



## WHAT WORKS - A PKAL ESSAY

# RESEARCH-RICH: THE UNIVERSITY OF ARIZONA STORY

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*Recognizing that today's STEM students will have opportunity to become members of a global STEM community, how can we capitalize on the unique capacities of the University of Arizona (a Research I university) to give our undergraduates the kind of research-rich, international opportunities for learning that would ensure their successful socialization into that community?*

Undergraduate research programs provide students with skills necessary to succeed in today's global society. Participants learn not only how to pose and answer questions, but they also learn the importance of networking, they develop communication skills, they learn to work in teams, and they frequently encounter others who share their scientific interests but come from very different cultural backgrounds.

Over the past twenty years, observation, creative thinking, and careful record-keeping have taught us how to maximize student gains through research experiences in research-rich environments. We also have learned how such programs can serve as the hub of a suite of programs that can benefit other populations including elementary and high school students, teachers, and community college students and faculty.

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This story emerged from the 2005 PKAL LI Leadership Seminar: *Research-Rich* held at the University of Maryland Baltimore County in Baltimore, Maryland.

This seminar was part of the 2004-2007 PKAL Leadership Initiative (LI) an NSF-funded initiative. The intent of this initiative was to nurture campus-based leadership teams tackling the interesting and challenging work of building and sustaining robust STEM learning environments for undergraduate students.



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## Benefits of Providing STEM Undergraduate Research Programs in Research-Rich Environments

Research I (R1) universities have a vital role to play in the development of the future STEM workforce. While they are sometimes criticized for neglecting undergraduate education, their research-rich environment provides an ideal setting for undergraduate research and related outreach programs. Reasons for this include:

1. **An abundance of research opportunities.** The volume and variety of ongoing research projects provide abundant opportunities to incorporate undergraduates into research groups.
2. **Research as a year-round activity.** Because research is taking place on the students' home campus, students can have an experience that is not limited to a single summer.  
  
By working year-round on their project, students can make more significant progress than they would if their research took place only during the summer through a program offered at another institution
3. **Research infrastructure.** The equipment, expertise, and supplies are readily available so no project is impeded by a lack of the necessary instrumentation.

4. **Availability of mentors of several types.** Because R1s have primary missions in both education and research, they attract graduate students and post-doctoral fellows who participate in the informal education of the undergraduate researchers.

Individuals a few rungs higher on the educational ladder become near-peer mentors who can provide valuable perspectives to undergraduates considering STEM careers.

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5. **Frequent campus seminars.** A large number of scientific seminars featuring both local and visiting scientists occur all year, exposing students to cutting edge research and introducing to students how that research is communicated in diverse fields.

This enables students to learn about research in a variety of disciplines and helps them to see how knowledge and different approaches can combine to solve scientific problems.

6. **On-campus conferences and poster sessions.** Each year R1s host multiple conferences and poster sessions. Some might be for scientific societies (i.e. the regional meeting of the AAAS or the American Chemical Society) or for graduate recruiting; others might be small specialized conferences bringing together people working on a very specific problem.

These provide venues for undergraduates to present their scientific results and thus develop presentation skills that will serve them in good stead.

7. **Research related workshops.** R1s offer free on-campus workshops to support the research community and these are accessible to undergraduates. For example, students might attend an imaging workshop or a proposal-development workshop.

Because they are a part of the research community, undergraduates are welcome at these "outside-of-class but still highly relevant" events. Thus students discover that learning is life-long, and that it is necessary to stay current with new technology as well as to develop and refine skills.

8. **International scholars.** R1s attract a large number of visiting STEM scholars and researchers. Undergraduates are drawn to these individuals through their shared scientific interests and learn about other cultures in the process.



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The relationship between the visiting foreign scholar and the undergraduate student can become the basis of a long-term friendship and potential collaboration. Students discover that science is international and that the problems facing humankind will require a solution from those who can work cross-culturally.

Reading about water-borne parasites in Peru, for example, doesn't enforce urgency in the way working directly on the problem with a Peruvian scientist does. This interaction often stimulates students to want to visit and work in other cultures.

Key to a successful undergraduate research program at an R1 institution is a supportive faculty. Fortunately, at the University of Arizona (UA), the faculty is very supportive of undergraduate research and has developed several model programs.

What follows is a brief description of two well-established programs: the Undergraduate Biology Research Program (UBRP) and the Biomedical Research Abroad: Vistas Open (BRAVO!) Program that both bring the resources of a R1 university to bear on undergraduate education.

## The Setting and the Programs

The University of Arizona (UA), Arizona's land grant institution, has an enrollment that tops 37,000. It consists of 18 colleges, including the state's only colleges of medicine, agriculture, public health, and pharmacy.

According to NSF, UA ranks 13th in research expenditures among public institutions and 21st among all colleges and universities in the United States (FY 2005/06, most recent data available).

Moreover, NSF ranked UA first in the country in research expenditures in the physical sciences.<sup>i</sup> UA also attracted more than \$530 million research dollars from all sources in 2005.<sup>ii</sup>

## The Undergraduate Biology Research Program (UBRP)

In 1988, UBRP was established to provide a central point through which students of any major could access a paid biologically- or biomedically-related research experience.<sup>iii</sup>

Starting with 19 students working in 13 faculty members' laboratories located in 6 different departments, the program has now grown to support more than 140 students each year who can work with any of the 240 faculty mentors in 43 departments and 8 colleges.

The program has historically been funded by participating faculty who write student wages into their research grants, and by external grants to the University of Arizona. Efforts are underway to build an endowment for UBRP that will make it a permanent part of what is offered to students.

UBRP program goals include:

- ◆ Enabling students to experience how research is done.
- ◆ Helping students to develop the skills and experience necessary to pursue post-baccalaureate training or work.
- ◆ Fostering a community of scholars and giving students a "home base" on campus.
- ◆ Providing experience through which students can make informed career decisions.
- ◆ Advancing science through students' discoveries.

UBRP is described in articles that appeared in the *Council on Undergraduate Research Quarterly*,<sup>iv</sup> the *Molecular Biology of the Cell*,<sup>v</sup> the *Pharmacologist*,<sup>vi</sup> and the *CUR Quarterly*.<sup>vii</sup>

## Biomedical Research Abroad Vistas Open! (BRAVO!)

More than 70% of UA students are in-state residents and most come from families of modest means. Many have never traveled outside of the Southwest United States.

In 1991 we created the BRAVO! Program to provide these students with a broader world view by building on their scientific interests.



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The goals of BRAVO! include:

- ♦ Introducing UA undergraduates to the international scientific community by enabling them to do paid research with the foreign collaborator(s) of their UA faculty mentor.
- ♦ Advancing collaborative projects between UA scientists and scientists abroad.

BRAVO! students become our scientific and cultural ambassadors—traveling to foreign countries where they readily integrate into a foreign research group.

To date, we have supported more than 160 BRAVO! students who have worked at institutions in more than 30 countries on six continents. BRAVO! is described in articles that have appeared in Council on Undergraduate Research (CUR) publications.<sup>viii</sup>

## Conclusion

R1 Universities are well positioned to play an important role in educating the global STEM workforce of the 21st century. Welcoming undergraduates into research groups at R1 institutions enhances students' educational experience as well as advancing science. ■

## References

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