Math SPIRAL at the University of Maryland

The Mathematics Summer Program in Research and Learning (Math SPIRAL) at the University of Maryland is a six-week program that seeks to enrich the mathematical education of outstanding students from underrepresented groups, and to inspire them to pursue advanced mathematics. It does so with a combination of academic and research activity designed to give the students a "taste" of graduate school in mathematics, along with a number of professional development events to expose students to many possible careers involving mathematics. Students receive a $3000 stipend, housing on campus, and 3 academic credits upon successful completion of the program.

There are several unique characteristics that distinguish Math SPIRAL from a typical REU.

Multi-institution program infrastructure. Math SPIRAL has been developed with the input and ideas of faculty liaisons from eight affiliated colleges and universities: Bowie State University, Howard University, Morehouse College, Morgan State University, North Carolina A&T State University, Spelman College, Trinity University of DC, and Xavier University of Louisiana. (All are HBCUs except Trinity, a women's university.) The faculty liaisons meet each year with the program directors at the University of Maryland, in addition to exchanging ideas and information electronically throughout the year.

Unlike programs that have an open application process, Math SPIRAL considers only students nominated by the faculty liaisons, to ensure the students' readiness and potential to grow from the program. The program provides a replicable example of an effective partnership between institutions to enrich and encourage the mathematical progress of outstanding students from underrepresented groups.

Targeting outstanding students early. Students enroll in Math SPIRAL on average between their sophomore and junior years. The program seeks to engage students at a time when they have decided to major in mathematics but have not decided what to do with their degrees (in particular whether to pursue graduate study). By entering the program at an early stage, Math SPIRAL alumni are equipped to participate in REUs at other institutions their next summer, and indeed many have.

Equal emphasis on classroom and research activities. Math SPIRAL involves a significant classroom component in addition to a research experience; both components are described in more detail below. The classroom component is designed to develop the students' skill at formulating mathematical proofs, both by covering in greater depth topics the students see in proof-based courses at their home institutions, and by introducing topics outside the usual undergraduate curriculum. Success in the student research projects is also measured by what the students can prove about their research problems.

History and Personnel

Math SPIRAL began in Summer 2003 under the leadership of Professor Daniel Rudolph with funding from the National Science Foundation. The National Security Agency joined NSF in 2004 as a primary program sponsor. The program was developed by Professors Rudolph, Duane Cooper (Morehouse College), and William Gasarch (University of Maryland), in collaboration with the faculty liaisons at each of the other affiliated colleges and universities. Professors Cooper, Gasarch, and Rudolph served as program faculty from 2003–2005. After Professor Rudolph moved to Colorado State University, the program has been directed by Professor Brian Hunt in conjunction with Professors Cooper, Gasarch, Marshall Cohen (Morgan State University and University of Maryland), and Leon Woodson (Morgan State University). They are assisted each summer by four excellent mathematics graduate students, who are primarily from underrepresented groups and serve as strong role models for the undergraduate students.

Academic and Research Program

The academic part of the program consists of two courses that run in parallel. One covers foundational mathematical topics, such as set theory, combinatorics, and the notion of a limit, with an emphasis on constructing mathematical proofs. The other covers nontraditional topics such as game theory, cryptography, and Ramsey theory. Each course is team taught by two faculty members and two teaching assistants who are mathematics graduate students from the University of Maryland. Students do daily homework assignments and have a final examination at the end of the program.

Students are presented at the beginning of the program with a menu of research projects, and formed into groups based on the projects they prefer. Each project is mentored by a faculty member and a teaching assistant, who meet daily with the student groups. Many of the projects involve the analysis of games, for which students can formulate conjectures about winning strategies based on playing the games and then learn how to prove them. Other projects explore areas such as probability and cardinality. Student groups give weekly

formal presentations, using a computer projectors, to the other program participants, and give each other written feedback. Their research culminates with a longer presentation on their results that they deliver in the final week of the program. In this way, the program develops the students' oral presentation skills in addition to their mathematical maturity.

Wednesdays are usually devoted to professional development, with a combination of field trips, campus visits, panel discussions, and colloquia. These activities give students an idea of different mathematical career possibilities, and the process of applying to and succeeding in graduate school. See the accompanying 2007 schedule for a day-to-day description of the current program.

Math SPIRAL Alumni: Demographics and Graduate Study

Although Math SPIRAL is still in its formative years, we can cite a number of program alumni from underrepresented groups who are making progress toward graduate mathematics degrees. A total of 73 undergraduate students have participated in the program during summers 2003–2007. Of these 73, a total of 69 are African American or foreign students of African heritage, and 34 are women.

Because students enter the program early in their undergraduate years, most of the 2006 and 2007 students, and some of the 2005 students, are still undergraduates. Math SPIRAL students all come from the University of Maryland (5 of the 73) or one of the eight affiliated colleges and universities. The program does not anticipate that an overwhelming majority of its alumni will enter graduate school in mathematics, but it seeks to significantly boost the number of students from the affiliated institutions that do.

While it is too early for any of the Math SPIRAL alumni to have received a Ph.D., one has received a master's degree in operations research from North Carolina State University. Eight other alumni have enrolled in Ph.D. programs in mathematics (at University of Texas and Washington State University), applied mathematics (at University of Maryland), statistics (at University of Georgia), or operations research (at North Carolina State University). And five others have enrolled in master's degree programs in one of these subjects, or in mathematics education. Several SPIRAL alumni are now pursuing graduate degrees in other subjects, including one in the chemistry Ph.D. program at Harvard University. All but two of the students cited in this paragraph are from institutions other than the University of Maryland, and all are African American with the exception of one African student and one Caucasian student.