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Research by Undergraduates Helps Underfinanced Colleges as Well as Students

By Anthony Carpi and Nathan H. Lents

While undergraduate research has been lauded as a transformative experience that helps nurture future scientists, its effect on *institutions* is often underappreciated. This is especially true for underfinanced, public, and minority-serving institutions, which are the least able to offer such experiences to students.

At the John Jay College of Criminal Justice, in the City University of New York, we have seen firsthand how an initiative to offer undergraduate research in our department of sciences has led to significant program development and increases in institutional investment and external funds. Our Prism project (Program for Research Initiatives for Science Majors) has catalyzed a self-perpetuating cycle of growth and expansion. And it has allowed our science department, located within a large minority- and Hispanic-serving college, to become a consistent feeder of minority and first-generation students into graduate programs in STEM (science, technology, engineering, and mathematics) fields.

As one of our recent science graduates told us, "Graduate school wasn't even on my mind before Prism."

As more colleges realize the benefits of undergraduate research, more graduate-school applicants have research experience under their belts, including presentations at conferences and even co-authorship on publications. While such experience was once rare, it is now expected, even required, especially at the most competitive graduate programs. Many students whose parents went to college understand this, but first-generation college students and others whose backgrounds give them less familiarity

with career plans are often at a disadvantage.

It has been documented time and again that undergraduate research leads to improved learning comprehension, academic success, and rates of retention and graduation. Further, undergraduate researchers are much more likely to pursue postgraduate education, a trend that is also true among underrepresented students in STEM fields.

However, undergraduate research programs in the sciences are expensive. Colleges must invest in designing and outfitting research labs, and faculty members involved in mentoring may need reduced teaching loads. Large research universities already have the necessary infrastructure, but many minority-serving institutions do not. Even more challenging, stipends and other financial incentives are important to ensure the participation of financially needy students.

Thus, while the trend toward undergraduate participation in research may benefit the state of science education nationally, there is a serious danger of exacerbating disparities if care isn't taken to support such experiences at institutions that may not be able to afford them.

Undergraduate research clearly benefits students, but the positive effects of mentoring on faculty and academic departments are less well known. Beginning in the late 1990s, we began our initiative to promote undergraduate research in the sciences. The effort has enhanced the visibility and success of our STEM programs and helped establish a collegewide culture of undergraduate research.

Before 1999, undergraduates rarely conducted research with faculty mentors. In 1999, three students (two minority men and one woman) were invited to participate in a pilot project that paired them with faculty members. When they graduated, in 2002, all went on to doctoral programs, a notable achievement for a program that had sent a total of five undergraduates on to Ph.D.'s in the prior decade.

This led to the formation, in 2006, of Prism, financed entirely by external sources. Since then the number of science graduates has more than tripled, and we have seen a fivefold increase in the number who go on to graduate school.

As student research became more visible, the college began to allocate more resources to the science department, beginning a self-feeding cycle of growth and expansion. The science department, in turn, hired more faculty members. Now it has 26 full-timers, up from 12 in 1999. Similarly, 88 percent of faculty members now serve as research mentors, up from 58 percent in the late 1990s. In 2012, external financing from federal, state, or private sources was more than \$2.25-million annually, up from \$140,000 in 1999. Nine of 22 faculty members had secured external financing in 2012, up from two in 1999.

While Prism is wholly paid for externally, scientific research requires a significant investment in facilities—a difficult commitment for an underfinanced institution. In 1999 we had only four laboratories, forcing some professors to use converted closets and even a projection room to conduct experiments. To support the growing participation in research, the college invested almost a half-million dollars in refurbishing existing classrooms and offices. By 2009, 22 newly dedicated research labs had been created, with more than six times as much laboratory space as before.

Following the success of a Prism undergraduate research symposium, in 2007, the college created an institutionwide event to celebrate student scholarship in 2008. In 2010, partially motivated by Prism's success, the provost created the Office of Undergraduate Research.

Possibly the most profound sign of the transformation spurred by the new focus on research is the growing number of graduates who pursue doctoral studies. Before 2001, a trickle of John Jay undergraduate alumni pursued doctoral studies in STEM programs. In 2012 alone, eight students, including six from underrepresented groups, entered STEM graduate programs. Graduate programs that currently enroll our alumni include those

at Albert Einstein College of Medicine, Cornell, Harvard, and New York Universities, the State University of New York at Stony Brook, and the University of California at Davis, among others.

Unfortunately, underfinanced public and urban institutions are among the least able to offer undergraduate research. One solution has been to create networks of off-campus research internships, often at elite universities interested in enhancing their diversity. However, this trend may actually be harmful to minority-serving institutions, eroding their capacity to create faculty-student relationships, develop student talent, and promote high-impact scientific research on campus.

Our experience serves as a strong argument in support of federal and private funds for undergraduate research at institutions that cannot afford to develop those programs themselves.

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Though the STEM disciplines often take the lead on undergraduate research, other disciplines can do it, too. My colleagues in History and Psychology have engaged undergraduates in their research with considerable success.

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Congrats with your program. It is good to see the positive benefits for the students and also the wider institution. I have seen similar benefits through the federally-funded TRIO Ronald E. McNair Postbaccalaureate Achievement Program. While I have not been a faculty mentor yet through our campus program, several of my colleagues have and they share the wonderful experiences for them. Keep up the excellent work and keep reporting your findings.

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The University of Houston-Downtown, a minority-serving, Hispanic-serving, regional comprehensive university, has emphasized undergraduate research for over a dozen years all across STEM areas, and the impact on student future success from entry into graduate programs, professional schools, and industry jobs has been spectacular.

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It's great to hear of the undergraduate research programs at CUNY John Jay. The Council on Undergraduate Research (<http://www.cur.org>) has been working with campuses within the CUNY system over the past few years, to assist in expanding and connecting their undergraduate research programs. This work has been funded by the National Science Foundation DUE grant 09-20275.

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