# How Can REUs Help Retain Female Undergraduates?

## REUs INCREASE ENROLLMENT IN GRADUATE PROGRAMS AND RESEARCH CAREERS

Research Experiences for Undergraduates (REUs) can increase the rates at which women and under-represented minorities enter the highest levels of IT research and development. REUs lead to greater understanding of research, confidence in research skills and general mastery of the discipline, and awareness of career paths requiring an advanced degree. As a result, students become more interested in pursuing an advanced degree.

## CRAFTING A PROJECT FOR UNDERGRADUATE SUCCESS

Student confidence and motivation to enter graduate school improve with positive research experiences. Positive REUs give students the feeling that they have made a real contribution, despite their lack of computing research background. Ideas for creating such an experience come from The University of Wisconsin's "Entering Mentoring" manual for training scientists to mentor (see URL below.) It recommends projects that:

- are multi-faceted, but with a reasonable scope for the time frame
- are feasible in relation to the student's existing skills, but also build on them
- have built-in difficulties that will be faced after the student has developed some confidence
- generate data or analysis that the student can present orally or in writing
- go *beyond* cookbook experiments or free programming labor

Faculty and graduate mentors should talk to students about their skills and interests, mentor them about scientific inquiry, and establish clear expectations for project outcomes.

## MODELS AND ELEMENTS OF A POSITIVE RESEARCH EXPERIENCE

Whether part of a formal program or a special opportunity for individual students, REUs can take several forms. For example, summer experiences can take place at another institution or on a student's own campus, where the social and academic setting is familiar. Academic-year experiences can occur as part of, or in addition to, the regular course load. Many faculty advisors bring undergraduates into their labs to work with their graduate students.

No matter what the model, certain components help motivate students to enroll in an advanced degree program:

- A collegial, supportive relationship with the faculty advisor and/or graduate mentor
- A large amount of time spent on research
- Clear communication of students' readiness and outcome goals (e.g., presentation of results) from the outset, making students feel well-prepared
- Student independence increases as the research process progresses

Students also are more likely to apply to graduate school when their research experience includes guidance on choosing a graduate program, writing a strong application, and setting expectations for the graduate experience and research careers.

## NSF REU SUPPLEMENTS: AN EASY WAY TO SUPPORT A BUDDING RESEARCHER AND FUTURE COLLEAGUE

The National Science Foundation makes it easy to support an undergraduate researcher. You can ask for a supplement for almost any NSF grant – or one held by a colleague – to support an undergraduate researcher with a substantial stipend. Ask your program officer for details.

## HOW CAN YOU SHOW UNDERGRADUATES THE BENEFITS OF A RESEARCH CAREER IN COMPUTING?

When advertising REU opportunities, it's helpful to know what motivates students to get involved. For example, many students participate in REUs because they want help in making career decisions; these students also are more likely to consider an advanced degree as a viable option, according to research by SRI International. A valuable tool for communicating the benefits of a research career is a slide show entitled, "Why choose a Ph.D. in CS?" available on the Computing Research Association's website: www.cra.org/highlights/student.html.

## RESOURCES

Barker, L. (2009). Student and faculty perceptions of undergraduate research experiences in computing. *ACM Transactions on Computing Education, 9*(1) Article 5.

Hunter, A.-B., Laursen, S.L. & Seymour, E. (2006, February). *The Benefits and Costs of Faculty Engagement in Undergraduate Research and their Sources*. Presented by Elaine Seymour at the conference To Think and Act Like a Scientist: The Roles of Inquiry, Research, and Technology in the Precollege and College Years, Texas Tech University, Lubbock, TX.

Russell, S. (2005). *Evaluation of NSF Support for Undergraduate Research Opportunities. 2003 NSF-Program Participant Survey: Final Report* (SRI International). Available at www.sri.com/policy/csted/reports/university/index.html#uro.



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# Faculty Perspectives (Case Study 1)

## Using REUs to Retain Female Undergraduates

**Undergraduate**

### WHAT DO FACULTY LIKE ABOUT RESEARCH EXPERIENCES FOR UNDERGRADUATES (REUs)?

Researchers Anne-Barrie Hunter, Sandra Laursen, and Elaine Seymour (co-author of *Talking About Leaving: Why Students Leave the Sciences*) interviewed 64 computer science, math, engineering, and science faculty members involved in undergraduate research programs. Faculty described several benefits of being involved: faculty career gains; pleasure of working with students as research colleagues; intellectual and professional growth; and satisfaction in students' "becoming scientists."

### CASE STUDY: VIRGINIA TECH UNIVERSITY

Professor Scott McCrickard has worked with undergraduates since he was a Ph.D. student at Georgia Tech, where he served as a graduate mentor in two summer outreach programs. Both mentoring experiences resulted in publications for him and his students. They have also influenced his research career at Virginia Tech, where he established the Virginia Tech Undergraduate Research in Computer Science (VTURCS) program in 2001. Despite enrollment decreases in the major and the program's slow start, VTURCS matured to include over 50 undergraduate students in 2005. In 2006, McCrickard expanded VTURCS with NSF funding for an HCI-focused REU site that targets women and minority students.

#### Why does he continue to do it?

McCrickard says he benefits as much as the students. He has published several small articles based on his partnerships with undergraduates, some of which combined nicely as case studies for journal papers. But he says the most valuable result is that it has created a research group and community around his interests.

#### How does he work with undergraduates?

McCrickard suggests giving undergraduates simple, focused tasks. This method allows him to see the capabilities of the undergraduates, and also helps his Ph.D. students create focused tasks and do something with the results of those tasks. He prefers to meet with his undergraduates and graduate students as a research team; these teams are composed of four to six undergraduates and his graduate students. Still, he recommends meeting with each undergraduate individually a few times each term as well. As the students gain confidence and experience, they can be given more complex tasks with deadlines further apart, leading them to the point where perhaps they will define their own thesis or dissertation topics.

### RESOURCES

For more information, please contact Professor Scott McCrickard at the Virginia Institute of Technology (mccricks@cs.vt.edu,) or Professor Margaret Burnett at Oregon State University (burnett@cs.orst.edu.)

### CASE STUDY: OREGON STATE UNIVERSITY

An REU need not be administered through a formalized program. Since 1992, Professor Margaret Burnett has always had one or two undergraduate researchers working for her.

#### What does she get out of it?

Burnett describes three kinds of benefits to her own career: increased productivity, relationships with new researchers, and making a difference in the students' lives.

The undergraduates round out her research group. When they take on research tasks otherwise done by graduate students, it allows graduate students to be more productive. She says that some of her undergraduates are more productive than some grad students at tasks such as software development, data analysis, user studies, and interface design. Some have even better writing skills than their graduate student team-members.

Burnett believes that she is not just giving opportunities to undergraduates, but that her own research community benefits as well. She writes, "These students are good—in fact, some go on to become famous. They appreciate the extra opportunities, they remember you, and they remain enthusiastic about all they learned from the experience."

According to Professor Burnett, there is an additional benefit. "Giving these students just a small amount of time can make a huge difference in their careers. Some have never thought of graduate school, or have believed themselves unworthy of aspiring to graduate school. These experiences change their lives. Eleven out of sixteen of my REUs have gone on to complete advanced computer science degrees."

#### How does she work with undergraduates?

Burnett says the undergraduates are regular members of her research group, like graduate students. They support software development of research prototypes and do everything else graduate students do: help to write, read, and review papers; attend group research meetings; help with empirical studies; and prepare posters for required presentations.

**NCWIT offers practices for increasing and benefiting from gender diversity in IT at the K-12, undergraduate, graduate, and career levels.**

*This case study describes a research-inspired practice that may need further evaluation. Try it, and let us know your results.*

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# Affinity Research Groups (Case Study 2)

## Using REUs to Retain Female Undergraduates

**Undergraduate**

The Affinity Research Group model (ARG) integrates student participation in research teams and a structured cooperative learning environment. The ARG model is especially effective for reaching out to students who are competent, but who lack confidence—students who are often not invited to do research. The result is greater engagement, increased confidence, increased likelihood of pursuing a graduate degree, and the development of collaboration skills.

The components of ARG are:

- **An annual orientation.** This event helps new student members to assimilate and build research skills.
- **A research project framework.** A clear project framework and project definitions are important for helping students understand the relevance of their assignments to each other and to the research goal.
- **Defined deliverables.** Defining the outputs, assigning tasks that an undergraduate can accomplish, and setting clear deadlines allow group members to develop domain expertise while structuring individual accountability.
- **Regular meetings.** These meetings promote productive faculty-student and student-student connections. They create a structure for reporting on progress, solving problems, sharing successes, and engaging in group and self-assessment.

The foundation of the ARG model is cooperative learning, which has five elements:

- **Positive interdependence:** Establishing an environment in which students understand that they will not succeed unless all group members succeed is key. Responsibility to others within the group ensures that each member feels a sense of contribution to the success of the group and feels comfortable calling on other members for support.
- **Face-to-face promotive interaction:** Regular meetings create opportunities for sharing resources, mutual encouragement, and applauding each other's efforts to accomplish challenging research tasks.
- **Individual and group accountability:** The group as a whole and each member are held accountable for meeting project milestones. Each task is associated with a deliverable and each member is assigned responsibility for completing tasks.
- **Group and professional skills:** Because ARGs include students with varying experience levels, faculty members must explicitly teach and model interpersonal skills necessary for group work. Basic skills include active listening, active participation, and recording minutes. More advanced skills include summarizing, providing direction, synthesizing ideas, asking questions, facilitating brainstorming sessions, and offering constructive criticism.
- **Group processing:** While faculty mentors direct programmatic changes, all members are involved in discussions reflecting on the group's progress: what activities and behaviors to continue or change.

### ARG BUILDS CONFIDENCE AND AWARENESS

***Nelly Delgado,*** *Senior Technical Writer for Microsoft, participated in an Affinity Research Group at the University of Texas-El Paso*

"I don't think I would have considered grad school had it not been for ARG. We wrote papers, went to conferences, and understood what it was to do research. I knew what it meant to get a PhD or to do a master's thesis." Having been a part of an ARG as an undergraduate made her more confident in her studies when she decided to attend graduate school. In her ARG she learned that "You don't have to have the answers in order to go on. You have to be interested in the question."

Nelly points to her experience in an ARG as something that helped prepare her for her present position: "I knew I had the foundation through my education and ARG to figure out problems and then write about it in a way people could understand. You have to work with different people. It's collaborative."

*A handbook on implementing the ARG is now available from the IEEE Computer Society (Gates et al., citation below).*

**RESOURCES**

Gates, A. Q., Roach, S., Villa, E., Kephart, K., Della-Piana, C., & Della-Piana, G. (2008). *The Affinity Research Group Model: Creating and Maintaining Effective Research Teams.* IEEE Computer Society. www.computer.org/arg

The Cooperative Learning Center at the University of Minnesota: www.co-operation.org

**Case Study Contributors:** Stephanie Hamilton and Sarah Sutter

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