

Building a Dynamic University-Community College Partnership: The Second Decade of a Broad, Mutually Beneficial Materials Science Collaboration

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ABSTRACT

Collaborations between community colleges, non-research centered universities and research universities can enrich the flow of students into Science, Technology, Engineering and Mathematics (STEM) majors and careers. The nation is beginning to understand the importance of such interaction especially with under-represented minorities and those with disabilities. For over fifteen years our group has developed new ways to integrate these students and their faculty to the research culture. This will lead to increased diversity and inform research university faculty of the great talent that is latent in these underserved pools.

INTRODUCTION

Partnerships between universities and community colleges are increasingly important for enriching the flow of students, particularly under-represented minorities and those with disabilities into STEM careers [1-4]. Howard University (Howard below) and Prince George's Community College (PGCC) have been working together for over 15 years, first in a unique REU program for community college students and since 2006 as part of NSF sponsored research and education programs. The partnership includes collaborative research in materials science and education, creation of instructional materials and new courses that support STEM education at both institutions. About eight years ago the collaboration was enriched by Gallaudet University (Gallaudet below) joining. Support came from NSF sponsorship of collaborations involving Johns Hopkins and Cornell (Partnership for Research and Education in Materials /PREM) and Harvard and MIT (Center for Integrated Quantum Materials STC/CIQM). Key accomplishments include involvement of PGCC and Gallaudet faculty and students with research programs, involvement of Howard faculty in PGCC curriculum changes and student

successes and the cross-mentoring provided to the student interns by the faculty and staff.

Experience shows that everybody benefits from these partnerships. They have changed perceptions on all sides. One of our colleagues wrote to us after being involved with a PGCC student who was mentored both at Howard and Hopkins:

In terms of the “transfer student” issue, I am also sure that the experience of one of our students, who came from a community college, was the difference-maker in giving him the confidence to apply to top research universities to complete his Bachelor’s degree. He had offers of admission from at least two such schools, and selected one after being offered a full scholarship. To have reached this level of achievement, including likely co-authorship on two manuscripts now in preparation, from a community college level of preparation is simply astounding.

One other benefit to my own group that I should mention: one of the postdoc mentors is now applying for academic positions, and has obtained an instructor position at a local college as a steppingstone. I am confident that his experience in mentoring diverse students is serving him well in this new role, and is a highly positive.

For research university partners this is important as they serve many community college transfer students as well as being the source of community college faculty. At Gallaudet, student participants and others increasingly declare STEM majors. The collaboration expanded students’ horizons to undergraduate research not only within our collaboration but elsewhere and eventually to graduate study. The involvement of PGCC faculty in research at Howard has built connections to the research enterprise. Faculty at Howard have become involved in educational materials creation with PGCC collaborators.

Our partnership has helped catalyze the construction of new buildings (Howard’s Interdisciplinary Research Building) and laboratory renovations at Gallaudet. The inclusion of Gallaudet, which predominantly serves deaf and hard-of-hearing students, has introduced another dimension of cultural awareness and diversity.

The collaboration provides year round opportunities to undergraduates for research with multiple levels of mentoring. Course development supports materials education from online textbooks for targeted classes, laboratory experiments with an emphasis on online collaboration typical of the modern workplace and spreadsheet based applets. New courses at PGCC include Materials Science for Scientists and Engineers and a one-semester General Chemistry for Engineers [5]. PGCC is working on a materials based curriculum for engineering that emphasizes materials and coordinating between entry level courses in engineering, mathematics, chemistry and physics. By visiting Gallaudet, other partners learn about classroom and laboratory accommodations for deaf and hard of hearing. PGCC and Gallaudet faculty and student participants have access to more advanced research facilities at Howard throughout the year.

DISCUSSION

Scientific training occurs in the context of research. Today this extends to the undergraduate level at colleges and universities and even into secondary schools. Students with research experience have an immense advantage over those who do not. Segregation of community college students, under-represented minorities (URM) and the disabled from these opportunities limits STEM career success. There has been a serious effort to involve STEM students in research, especially through summer and targeted URM programs but most are temporally and spatially disjoint from the research enterprise, often bringing unprepared students to research institutions for some weeks without involvement of the faculty at their home institutions or continuity beyond the summer. Administrators, faculty and students at minority serving institutions are often isolated from the international community of research universities, entry to which is difficult for outsiders.

About eleven years ago the NSF/Division of Materials Research introduced a program designed to knock down these silos, the Partnerships for Research and Education in Materials (PREM), which teamed a minority serving university with a research university Materials Research Science and Engineering Center (MRSEC), in our case Howard with the Johns Hopkins MRSEC [6]. Our PREM broadened this to develop an innovative and successful model for bringing non-traditional populations into the pipeline from community colleges (PGCC) and expanded in 2010 to an institution serving deaf students (Gallaudet). In 2012, when the Hopkins MRSEC lost funding, the collaborators joined with the Cornell University Center for Materials Research in a successful PREM, and in 2013 in a successful Science and Technology Center proposal with Harvard and MIT as part of the Center for Integrated Quantum Materials. CIQM extended the model to other non-research centered institutions in the Boston area including Bunker Hill Community College, Mt. Holyoke, Wellesley and Olin Colleges. Our experience can benefit others building programs serving these different types of institutions, their students and faculty and the nation.

We have found three important principles: continuity, preparation, and committed partners [6] who work together as equals.

Ten week Research Experiences for Undergraduates (REU) are interesting for students who are acculturated to research, but often involve a frantic last week. This is especially true for research naïve students such as those from community colleges, minority serving institutions and those serving the disabled. Our practice has been that students spend their first summer at Howard, they have the opportunity to continue during the academic year and selected students can go on the next summer to one of our research partners. During the summer at Howard we emphasize proper laboratory behavior and safety, record keeping, searching and analyzing publications, writing and presentation skills and move to instrument training, including optical, electron and atomic force microscopy, device characterization and lithography. Each student has a research project, but our time horizon is longer. In practice there is enough progress for a poster presentation at the end of the summer. The students must suggest future work and direction for the project especially in cases where the summer was not sufficient to complete the project.

Based on a successful earlier REU program for Maryland community college students at Howard we provide tutoring and repeat simple rules for successful transfer. Students are advised not to take heavy loads during their first semester, to take additional courses to help them maintain their full time status in case they end up dropping another course. They are also encouraged to join a major's club and provided with tips on how to approach instructors with well-defined questions. The value of study

groups are stressed. These may seem simple, but are ones that often expose community college students to transfer shock.

We encourage those who have spent a year at Howard to apply to other summer research programs. A pleasant surprise has been how the training the students received makes them both attractive to and successful in research institution REUs.

Howard acts as middleware, providing an on campus living experience for the community college students and exposing them to the research culture particular to scientific laboratories and graduate school. This role can be played not only by research involved minority serving institutions but by comprehensive universities with advanced research programs.

A central issue for REU programs is follow on. Student internships bring short term benefits to the organizations where the interns work while at the same time benefiting the interns by reinforcing or leading to STEM career choices. Yet, there is a low multiplier effect beyond students communicating their positive experience to other students in their class. Involvement of faculty from PGCC and Gallaudet has built long term involvement coupled with a more mature and sophisticated intellectual exchange. The partnership created a materials science seminar class at PGCC which was cross listed over all STEM departments. Guest lecturers from the other partners were treated by the students as special occasions and attracted crowds well beyond the enrollment. PGCC engineering students use Howard instrumentation in their classes. Even something as simple as posting duplicate copies of the students' research posters had a constant and positive reinforcing effect. Such things and more required that the faculty members be committed to the program and willing to devote time and effort. The effort must be supported but it need not be high.

Our partnership has a basic principle that the final choice on selected students be made by the faculty at their schools, often in consultation with each other. As partners who have developed trust with each other, we can be honest. This contributes to formative evaluation of the selection process and feedback from the host laboratories allows what proved to our great pleasure to be an affirmation of the skills and potential of the Howard, PGCC and Gallaudet students.

Because the Howard, PGCC and Gallaudet faculty are partners, we had an interest in informing others at our institution about the program and recruiting new students. The PREM made duplicates of the student presentation posters that were placed in the hallways of their building, unique for a community college and unusual at Gallaudet. PGCC started a STEM cross-listed nanotechnology seminar at which faculty from partner universities presented, but also where the REU students could talk to other students about their experience. Most community college students are not aware of REU programs. Our partnership guides them to apply for and win appropriate research internships. We also web cast some group meetings from the Cornell MRSEC which was of great benefit to the faculty and graduate students at Howard.

Faculty and Student Teams (FaST)

Eight years ago the PREM began working with Gallaudet to develop a STEM training program with deaf students. Because sign translation would be needed, Faculty and Student Teams (FaST) was an obvious mechanism. Having a signing scientist is superior to a sign interpreter because of the special vocabulary and understanding of the subject matter that the scientist has and especially for lab safety. Sign interpreters are used for special events such as poster sessions and visits to our partner research universities.

FaST has many advantages when students are not used to research. FaST faculty provide constant expert supervision and instruction for their students, freeing host

laboratory personnel. Discussions between faculty can take part at a higher level and, on the other side, the presence of a faculty member provides a level of security to students uncertain of their ability as well as the host labs. Faculty transfer their experience to their home institution and are in the best position to recruit new students.

Faculty at all levels share a common experience of research universities, but those who teach at community colleges and non-research institutions can lose touch. They constitute an important, but neglected part of STEM research workforce attrition. Involving such faculty as part of FaST, in summer research and continuing during the academic year has multiple benefits. The faculty maintain and advance their research skills and improve their ability to obtain support and continue research at a host laboratory or at their institution either with partners or independently. A FaST approach encourages entrepreneurship. At community colleges and non-research undergraduate institutions, grant agency funding by itself is significant to the administration and faculty career advancement. We have supported FaST faculty members from PGCC and Gallaudet.

Student outcomes

Over the last decade our programs have given research opportunities to 32 students with a dozen having at least two years experience (see Table I). Many have obtained at least a bachelor's degree and others are enrolled in university including a few in graduate school. Students have presented at professional society meeting including the Materials Research Society and American Physical Society. Some students have been co-authors on papers, a considerable feat for community college students.

One of the PGCC students is enrolled in the doctoral program at UC Berkeley and has won an NSF Fellowship, another earned a Masters in biopharmaceutical engineering and two others graduated from Virginia Tech and are working in industry.

One Gallaudet student is now working as a researcher at NIH and plans to go to Pharmacy School. Another is teaching at a Deaf and Blind High School in Florida while working on new American Sign Language signs for nanotechnology terms at Boston University and plans to go to graduate school. A recent graduate has joined a master program in Chemistry. Another is working at a biotechnology company.

Table I. Summary of Student Experience

	PGCC	Gallaudet
Total number of students	20	12
Number of students with multiple years	9	3
BS graduates (number in or through graduate programs)	9 (3)	8(1)
In progress toward BS degree	8	4
Co-authors on publications	5	--

CONCLUSION

Well designed undergraduate research programs leveraging the strengths of a variety of partners will be effective. The right community college, under-represented minority or deaf students in an R1 REU, or a graduate program can change attitudes. Selection and preparation are important. Without the experience of a research institution, under-represented minority, and community college students and the disabled can easily be excluded from many professional opportunities and friendships. Further introducing students at research universities to under-represented minority and disabled students in a setting where the later impress will pay off later when they have to deal with diverse institutions, colleagues and employers. Moreover community college and disabled students get a real research experience using equipment unavailable at community colleges. The inclusion of the under-represented groups and deaf and hard-of-hearing students introduces new dimensions of diversity which contributes to a more vibrant and culturally enriched scientific research environment. The faculty, mentors and staff working with deaf and hard-of-hearing students become more aware of the logistics and challenges involved in providing accommodation and access to people with disabilities.

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