

The First Summer Undergraduate Research Program at Clayton State University

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The Bachelor of Science in Mathematics degree is a new program at Clayton State University (CSU) that started in Fall 2004. We recently produced our first two graduates in the Summer of 2006. Currently there are 20 mathematics majors in the department. As a part of the curriculum, each student is required to do a research project and present his/her result in the Math Department Colloquium Series. The mathematics faculty maintains strong commitment in providing research training as an essential part of undergraduate experience for students. I have been actively engaged in undergraduate research since my arrival at CSU, and this inspired me to seek funding from the Mathematical Association of America through their National Research Experience for Undergraduates Program (NREUP). This program is funded by the National Science Foundation, the National Security Agency, and the Moody's Foundation. The grant application requires the Principal Investigator to list students who may participate provided that there will be funds. I received the grant in April 2006 to support four minority students during the Summer of 2006. The program ran for six weeks, starting from May 30. This is the first summer undergraduate research program housed by the Department of Mathematics at CSU. In addition to gaining the experience of organizing such program, I enjoyed my time working with students.

The MAA NREUP. Quoting from the MAA NREUP website, this project “supports the participation of mathematics undergraduates from underrepresented groups in focused and challenging research experiences to increase their interest in advanced degrees and careers in mathematics.” The project has grown significantly, from only four programs in 2003 12 programs in 2006. The program is directed for underrepresented minorities in the mathematical sciences. It provides financial support both for the principal investigator and the students with a maximum total of \$25,000.

Recruitment. For the NREUP, the recruitment process has to be done before the grant is awarded. I spent about three weeks prior to the due date of the proposal to recruit students on campus. Although approximately 63% of CSU student population is composed of minorities, they make up only about 10% of CSU's math majors. Because of this fact, I did have some difficulties in recruiting students.

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However, I also found it helpful to talk to my colleagues to seek recommendations from them of students they are familiar with. In addition, my involvement in our Math Club helped me greatly, since I was able to get in touch directly with students. I was able to recruit three minority students from Clayton State to work along with me for six weeks in the Summer of 2006.

Program Overview. The topic of this summer research experience for undergraduates program was the investigation of solutions of boundary value problems in differential equations. In participating in this summer project, students learned about different types of boundary value problems and some of the classical problems in differential equations, primarily the uniqueness and existence of solutions. Using different methods, such as solution matching and shooting methods, students investigated the third order boundary value problems satisfying different boundary conditions. Based on this research topic, each participant was required to have taken Calculus II.

Because of the nature of the grant application procedure, the program started with a pre-program meeting. Since there was no guarantee of program funding at the time students signed up, this meeting was scheduled to prevent any future conflicts of students' summer plans. I felt that it was important to have students' full commitment to the program and for them not to take any courses during the duration of the program. In this meeting, I explained the scheduling and the expectations of the program.

My intention in working with undergraduate students is to provide them with the experience of doing research. In addition to gaining mathematical knowledge, they would also learn each aspect of research, from looking for ideas, searching for references, finding and summarizing the results, to finally presenting them both through formal presentations and articles. With this in mind, for this summer research program, each student was expected to accomplish the program goals which include

- to gain a working understanding of boundary value problems in differential equations,
- to propose their own boundary value problems,
- to document their work in a journal-formatted paper,
- to present their project in a seminar or conference environment both on campus and off campus.

During the first two weeks of the program, students were given intensive introductory lectures on differential equations and boundary value problems. The group had a Q&A session and discussion in each meeting. At the end of each meeting, an assignment was given for discussion on the following meeting. Students worked together on their assignments in the process of gaining familiarity with mathematical proofs and some theories of differential equations.

Following the introductory weeks, students worked on individual research problems. Each week, students brainstormed together to develop individual research problems. Although each student had his/her own individual research problem, students helped each other throughout the program. They discussed their research project with the group, in addition to discussing the progress with me in the daily meeting.

While working on the individual research problem, each student was expected to turn in a draft article at the end of each week; these papers were then returned, with feedback, at the beginning of the following week. Often, students would also discuss the feedback with the me. By having the papers typed in as the program progressed, it helped avoid delays at the end of the program and students actually became more familiar and more comfortable with their work.

I also think that peer review is an important part of the research process, hence, prior to the final presentation of their research, students distributed their papers among the group and were asked to give each other feedback. To prepare for the final presentation, they also gave practice presentations where their peers listened and gave input.

The program was concluded with a formal presentation on campus. The event was announced in the campus paper, and we invited the Provost, Associate Provost and Dean of Retention from the Office of Academic Affairs, faculty members and students of College of Information Technology and Mathematical Sciences (CIMS). We also invited family and friends of the students to witness their proud moment of accomplishment.

In their presentations, each student discussed their research project and answered questions from the audience. The participants expressed their appreciation of the opportunity and the experience during the intensive six weeks, where they learned what mathematics research means, starting from learning some basic concepts and concluding with proving mathematical problems.

Guest Speakers. I think it is important for students to see how the topic that they are learning is being applied or to meet other mathematicians who do similar research. I invited two local guest speakers; the first speaker, Jason Lanz, was a thermal analyst from Lockheed Martin Marietta who uses the finite difference method in his simulation for the F-22 project, the second speaker was Jeff Ehme of Spelman College whose research expertise is differential equations. Students had the opportunities to meet both guest speakers and spent lunch together with them.

Social Activities. As a part of the program, each week ended with an informal gathering. We planned different activities, including going to the movies, visiting the World of Coca Cola, and going bowling. During the duration of the program, I also liked to sit down and join the students for lunch. We went to different restaurants on several different occasions. This turned out to be a nice way to get to know the students and for the students to get to know me. As a celebration, at the end of the program, students invited their families and friends to go white water rafting at the Ocoee river in the Southeastern Tennessee.

Project Evaluation. The program ran with a total of three students. One student decided that research is not for her, while the other two said that they enjoyed this summer experience despite some frustrations that they experienced along the way. This experience also inspired them to pursue a graduate degree once they finished at Clayton State. Both students will highly recommend this type of program to other undergraduate mathematics majors. The program gave them experiences that went beyond what they learned in the classroom, as well as the opportunity to work alongside their professors and peers. Perhaps, more importantly, they gained research experience that broadened their mathematical knowledge.

I asked students to give feedback regarding the program, to include the research content and the structure of the program. One of the student commented *“The program was a rewarding experience, not just financially, but mostly academically... The program taught me how to work together with others. During the six weeks, I experienced frustration when I couldn’t figure the proofs out or I got stuck, however I also experienced excitement and learned how to be patient when doing research, which helped tremendously. The best part of completing this program was that I felt extremely proud of myself for such an achievement because there were times when I doubted myself... Overall, I would most definitely do another program like this with or without the financial reward.”* Another said that it was very rewarding to learn how to apply a method in a different approach from the journal articles he read. He was able to understand how the method works and applied it on his own research problems.

The students will present their results at conferences. One student will be presenting a poster at the Joint Mathematics Meeting in New Orleans and plans to attend the Mercer University Undergraduate Research in Mathematics Conference in February 2007. Students also plan to attend the Harriett J. Walton Symposium on Undergraduate Mathematics Research hosted by Morehouse College in April 2007.

Conclusion. I cannot place a value on my experience working with these students this past summer. I hope to continue working with students in a similar program environment in the future. Because this is our first summer research program, there are many areas that we can improve. To have a more successful program, we will need to recruit more students and have more participation from our faculty members. Collaborative work among the faculty members, not only as faculty mentors but also as the program administrators, will help the program to run more smoothly. It is also important to have a better screening process of the participants. Improvements under consideration include requiring recommendation notes or letters from faculty members, an unofficial transcript, and for students to list their summer plans. I also found it crucial for students not to take any courses while participating in an intensive research program like this.

We hope to have more opportunities like this for the students at Clayton State University.

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