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**Promoting Undergraduate Research in Mathematics**

# National Research Experiences for Undergraduates Program (NREUP)

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## 1. Introduction

The MAA began its Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) Program in 1990. The goals of SUMMA are to increase the representation of minorities in the fields of mathematics, science, and engineering, and to improve the mathematics education of minorities. A number of factors led SUMMA to concentrate on mathematics-based, pre-college intervention (enrichment) programs in the 1990s. But in Summer 2003, SUMMA inaugurated the National Research Experiences for Undergraduates Program (NREUP) with funds from the National Security Agency (NSA). The goal of NREUP is to provide undergraduate students from underrepresented groups majoring in mathematics or a closely related field with challenging research experiences to increase their interest in obtaining advanced degrees in the mathematical sciences.

SUMMA had applied to the National Science Foundation (NSF) in Fall 2002 for funds to conduct a traditional REU at a university campus for 24 underrepresented minority students. That program was modeled on a successful partnership of the Society for the Advancement of Native Americans and Chicanos in Science (SACNAS) and the University of Puerto Rico at Humacao. Their lead researchers were Herbert Medina of Loyola Marymount University and Ivelissa Rubio of University of Puerto Rico. The proposal was not funded by NSF.

## 2. NREUP

Starting only with funds from NSA in 2003, NREUP was radically restructured to support small research groups of one faculty member and four underrepresented students at multiple sites. The Summer 2003 pilot consisted of 3 students at California State University at Chico, 1 student at Goshen College (IN), and 4 students at Texas Southern University. A new proposal to NSF based on this model of supporting several small sites was submitted in Fall 2003 and funded. The combination of NSF and NSA funds made it possible for NREUP to support six sites

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and 25 students in Summer 2004. The Moody's Foundation also provided support so that NREUP was able to support twelve sites and 51 students in Summer 2005. NREUP submitted a new proposal to NSF in Fall 2005 which was funded. Those funds together with funds from NSA and the Moody's Foundation allowed NREUP to support twelve sites and 52 students in Summer 2006.

The following tables show the sites, site directors, research topics, and numbers of students, their ethnicity and gender by year.

| | Site | Director | Topic | Student No., Ethnicity Gender |
|---|---|---|---|---|
| Summer 2003 | CA State Univ. Chico | Thomas Mattman | Knot Theory | 1 Af. American (f)<br>1 Latina<br>1 As. American (m) |
| | Goshen College | David Housman | Fair Division | 1 Af. American (m) |
| | TX Southern Univ. | Nathaniel Dean | Geom. Graph Theory | 4 African Americans (2 m, 2 f) |

| | Site | Director | Topic | Student No., Ethnicity Gender |
|---|---|---|---|---|
| Summer 2004 | CA Lutheran Univ. | Cynthia Wyels | Graph Pebbling | 1 Af. American (f)<br>1 Latina, 2 Latinos |
| | CA State Univ. Chico | Thomas Mattman | Knot Theory | 2 Latinos<br>1 As. American (m)<br>1 Nat Pac Islander(m) |

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|---|---|---|---|---|
| | East TN State Univ. | Debra Knisley | Comp. Biology | 4 African Americans (3 f, 1 m) |
| | Goshen College | David Housman | Fair Division, Coop. Games | 1 As. American (f)<br>2 African Americans (1 m, 1 f)<br>1 Latino |
| | TX Southern Univ. | Nathaniel Dean | Graph, Game Theory | 4 African Americans (2 m, 2 f) |
| | VA State Univ. | Dawit Haile | Graph Theory | 4 African Americans (3 m, 1 f)<br>1 Caucasian (m) |

| | Site | Director | Topic | Student No., Ethnicity Gender |
|---|---|---|---|---|
| Summer 2005 | Atlanta Metro College | Jack Morrell | Discrete Math. | 1 As. American (m)<br>3 Af. Americans (m)<br>1 Latino<br>1 Nat Pac Islander(m) |
| | CA Lutheran Univ. | Cynthia Wyels | Graph Pebbling | 1 Af. American (m)<br>3 Latinos |
| | CA State Univ. Chico | Thomas Mattman | Knot Theory | 2 African Americans (1 m, 1 f)<br>2 Latinos |
| | East TN State Univ. | Debra Knisley | Comp. Biology | 4 Af. Americans (f) |
| | Goshen College | David Housman | Fair Division, Coop. Games | 2 Af. Americans (f)<br>2 Latinos |
| | Howard Univ. | Louise Raphael Daniel Williams | Bioinformatics | 4 Af. Americans (m) |

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|---|---|---|---|---|
| | IN Univ. -Purdue Univ., Indianapolis & St. Mary's College of MD | Benzion Boukai et. al. & Katherine Socha | Theory, Apps. of Math. | 4 African Americans (2 m, 2 f) |
| | Morehouse College | Brett Sims | Modeling Biomagnetism | 4 Af. Americans (m) |
| | Rochester Inst. of Technology | Darren Narayan | Combinatorics | 2 African Americans (1 m, 1 f)<br>2 Latinas |
| | Spelman College | Jeffrey Ehme | Cryptographic Math. | 4 Af. Americans (f) |
| | TX Southern Univ. | Nathaniel Dean | Game, Graph Theory | 2 Af. Americans (m)<br>2 Latinas |
| | VA State Univ. | Dawit Haile et. al. | Cevian Algebras | 4 African Americans (3 m, 1 f)<br>1 Caucasian (m) |

| | Site | Director | Topic | Student No., Ethnicity Gender |
|---|---|---|---|---|
| Summer 2006 | Atlanta Metro. College | Jack Morrell | Discrete Math. | 4 Af. Americans (m)<br>1 As. American (m)<br>1 Latino |
| | CA State Univ. Channel Islands | Cynthia Wyels | Graph Labeling | 2 Latinas<br>3 Latinos |
| | CA State Univ. Chico | Thomas Mattman, Sergei Fomin | Knot Theory, Math. Modeling | 3 African Americans (2 m, 1 f)<br>1 Latino |
| | Clayton State Univ. | Aprillya Lanz | Diff. Eqs. | 2 Af. Americans (f)<br>1 As. American (f) |

| | | | | |
|---|---|---|---|---|
| | DE State Univ. | Mazen Shahin, Elena Surovyatkina | Nonlinear Dynamics | 3 African Americans (2 m, 1 f)<br>1 Latino |
| | DeVry Univ. of NJ | Dov Chelst | Network Analysis | 4 African Americans (3 m, 1 f)<br>1 Latino |
| | Grambling State Univ. | Brett Sims | Modeling Biomagnetism | 4 African Americans (3 m, 1 f) |
| | Spelman College | Monica Stephens | Climate Modeling | 4 Af. Americans (f) |
| | St. Mary's College of MD | Katharine Socha Et. al. | Theory, Apps. of Math. | 4 African Americans (2 m, 2 f) |
| | St. Peter's College | Brian Hopkins | Ramsey Theory on Finite Groups | 4 African Americans (2 m, 2 f)<br>1 Latina |
| | Univ. of TX Arlington | Tuncay Aktosun Minerva Cordero | Modeling the Vocal Tract | 2 Latinas<br>2 Latinos |
| | VA State Univ. | Dawit Haile | Cevian Algebras | 4 Af. Americans (m) |

NREUP has served 136 students (128 from underrepresented groups) since Summer 2003. All of the students have been U.S. citizens or permanent residents. The following table gives the breakdown by ethnicity and gender.

| | African Americans | Latinas/ Latinos | Native Pacific Islanders | Asian Americans | Caucasians |
|---|---|---|---|---|---|
| Male | 53 | 22 | 2 | 4 | 2 |
| Female | 40 | 11 | 0 | 2 | 0 |
| Total | 93 | 33 | 2 | 6 | 2 |

## 3. Outcomes

The success of NREUP must be judged on whether it increases the interest of the participants to pursue graduate studies in the mathematical sciences. If a student is a rising senior when a NREUP participant, then it is easy to track his/her matriculation into graduate school. With younger students, tracking is more difficult for two or more years into the future although planned enrollment can be noted. The site directors can provide contact information but students are less responsive once they have left the program. It might be beneficial for NREUP to focus on rising seniors in its current incarnation with rising juniors and sophomores encouraged to participate in later years. Pre- and post-surveys and

faculty/student comments verify the effectiveness of NREUP in increasing student interest in graduate study. Moreover, NREUP improves students' confidence in their ability to do independent research.

The following results have occurred.

- Summer 2003: All seniors (3 students) attended or planned to attend graduate school.
- Summer 2004: 9 out of 25 students attended or planned to attend graduate school. Some seniors entered the workforce or did not respond to the evaluator.
- Summer 2005: Data collection continues in conjunction with Summer 2006 results.

## 4. Conclusion

The MAA's focus on undergraduate mathematics includes great interest in the Association and among MAA members on undergraduate research. MAA has also focused on encouraging underrepresented minority students to study mathematics and consider careers in mathematics and mathematically intensive fields through a variety of programs under the SUMMA banner. Thus, NREUP is a perfect match of interests with the MAA. Believing that researchers are made not born, SUMMA has established NREUP as a means of addressing the dearth of minorities pursuing graduate studies in the mathematical sciences. Significant numbers of students are benefiting from NREUP and should be attending graduate school in the near term. Other efforts are underway to address these concerns but NREUP can make an enormous impact in the next few years.

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