

Valparaiso Experience in Research for Undergraduates in Mathematics

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Introduction

Valparaiso University is a comprehensive university with nationally recognized academic programs. The approximately 3,500 undergraduate students choose to come to Valparaiso based on its reputation for student centered education with small class sizes. While not required for all students, undergraduate research is part of campus life for many. Each spring the university celebrates undergraduate scholarship with a one-day conference at which over 50 undergraduate projects are represented with talks and poster presentations. In addition to this conference, the engineering senior projects, the senior honors projects, and projects involving the performing arts have their own showcases.

Faculty of the Department of Mathematics and Computer Science have been mentoring undergraduate research for over 15 years. For the past ten years, the department has had a formal undergraduate research program that involves students starting at the freshman year. Each year several groups of students work with faculty mentors during the academic year. These projects finish with a written report, many of which result in presentations at conferences and some in professional papers. In addition to the research groups, faculty regularly work with students in a more informal setting on different projects that usually grow out of classroom assignments.

Building on our experience with undergraduate research groups working during the academic year, we established an REU site two years ago. Consistent with the department's philosophy that mathematics is widely accessible and applicable, our goal is to recruit students for whom this experience will be most beneficial.

Recruiting

At the time of this report our REU program has been in existence for only two years. We received funding so late in the funding cycle that we asked for and were granted a year of delay in starting our program after funding. This gave us ample time to prepare for the recruitment process. We distributed flyers at the Joint Mathematics Meetings and sent mailings to all our target institutions. These

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included small Midwestern colleges, Lutheran colleges nationwide and minority serving institutions. We had approximately 60 completed applications for the first summer. In the second year we did very little advertising, and received about the same amount of applications. Both years we had many very high quality applicants, and we do not wish to dramatically increase the size of the applicant pool. We look for students who are early in their studies and have not yet decided on attending graduate school yet. We also look for students without previous research experience and whose home institution is unlikely to offer a comparable experience.

The only mathematical requirement for participation is a completed Linear Algebra course to ensure that the students have had an introduction to writing proofs.

Participants

In the first two years of the program we had fourteen rising juniors and four rising seniors, sixteen of whom were from schools without PhD programs. We feel very successful in reaching most of our recruiting goals; it is especially noteworthy that 50% of the participants in the first two years were women. We are trying to identify ways of attracting more minority applicants. We had only two qualified African-American applicants in the second year. One of these applicants was one of only two students who turned our offer down and the other student had a successful research experience at our REU.

Staff

Each summer, three faculty direct the projects. In the first two years we had six different project directors. In addition to the project directors, the PI or the Co-PI of the grant serves as the site director overseeing general aspects of the program. The University of Nebraska-Lincoln supports a graduate student who acts as an assistant for our program. We find the presence of the graduate student extremely useful.

Program Overview

Each year we have nine students working in three groups on three very different research projects. The six projects so far have been in voting theory, algebraic topology, network flow optimization, matrix theory, statistics and graph labelings. We feel that it is a strength of our program that each year the students are exposed to three different areas of mathematics. The program runs for nine weeks, and it is divided into three parts.

During the first week the project leaders give lectures to the whole group introducing the topics. This ensures that every student understand all three projects.

During weeks two through seven the groups work under the direction of their faculty advisor. Each group sets its own schedule, but generally, the advisors meet the students 3-4 times a week. Every Thursday the research groups present their progress to the whole group. The faculty advisors give feedback to their own group and these presentations improve dramatically on a weekly basis. On Thursdays we also schedule special lectures given by faculty advisors, the graduate advisor, or visitors. This lecture is followed by a common lunch with opportunity for conversations and discussions of the cultural and recreational opportunities of the following week.

We also schedule 2-3 visits to nearby graduate schools to raise students' awareness of the requirements for graduate programs. Each year a few of our participants come to the program with the conviction that they will pursue graduate studies in mathematics. These students lead the discussions with questions, while the others generally just observe the conversations. We found that it is important to be very specific in communicating our expectations with the graduate schools regarding our visits in order to provide a meaningful experience for the students. It is also essential for our students to have an opportunity to talk to graduate students without faculty hanging over their shoulders.

The last two weeks of the program are spent on preparing the final document, a poster presentation and an oral conference presentation. Each project must prepare a final report. If the results are deemed publishable, the advisor of the group works with the research group during the rest of the summer and in the following academic year to prepare a paper for submission. Although publishing is not necessarily the goal of any project, four of our six projects have resulted in or will result in submissions to refereed journals. During the last week of our program Valparaiso University organizes a poster presentation where all the undergraduate students conducting summer research in the sciences showcase their work. This mini-conference was very well attended by both faculty and students in the past. We also participate at an undergraduate research conference hosted by Indiana University where all the mathematics REU students working in Indiana get together and present their work.

We encourage all our participants to participate at the Joint Meetings after their summer experience. All three groups presented posters at the Joint Meetings in 2006, and we expect the same for our second cohort in 2007. Most of the first cohort did much more than that by giving presentations at regional and national meetings, including AMS regional meetings, the Nebraska Women Conference, and other undergraduate conferences. Students seem to have no problem locating funding at their home institutions to travel to these conferences.

Facilities

The students and the graduate assistant live in the same residence hall together with other students conducting research on campus. As there is no regular dining hall services during the summer, both years the students organized cooking groups and had at least some dinners together.

Each group has a key to a study room in the library. The study rooms are small rooms with movable white board easels. Most groups chose to work in these rooms, a few preferred the common areas of the residence hall.

The students have access to the university's computer network, including Math-SciNet, and inter-library loan services.

The Thursday presentations take place in a small "smart" classroom in the building that is the home to the Department of Mathematics and Computer Science.

Social Activities

During the first two weeks of the program we organize trips to the dunes of Lake Michigan, and to a museum in Chicago. We host a picnic for all undergraduate research students on campus and we invite our participants to the home of one of the advisors for a cook out. These activities help the students become familiar

with each other, with other students, and with some of the most attractive tourist destinations. Thereafter, after the common lunch on Thursdays, the graduate assistant presents all the cultural and recreational options available during the weekend and the following week. The students seem to find ample number of interesting activities. Both years they went to baseball games, visited the Taste of Chicago, went to the local drive-in theatre and participated in the departmental Fourth of July picnic.

Student opinion

One of our participants from the first cohort organized a luncheon for undergraduate research in mathematics at his own institution to promote student interest. Together with faculty from his institution and a participant from another REU they discussed the different programs. This is an excerpt from his e-mail, sent to us in March after his REU experience:

“Some key points that stood out about Valpo’s REU:

- *Groups of three instead of two.*
- *We were very well prepared for speaking about our work.*
- *Our group interacted on so many more levels beyond just math, (I left with a strong sense of community that people of other programs did not express.)*
- *We visited a variety of graduate schools.*
- *Melissa was an amazing help and having a graduate student around was great.*
- *Our reunion in San Antonio was also another unique thing.*
- *The guest speakers we had was another item that stood out at the meeting.*
- *In general, there was a lot more active emphasis on what it is like to think and work like a mathematician.”*

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