Introduction

SUMSRI is a program designed to prepare participants for the rigor and pace of graduate school. We feel that this preparation will allow the participants to successfully complete and compete in graduate school. Because of the small number of African Americans, Latinos, and Native Americans with doctoral degrees in the mathematical sciences, we are particularly interested in these undergraduate students. The Institute aids participants by intervening in their learning development at a crucial stage. The main goals are:

- Address the shortage of underrepresented minorities and women mathematicians by producing minority and women research mathematicians.
- Provide the students with a research environment and improve their research abilities.
- Improve the student's ability to work in groups and give them a long term support group.
- Provide role models.
- Improve the students' technical writing skills.
- Give the participants an opportunity to give a talk and to write a technical research paper.
- Familiarize them about graduate school and inform them about available financial aid for graduate school.
- Make the students aware of career opportunities in the mathematical sciences.
- Prepare the students for the GRE.

In the summer of 1999, the Institute operated for seven weeks. During these seven weeks, students participated in a research seminar in linear programming, statistics or algebra. Workshops in technical writing and GRE preparation were held. Also, eight colloquium talks and two short courses on algebra and real analysis were given.

Fifteen participants were accepted into the Institute. These students were from colleges across the country. All of them had completed college level introductory mathematics and/or statistics courses and at least one proof based mathematics course. The average GPA in the mathematical science courses for the participants was approximately 3.5. Each applicant wrote a brief essay on why they wished to participate in the Institute. Two recommendations from faculty members at the student's home institution were received for each applicant. Seven of the participants were African American, seven were Caucasian, and one was Indian. Of the fifteen participants, twelve were female.

Seminar instructors suggested topics that would challenge students to work in teams, draw on their critical thinking and research skills, familiarize them with current literature on the topic, set parameters of the research, and utilize computer modeling programs.

The linear programming students tackled variations of the traveling salesman problem. This problem looks for the minimal travel required for a salesman to cover a specified route.

Kathleen Bellino and Rehka Narasimhan looked at where best to place a movable point, such as a warehouse, based on the fixed location of three cities. This is a variation of the famous traveling salesman problem. The problem can be stated as follows: The point H from which the traveling salesman can start is movable in the plane. Assume there are three fixed points or cities. For each position of H find the minimal trip which starts and ends at H after visiting all fixed cities. In their research, they discovered some interesting geometric properties of the regions formed when two paths have equal length.

Melissa Desjarlais investigated a variation of this problem using four fixed locations. Given a grid in the Cartesian plane, four fixed points are chosen to represent cities. A fifth point H is movable and it represents the traveling salesman's home. Each tour starting at H, visiting all four cities and ending back at H is assigned a color. At each lattice point in the grid, the shortest tour that begins and ends at that point is determined, and the point is given a corresponding color. This produces various colored regions of the plane, and the relationship between the four fixed points and the resulting colored regions are discussed.

James Williams presented still another variation of the traveling salesman problem. Given are four fixed points in three space, each representing a city, and a movable point, which represents the traveling salesman's home. We show that there are only six possible tours that the salesman can take, which start from home, visit each city and then return home. Each tour is assigned a different color. At each point in space, the shortest tour that begins and ends at that point is determined and the point is colored the corresponding color. This produces various colored regions. Mr. Williams studied the relationship between the four fixed points and the resulting colored regions.

The statistics students took on the challenge of randomized response. Randomized response is a method to determine the answers to sensitive questions that a test subject may be unwilling to answer truthfully. Rachel Kahlenberg, Rebekkah Dann, Bethany Lyles and Lynn Holmes conducted research in which students drew a card to determine the answer to two questions. The results were then applied to the question of cheating using a graphic calculator.

Again using randomized response methodology, Bethany Lyles and Lynn Holmes enlarged the sample population and tried to determine how many students at Miami University cheat using graphing calculators. They asked 48 Miami students to flip a coin twice to derive their results.

Rachel Kahlenberg and Rebekkah Dann also investigated the changing number of four-letter words in use in the English language. The number of four-letter words in the English language, which can be represented by the entries in a dictionary, can also be estimated using the population density method. This method estimates the total number in the population by using quadrat samples. Comparing dictionaries from 1950 and 1986 yields data that can be used to note the changes in the number of four-letter words in the English language.

Dugald Hutchings, Margaret Hall, Joy Coleman and Megan Ruhnke looked into a problem concerning the Cayley addition table for Z_n presented in the June-July 1999 American Mathematical Monthly. In this article, Hunter Snevily stated, "Few mathematical objects could be considered more simple than the Cayley addition table for

Z_n, but we show that even these simple objects have some interesting and unproved properties." He then proposed the following conjecture.

> Let n be a positive odd integer. Then for any k $\in$ {1,2,…,n}, the k $\times$k submatrix of the Cayley addition table of Z_n contains a latin transversal.

A transversal of a square matrix is a collection of n entries, no two of which are in the same row or column. The additional latin attribute is used when the entries are distinct. In their research, they analyzed this conjecture.

Final presentations of the research projects were given in the final week using overhead projector slides and Power Point.

Three students attended NAM's Math Fest in Houston, Texas. James Williams gave a talk on his research, while Joy Coleman and Margaret Hall gave a poster presentation. Still more students attended the Joint AMS-MAA-SIAM Meeting in Washington, DC. Lynn Holmes and Bethany Lyles, Dugald Hutchings, Megan Ruhnke, and Margaret Hall, Kathleen Bellino, James Williams, and Melissa Desjarlais presented poster presentations on their research. Ms. Bellino and Ms. Desjarlais both won prizes for their work.

By providing this intensive research program, we endeavored to encourage those who attended SUMSRI to pursue advanced degrees. On student evaluations, 12 students stated that, before attending SUMSRI, they were thinking about pursuing a graduate education. After participating, all fifteen participants emphatically stated that they were definitely going to pursue a graduate education. In the brief period that has followed the summer Institute, the program has made a difference in their lives by encouraging them to participate in national meetings, doing poster presentations, forming supportive groups for one another, and finding role models in the instructors and colloquium speakers.

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