathematics and in particular going to graduate school, whatever that meant. I soon found my assumption to be somewhat limited; research was more difficult than I had thought.

The first few weeks were set aside to become familiar with previous work done in the field. Then all of the students picked a question on which they wanted to work. The remaining time we met with our individual mentors and tried to get as much accomplished as was possible in the remaining five weeks. All the while, we gave talks to the rest of the group on our work. At the end of the program everyone was required to write up his or her results in a short paper.

I came away from the program with nothing but positive thoughts. Although the work was difficult, the REU gave me a more realistic look at graduate school. I realized that graduate school was not something that anyone should jump into lightly—it is more than just five extra years of college; it is a major life decision. Moreover, I got to interact with students like me, learn about other fields in mathematics, practice giving talks, and visit new regions of the United States.

When I got back from LSU, I was excited about mathematics and going to graduate school. I dove into mathematics, trying to take as many courses as I could handle. I had a fire in my belly; I wanted to be able to really understand all those articles I had struggled with during the summer. As the year progressed I chose to again apply to REU programs for the following summer. I also advertised the REUs to every student who showed a knack for mathematics.

I spent the next summer at Cornell University in Ithaca, New York. Having gone to the REU program the previous summer, I had an idea of what the upcoming summer would entail. Indeed, the programs were similar, but some aspects were different. At Cornell we had guest speakers give hour-long talks on their fields of interest on Mondays and Wednesdays. Although not every student was interested in every talk, each talk did give us a different perspective of mathematics. I felt that all of the students found an interest in at least one of the areas. We also participated in a weekly jam session. This was a time for the students to practice giving talks in front of an audience and to share the research we had accomplished that week. I found this to be especially beneficial in two respects. First, it allowed me to practice giving talks, not something you get to do every day. Second, it helped me understand that you cannot learn mathematics by reading alone; mathematics is a language that needs to be spoken.

I was particularly lucky that summer. I spent part of the summer investigating different areas of convex geometry. In particular, I read through an abundance of material on sphere packing and geometric crystallography with two other students. However, these readings came to a halt when Jade Vinson (another REU student) and I found a new result. We began writing our result into a paper to be published—"The Voronoi Vectors of a Lattice". Now I was really doing mathematics, not reading it. The fun was just beginning. This was a great experience, a feeling I could not have understood without actually writing the article myself. We worked for about three weeks straight trying to make the paper perfect. The end result: a chance to publish a paper and give a talk at the Mathfest in Seattle, Washington.

I would recommend an REU program to any undergraduate who plans to pursue graduate studies in mathematics. In both of my experiences there were stimulating problems to work on and a cooperative atmosphere with little or no outside distractions from research. This kind of environment is not something that comes up often, even for tenured professors.

Partial List of REUs for Summer 1998

The following is a list of some of the Research Experiences for Undergraduates programs in mathematics that will run in the summer of 1998. This is only a partial list, containing those REU programs funded on multiyear grants; at press time decisions about proposals for REU grants to start in 1998 had not yet been made. For the full list of programs, please consult the Web site of the NSF's Division of Mathematical Sciences, http://www.nsf.gov/mps/dms/reulist.htm, or contact Lloyd Douglas, telephone 703-306-1874, e-mail ldouglas@nsf.gov.

College of William and Mary
Matrix Analysis and Its Applications
David J. Lutzer
djlutz@mail.wm.edu
http://www.math.wm.edu/~lutzer/anncment.html

Cornell University
Analysis on Fractals, Complex Dynamics, Combinatorics
Robert S. Strichartz
reu@math.cornell.edu
http://math.cornell.edu/~michelle/reu.html

Hope College
Algebra, Dynamical Systems, Probability and Number Theory
Tim Pennings
pennings@math.hope.edu
http://www.math.hope.edu/reu.html

University of Illinois at Urbana-Champaign
General Physics with Emphasis on Nonlinear Physics
David Campbell
reu@physics.uiuc.edu
http://www.physics.uiuc.edu/undergrad/REU/REU98/

Indiana University
Algebra, Topology, Analysis, Probability, and Applied Mathematics
Daniel Maki
reu@indiana.edu
http://www.math.indiana.edu/reu/home.html

Michigan Technological University
Probability, Combinatorics, Number Theory, Statistics, Algorithms and Geometry
Anant P. Godbole
anant@mtu.edu
http://math.mtu.edu/

University of Minnesota-Duluth
Discrete Mathematics, Combinatorics and Graph Theory
Joseph A. Gallian
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University of Missouri-Rolla
Parallel Numerical Computing
Daniel I. Okunbor
okunbor@cs.umr.edu
http://www.cs.umr.edu/nsf/

Oregon State University
Analysis of Algorithms, Geometry, Population Dynamics, and Topology
Dennis J. Garity
reu@math.orst.edu
http://www.orst.edu/~garityd/REU/reuhome.htm

Pennsylvania State University-Erie
Mathematical Biology
J. Carl Panetta
panetta@wagner.bd.psu.edu
http://euler.bd.psu.edu/science/math/REU/index.html

University of Tennessee-Knoxville
Selected Topics in Pure and Applied Math
Suzanne Lenhart
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http://www.math.utk.edu/Docs/reuflyer.html

Trinity University
Dynamical Systems, Algebra and Statistics
Saber Elaydi
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Utah State University
Nonlinear Dynamics
Emily Stone
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http://www.physics.usu.edu/reu.html

University of Washington
Inverse Problems
James A. Morrow
morrow@math.washington.edu
http://www.math.washington.edu/~morrow/reu98/reu.html

Williams College
Geometry
Colin Adams
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http://www.williams.edu/Mathematics/SMALL.html