

## What Students Say About Their REU Experience

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### The 2006 AMS Survey of REU Graduates

Do REU's do any good?

At a time when more than 80 mathematics REU sites are running; and at a time when the term *undergraduate research* has become a solemn mantra among university administrators; and at a time when some undergraduates believe a refereed article in a mathematics journal is *necessary* for admittance into a good graduate program, this question might seem more than somewhat impolite.

Yet the very pervasiveness of good feeling toward the REU movement seems to create a perceptible murmur of skepticism, a suspicion in some parts of the mathematical community that this whole REU business is wildly overblown. A second reason for this suspicion is that, for many older mathematicians, REU's constitute an unknown quantity.

Thus it is especially timely that in the early months of 2006, the American Mathematical Society did a survey of graduates of REU's in mathematics. The purpose of the survey was to discover what effect REU's in mathematics were having, for good or for bad.

The survey asked what students thought was useful about their REU and sought to find out what had happened to a large echelon of REU students several years after their REU experience. The questions were designed by a committee of five people, including the second author.

At the request of the organizing committee of the AMS-NSA sponsored 1999 Conference on the Summer Undergraduate Mathematics Research Programs the AMS assembled a list of names and addresses of 560 students who participated in an REU program in mathematics between 1997 and 2001. Despite annual appeals from the AMS to update addresses, by 2006 only 444 addresses remained current. In early 2006 the organizing committee of the 2006 AMS-NSA Conference on Promoting Research in Mathematics by Undergraduates sent a survey consisting of 30 questions

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about their REU experience to these 444 students. Because the respondents were commenting on an event at least five years past, they had time to gain perspective on their undergraduate research experience, and were unlikely to be swayed in their responses by an emotional afterglow of a summer's camaraderie. Responses were received from 262 students (59%). Of these, 55% were male, 9% were Latino, and 2% were African Americans. Almost without exception, these respondents were reporting on a summer research program, and for a large majority (75%) this program was held at a college or university different from their own.

The first striking result emerges when these students are asked whether they think their REU was valuable to them. They were offered three choices: *Not Valuable*, *Somewhat Valuable*, or *Valuable*. The answers exhibit a strong consensus. Fully 84% answer that it was *Valuable*; only one respondent says it was *Not Valuable*; the rest answer *Somewhat Valuable*. (Interestingly, 100% of Hispanic students declared their REU experience to be *Valuable*). This is a clear endorsement of REU programs.

The most important question about REU's is whether they really are successful in achieving their goals. Of course goals vary. But the goal of the National Science Foundation and the National Security Agency, (the two principal financial sponsors of the REU programs), is to enhance the research infrastructure of mathematics within the United States. It is therefore impressive that 78% of all of these respondents entered graduate school intending to obtain a Ph.D., and 14% more entered graduate school with the intention of obtaining a Master's degree. Nearly all of those entering graduate school (93%) were seeking degrees in one of the mathematical sciences. These are remarkably high numbers.

Some REU directors believe in the need for a strong instructional element in their program, but apparently they are a minority. Only 31% of the respondents said their REU had a strong instructional component. Moreover, the responses of this sub-population of graduates of REU's with strong instructional elements seemed not significantly different from those whose REU focused exclusively on research. This suggests that both approaches can work well.

It is sometimes said that REU's are only getting the students who have already decided to go to graduate school in mathematics. But the survey results do not support that viewpoint. Out of 262 respondents, a total of 231 entered graduate school (82%), and of these, 78% said that the REU was definitely a factor, or somewhat a factor, in their decision to do so. Only 32% of those who did not go to graduate school say the REU was definitely or somewhat a factor in their decision. This might be the most significant finding of the whole survey. It suggests that REU's are valuable precisely in the way they nurture the *commitment* of a student to pursue a career in mathematics.

The respondents seem quite clear-eyed, however, about what an REU can and cannot accomplish. An overwhelming majority (82%) of those going to graduate school say the REU did not shorten their time there. Another clear majority (53%) of these say the REU did not influence their choice of a thesis area (although 36%

report their REU had at least some influence on their choice). But two out of every three of these say that the REU had some effect in accelerating their development as research mathematicians.

Most respondents believe that graduate admissions committees saw their REU experience as valuable. Three out of every four say that it helped them get into a better graduate program. Moreover two out of every three respondents who had won a fellowship thought that the REU was a factor in the award.

### Snippets From Student Comments

But numbers cannot wholly convey the force of the feeling that comes through from those 79 respondents who chose to append a comment to their response. These comments were sometimes quite extensive. To give the reader some sense of the flavor of these, we have chosen one snippet from each, which seems most nearly to capture the overall opinion expressed. With only five exceptions, these are quite favorable to REU's. The less favorable five appear at the end.

... built my self-confidence . . . .  
*... a good experience, learned so much.*  
 ... learned a huge amount, enjoyed it immensely.  
*... greatly influenced my desire to do research.*  
 ... an excellent experience; fun and challenging.  
*... REU is good.*  
 ... REU's are wonderful experiences.  
*I'm glad I participated in it.*  
 ... pivotal in my attending grad school.  
*... good to experience the frustration of dead ends and elation of breakthroughs.*  
 ... learned at the REU that I enjoyed [research].  
*... really thankful for the experience...*  
 ... a great experience.  
*... a fantastic experience...*  
 ... helped me understand what research IS...  
*... one of the most valuable aspects of my undergraduate career.*  
 ... changed my entire career.  
*... its value can not be overstated.*  
 ... pushed me ... to pursue a Ph.D. Thank you!  
*REU was very helpful in getting to grad school.*  
 I view my REU as a good experience...  
*I'd recommend it to anyone...*  
 ... helped me ... see myself as an equal among all my peers and not as the minority student.  
*... got a sense of what mathematical research would be like.*  
 ... taught me how to chip away at research ideas...  
*My REU experience was very positive...*  
 ... an invaluable experience...  
*I would not have attended graduate school had I not participated in an REU...*  
 ... REU experience was invaluable.  
*REU's ... were life-changing experiences.*

... a wonderful experience.  
 ... *made me excited about doing research.* ...  
 It was very motivating and encouraging.  
*It also planted the idea of graduate school.* ...  
 I enjoyed my REU experience. ...  
 ... *helped me later on in ... graduate school.*  
 ... during my REU experience I first realized I could actually do mathematics. ...  
*Thanks for the wonderful experience.* ...  
 I found that I liked [research], so I went to graduate school.  
 ... *one of the principal factors behind my decision to attend graduate school.* ...  
 ... extremely fortunate that I had the opportunity. ...  
 ... *REU was a great experience.*  
 ... an invaluable research experience.  
*REU I attended was very helpful.*  
 ... greatly influenced my decision to pursue the Ph.D. that I will receive in May.  
*I enjoyed my REU experience.*  
 ... it seems to be almost necessary to have done an REU to get an external fellow-  
 ship.  
 ... *was very instrumental in helping me decide to go to graduate school.* ...  
 Through my REU, I was greatly encouraged.  
 ... *technical skills I picked up during my REU have been very useful.* ...  
 ... a life-altering experience.  
 ... *REU was very interactive and collaborative.*  
 Were it not for ... the REU, I likely would not have considered this career path.  
 ... *REU was crucial for my grad school experience.*  
 My REU was great fun—but not much work.  
 ... *wish my REU had had a more instructional component.*  
 ... more should be done in REU's to encourage students to dive into the literature  
 as soon as possible.  
*Unfortunately, bad professors do exist.*  
 ... a rigorous undergraduate education in mathematics is much more useful than  
 an eight-week summer program.

The survey provides overwhelming evidence that REUs are achieving the goals  
 for which they were created: to encourage mathematically talented students to pur-  
 sue graduate degrees and to provide participants a meaningful research experience  
 at the undergraduate level that accelerates their development as research mathe-  
 maticians. A side benefit to the mathematical community is that REUs provide an  
 early introduction to the profession.

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