

Partnerships and Collaborations Impacting Student Research Programs at Community Colleges

Abstract

The authors discuss efforts at New York's Suffolk County Community College to engage minority and nontraditional students in STEM research and presentation opportunities. Using mixed methods and quantitative descriptive analysis, their research examines the impact of extended research experiences on the students' academic and career paths. The 182 students in the NSF S-STEM cohorts from 2007 to 2016 had dramatically higher retention and graduation rates as well as GPAs when compared to their STEM peers not enrolled in the NSF S-STEM program. Findings indicate that community college student researchers perform better academically than their peers who chose a more traditional path and that success in STEM encourages increased college persistence.

Keywords: *community colleges, minority student retention, partnerships, STEM, undergraduate research*

Community colleges are an undervalued resource with the potential to help many students move through STEM degree programs and enter STEM careers. More than half of all undergraduates begin higher education at a community college. However, more than two-thirds of community college students who declare a STEM major do not complete that degree, according to a 2014 report by the National Center for Education Statistics (NCES 2013) and the 2016 fact sheet of the American Association of Community Colleges (AACC).

Those all-important first two years of STEM education for many students takes place at the often-overlooked community-college level. According to the AACC, community-college students composed 49 percent of all undergraduates, and 43 percent of first-year students in 2016, including those who went on to pursue STEM careers. According to the National Science Foundation's Science and Engineering Indicators 2016, almost 20 percent of U.S. residents who were awarded science and engineering doctoral degrees, and 46 percent who graduated with bachelor's and master's degrees in science and engineering in recent years, earned credits at a community or two-year college. In 2013, 86,000 of more than 1 million associate's degrees (8.6 percent) were in science and engineering fields.

The National Survey of Student Engagement indicates that active and collaborative learning are critical indicators of student engagement and therefore student success (NSSE 2016). Undergraduate research opportunities, which are active and

collaborative experiences, attract and retain community college students in the STEM fields that are crucial to the country's economic success and global competitiveness. These high-impact best practices are cited as especially important for traditionally underrepresented populations.

However, there are challenges posed by limited on-site research facilities and large faculty teaching loads. Partnerships and collaborations with research-based institutions can mitigate these challenges. By leveraging professional networks of involved community partners, faculty members, and administrators, initial outreach to research sites can yield student opportunities (Amey, Eddy, and Ozaki 2007).

At Long Island's Suffolk County Community College (SCCC), these challenges have been met through valuable networks with regional colleges and universities, as well as with nearby Brookhaven National Laboratory (BNL) and the national laboratory system. To a large extent, these networks of partners and collaborators have grown from individual collaborations.

SCCC has secured 15 years of consecutive funding through NSF's S-STEM program to financially and academically support STEM students. Awarded in October 2016, the latest grant Support for Undergraduates at Community College Engaged in STEM Studies (SUCCESS) will reduce barriers affecting achievement gaps and increase the number and scope of STEM research opportunities by providing additional scaffolding to strengthen educational outcomes for SCCC's STEM scholars.

Theoretical Underpinnings

The SUCCESS program is based on the importance of partnerships and collaborations, which provide extended venues for early research and build a sense of a large STEM community. Diversity of thought and expanse of resources are cited as the rationale for partnerships and collaboration, particularly at the community college. Collaborative relationships in support of research provide the best possible learning experiences for future STEM professionals and help develop workplace/lab skills. Collaborations bring together people with different ideas and approaches, which leads to innovation (Pinelli and Hall 2012; Amey et al. 2007). These relationships must be beneficial to all stakeholders for the partnership to be sustained. For example, Research Experiences for

Undergraduates (REU) sites can benefit from a cost-sharing arrangement that may be accomplished through grant funds. It is essential that the community college program organizers nurture the collaborations with off-site research programs by attending symposia that usually conclude such experiences. In this manner, support of early research at the community college can solidify the partnerships.

The literature addresses the value-added of early research to foster increased scientific literacy, intellectual curiosity, and improved employment prospects. These factors further contribute to a growth in technical skills and critical thinking skills (Malcolm and Feder 2016; Hensel and Cjeda 2014; Pinelli and Hall 2012). The importance of student research opportunities has been broadly recognized nationwide, as Oregon State University has highlighted through its podcast series *Research in Action*.

Partnerships and Collaborations

Suffolk County Community College’s STEM ecosystem (see Figure 1) is a continually developing and symbiotic network that benefits all parties (Rundell-Singer 2015). Originally collaborations between individuals who had worked together, this ecosystem is now composed of formal arrangements, complemented by the longstanding informal personal collaborations that are based on trust.

The formative collaborations were based on information sharing—data, activities, and plans. These trust-building actions led to meeting the needs of the collaborators and the beginnings of formal memoranda of agreement. Research sites required students to fulfill their missions and grant-funded objectives while Suffolk students desired options for research in authentic settings. Today, partners routinely confer about academics, student transfer options, conference support, and proposal generation. Capacity has been expanded at the community college for both students and faculty (Hirst et al. 2014); research institutions have a pipeline of researchers to contribute to innovations.

Program Description

The SUCCESS program resulted from

a collaborative network and is constantly informed by interactions with network partners (see Figure 1). It is designed to increase the number of low-income, academically talented STEM students who graduate, transfer to a four-year program or directly enter the STEM workforce. The program develops, scales, and enhances student support, curricular activities, and early research opportunities via internal and external partnerships and collaborations. Students majoring in a STEM discipline with a GPA of at least 2.8 and with financial need as determined by SCCC’s Office of Financial Aid are invited to apply to the NSF S-STEM program. Once admitted, students can access community- and network-building events, a scaffolded mentoring system, advisers and professional tutors, and early research opportunities considered as best practices for engaging community college students and contributing to their academic growth (see Table 1). The scholarship support, authentic research experiences, networking, and community-building activities—coupled with the network of partnerships and collaborations with STEM champions in local, regional and national arenas—indicate significant gains in STEM student performance, retention, completion, and transfer, which are critical to STEM persistence.

Internal partners and collaborators include SCCC’s STEM departments and faculty; the American Chemical Society (ACS)

Figure 1. Suffolk County Community College’s STEM Ecosystem

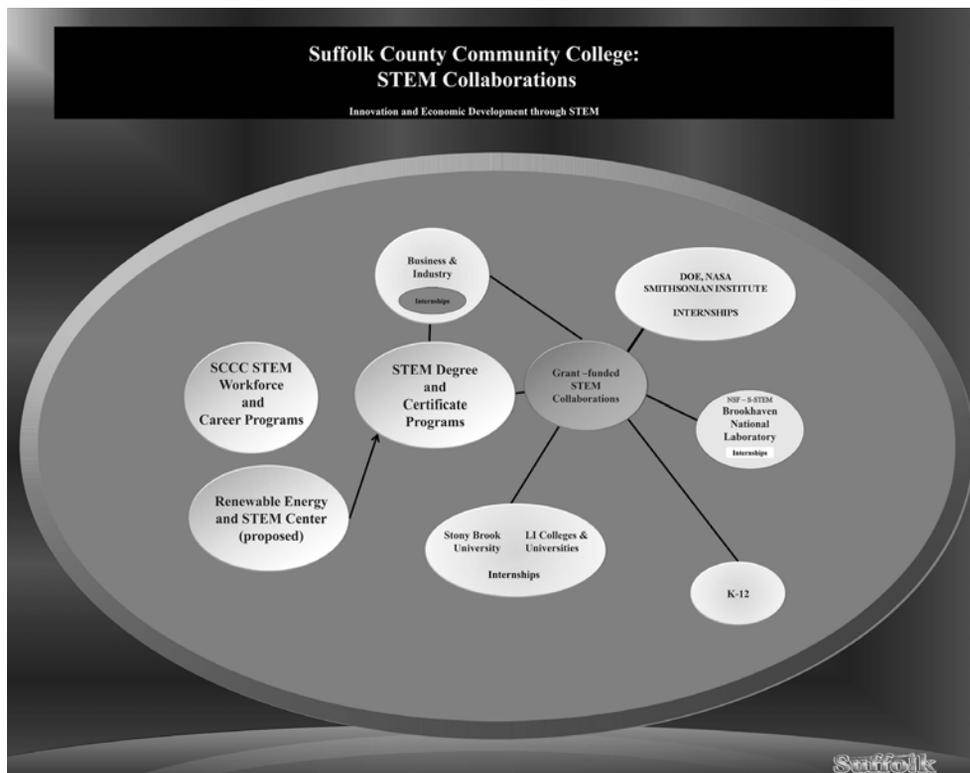


Table 1. Program Elements

Program Elements	Activities	Partnerships and Collaborations
Retention through community building among S-STEM scholars within the institution	<ul style="list-style-type: none"> • NSF S-STEM scholars meet formally approximately 15 times per year • Monthly meetings host invited speakers who are diverse in terms of ethnicity and gender (50 percent), and 80 percent of speakers are drawn from partners and collaborators 	<ul style="list-style-type: none"> • STEM clubs and programs: ACS, Engineering/Technology, CSTEP, STEP • Monthly meeting held jointly with NYS CSTEP students • One-on-one networking provided by diverse role models and potential career and academic mentors lowers societal and aspirational barriers for STEM scholars to explore and apply talents and skills to new and unique arenas not previously considered
Tutors, study groups, and supplemental instruction programs through academic support service	<ul style="list-style-type: none"> • Individualized, discipline-specific, one-on-one tutoring sessions • NSF S-STEM projects office for informal STEM scholar community, study groups, and networking at nonresidential college: videoconferencing; 3D and poster printing • Annual field trip to Mohonk Preserve (NY) and Stony Brook University • Convergences with other grant-funded programs: IRACDA, LSAMP, ATE, SENCER, Helmsley, LICF • Introduction to Research Methods (IRM) course developed as academic complement to off-site research experiences of many students 	<ul style="list-style-type: none"> • Peer-to-peer mentoring by NSF STEM scholars of local secondary school (STEP) students • Researchers at Mohonk Preserve provide access to daily database of oldest U.S. archived weather data • Peer-to-peer: Underrepresented Stony Brook students lead tour and provide guidance • IRACDA and LSAMP consortial partnerships provide mentoring and paid research internships • Cross-disciplinary SENCER and HCT projects involve faculty/students in civic engagement study “Water Quality on Long Island” • LICF provides intensive tutoring to lower barriers for transfer and persistence • IRACDA postdoctoral teaching fellows partner with multidisciplinary STEM faculty for IRM course development and implementation-subsequently offered to SBU and Nassau Community College partner students
Support and mentoring of students by faculty and other professionals	<ul style="list-style-type: none"> • Each NSF S-STEM scholar is paired with at least one discipline-specific faculty mentor. 	<ul style="list-style-type: none"> • Faculty mentors provide academic and career guidance on a monthly basis. • Faculty mentor research scholars at federal lab via the FAST (Faculty and Student Teams) program • Peer-to-near-peer mentoring of research scholars by IRACDA postdoctoral teaching fellows from SBU and/or NSF S-STEM alumni peer-mentor scholars
Early research internship experiences	<ul style="list-style-type: none"> • 54.2 percent of STEM scholars engaged in early collegial and research opportunities at local colleges and universities and regional and national research centers (58/107 for 2011–2016) • Competitive selection of students to participate in paid summer research at national labs, NASA, and REUs (See Figure 2 for locations within the United States and abroad) 	<ul style="list-style-type: none"> • BNL, SBU, and LI STEM Hub business and industry mentors provide access to research opportunities, internships, job shadowing experiences, and professional experiences • BNL annual “mini-semester,” a one-week intensive immersion experience for undergraduates considering research • Offers to students by national labs/REUs to continue their research after conclusion of summer research internships • Employment at national labs • Scholarship offers for students to continue their education
Participation in regional professional, industrial, or scientific meetings and conferences	<ul style="list-style-type: none"> • Student researchers present posters/papers individually or with student/mentor/faculty collaborators from other institutions at local, regional, and national conferences and competitions such as Science and Energy Research Challenge (SERCh), National Conference on Undergraduate Research, Emerging Researchers National Conference, and NASA 	<ul style="list-style-type: none"> • Student researcher presentations at academic partner symposia, including SBU, Farmingdale State College (SUNY), BNL, annual CSTEP statewide conference, and annual SUNY Undergraduate Research Conference • Student research presentations at the LI STEM Hub Annual conference

student chapter; the student Technology Club; the New York State Education Department's Collegiate Science & Technology Entry Program (CSTEP) and the Science & Technology Entry Program (STEP) for secondary students; the Science Education for New Civic Engagements and Responsibilities (SENCER) initiative, NSF Advanced Technological Education (ATE) projects; the National Institutes of Health (NIH) Institutional Research and Academic Career Development Award (IRACDA) projects; and the NSF Louis Stokes Alliance for Minority Participation (LSAMP) projects. In addition, two private foundation awards, the Helmsley Charitable Trust (HCT) and the Long Island Community Foundation (LICF), support the program.

External partners and collaborators include BNL, the State University of New York (SUNY) administration and its applied learning division, SUNY institutions throughout New York such as Stony Brook University (SBU), the Empire State STEM Learning Network, and the Long Island STEM Hub.

Existing STEM initiatives have been applied to programs so that additional and more varied benefits and services may be provided. Two previous and successful NSF S-STEM programs created SCCC's robust STEM learning community and provided financial support for high-achieving, underrepresented students. Both programs were highly effective in transitioning scholars to four-year institutions to continue their STEM education. Project survey data to date mirror those identified in the science education literature (Basu and Barton 2007; Bystydzienski and Bird 2006): students learn best in authentic settings, excel in communities with support, and show interest in emerging STEM fields and the environment.

A small grant from the LICF funded a pilot program (2012–2014), which implemented one-on-one course-specific tutoring and targeted support services above and beyond the scope of existing programs. This pilot program provided direct evidence of the benefits of scaling and sustaining these programmatic supports to both lower curricular barriers and strengthen the ability of academically talented, financially needy STEM scholars to achieve timely completion of their associate degrees. This form of targeted support is now funded through SUCCESS.

A crucial community element is the peer-to-peer mentoring initiative, which has been recognized by the previously mentioned studies as a means to lower the barriers of gender perceptions and increase success of STEM scholars. Near-peer mentoring is also provided by a collaborative NIH grant with SBU: the Institutional Research and Career Development Award (New York Consortium for the Advancement of Postdoctoral Scholars) involves postdoctoral fellows at SBU mentoring NSF S-STEM scholars engaged in summer research, thereby expanding the students' STEM community.

Finally, since community college students embarking on authentic, self-directed research for the first time may not be familiar with a literature review, the identification of research questions, statistical methods, and the presentation of results, SCCC implemented an online Introduction to Research Methods course. This three-credit course prepares students to begin research as active participants; SUCCESS is structured to pay the tuition cost. After completing the course, students are prepared to analyze their results and present findings at conferences, and are encouraged to publish in SCCC's online student journal. The online modality permits SUCCESS students to take this course prior to their research experience or as a complement to the actual research activity; they also have the option to take it on campus or at any of the partner sites.

Authentic Research Internships, Presentation Prospects, and Publication Opportunities

The authentic active-learning methodology and paid research internship experiences at more than half of the nation's federal laboratories and SBU's REUs are the pedagogic centerpieces of STEM programs at SCCC, which have positively affected student engagement and performance. The program focuses on strategies to empower scholars to develop professionally as they continue their academic journey.

At SCCC, research experiences are a premier goal for all STEM students. The benefits are made clear through the insights shared by the invited speakers. Students are made aware of such opportunities throughout the program and receive encouragement from project leaders, mentors, and STEM department faculty to apply. Project leaders indicate which programs are best suited to each student, based upon their academic credentials. For example, a first step is often the BNL mini-semester or a university REU, as national laboratories require at least one full year of math and science courses.

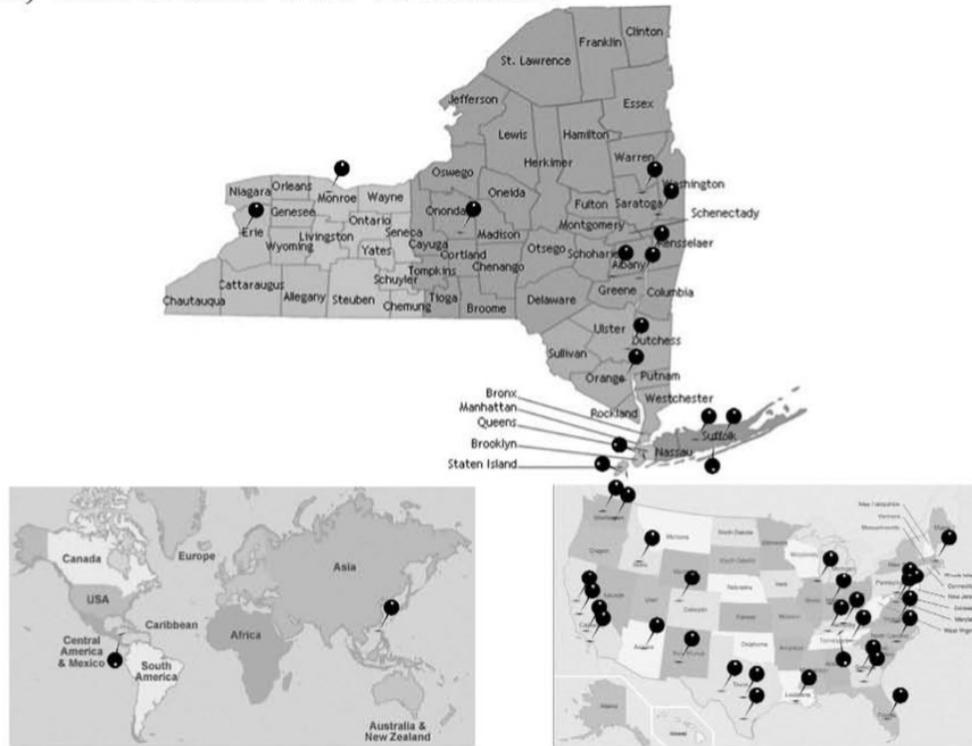
Next, NSF S-STEM program students are encouraged to apply for opportunities at NASA and government laboratories such as BNL, Lawrence Berkeley National Laboratory in California, Oak Ridge National Laboratory in Tennessee, Pacific Northwest National Laboratory Washington, Idaho National Laboratory in Idaho, and Los Alamos National Laboratory in New Mexico. After the first such experience, they are often invited by laboratory researchers to return the following summer. To date, 82 of the 182 NSF S-STEM scholars who enrolled in the program from 2007 through 2016 have been active researchers, and 44 percent have participated in paid research internships. Table 2 lists representative titles of student research projects and host institutions. Figure 2 represents the broad array of geographic student research.

Table 2. Selected Student Research Projects

Research Poster/ Presentation Title	Internship	Laboratory location	Presentation venue(s)
“Generation of TALEs to Block REST RE-1 Site Interactions”	SUNY Chancellor’s Biomedical Education Pipeline Research	Stony Brook University	Stony Brook University Symposium 19th Annual Pine Barrens Research Forum at Brookhaven National Laboratory
“Troubleshooting, Project Management, and Asset Tracking of HVAC Systems”	DOE Community College Internship	Brookhaven National Laboratory	Brookhaven National Laboratory Symposium 19th Annual Pine Barrens Research Forum at Brookhaven National Laboratory
“Effect of Histone Deacetylase Inhibition on Radiosensitivity of Primary Human Fibroblasts Following Charged Particle Irradiation”	DOE Community College Internship	Brookhaven National Laboratory	Brookhaven National Laboratory Symposium National Conference on Undergraduate Research, Spokane, WA First annual SUNY Science Undergraduate Research Conference: SUNY Brockport 19th Annual Pine Barrens Research Forum at Brookhaven National Laboratory
“The Effect of Toca 1 on Cluster Induced Endocytosis Internalization and Colocalization in Raft Mediated Endocytosis”	DOE Community College Internship	Brookhaven National Laboratory	Brookhaven National Laboratory Symposium National Conference on Undergraduate Research, Lexington, KY NSF student panelist for S-STEM projects meeting, Arlington, VA
“Development of New Diagnostic Tools for Battery Materials”	DOE Science Undergraduate Laboratory Internship	Lawrence Berkeley National Laboratory, Berkeley, CA	SULI Research Symposium at Lawrence Berkeley National Laboratory
“Developing a Technique for Chromium Speciation Analysis Using Inductively Coupled Plasma Optical Emission Spectrometer”	DOE Community College Internship	Pacific Northwest Laboratory, WA	Second Annual SUNY Science Undergraduate Research Conference, SUNY Cobleskill “Exploration and Observation: Undergraduate Student Research and Creative Activities Forum,” Albany, NY
“NASA: Utilizing ‘iDepths’ to Probe Mars”	National Aeronautics and Space Administration (NASA)	Johnson Space Center, Houston, TX	Second Annual SUNY Science Undergraduate Research Conference, SUNY Cobleskill “Exploration and Observation: Undergraduate Student Research and Creative Activities Forum,” Albany, NY
“Quantifying Isobutane Leakage Rates from Binary Geothermal Poster Plants”	DOE Community College Internship	Idaho National Laboratory, Arco Desert, ID	“Exploration and Observation: Undergraduate Student Research and Creative Activities Forum,” Albany, NY Second Annual SURC: SUNY Undergraduate Research Conference, SUNY Cobleskill “Advanced Energy Conference,” Jacob Javits Convention Center, New York, NY
“Analysis of Various Schemes for the Estimation of Atmospheric Stability Classification”	DOE Community College Internship DOE Science Undergraduate Laboratory Internship	Brookhaven National Laboratory	Brookhaven National Laboratory Symposium 2012 Emerging Researcher National Conference in STEM, Atlanta, GA “Exploration and Observation: Undergraduate Student Research and Creative Activities Forum,” Albany, NY
“Sustainment of Meteorological Sensors on the Long Island Solar Farm”	(2) DOE Community College Internship (1) Research Experiences for Undergraduates	Brookhaven National Laboratory 2011 REU Stony Brook University 2010	Brookhaven National Laboratory Symposium 2013 Emerging Researcher National Conference in STEM, Washington, DC

Figure 2. Geographic Impact

Oh, The Places You've Been...



Students also learn important communication and self-management skills that contribute to their future career success. Faculty mentors and counselors assist students in synthesizing acquired practical skills. Student researchers are encouraged to present their findings locally, regionally, and nationally. Annual venues include the Long Island STEM Diversity Summit, the Long Island STEM Hub Annual Celebration, the Long Island Pine Barrens Research Forum, BNL, the SUNY STEM Diversity Summit, SUNY Undergraduate Research Conference, the National Conference on Undergraduate Research, the Emerging Researchers National Conference, and the Columbia University Research Symposium.

Findings

Data from SCCC's Office of Planning and Institutional Effectiveness (2016) indicate that the program is making a difference in STEM student success relative to persistence, graduation, and transfer in STEM. The NSF S-STEM cohorts (N=182) of 2007–2008 to 2015–2016 had significantly higher GPAs, on average, than their STEM peers (N=8531) who were not in

the NSF S-STEM program (3.32 vs. 2.67). Also, the semester-to-semester retention rate for the NSF S-STEM cohorts was significantly higher (86.5 percent vs. 68.5 percent), and they graduated at more than twice the rate of their STEM peers who were not in the NSF S-STEM program (58.2 percent vs. 28 percent).

Additional critical comparative data (Office of Planning and Institutional Effectiveness 2016) indicate that research internships also have a positive effect on persistence and success. NSF S-STEM students transferred after graduating at a significantly higher rate than their STEM peers who were not in the NSF S-STEM program (54.7 percent vs. 36.9 percent), and the NSF S-STEM Research Scholars had a higher GPA, on average, than their NSF S-STEM peers (3.47 vs. 3.31). Finally, NSF S-STEM Research Scholars transferred after graduating at a significantly higher rate than their NSF S-STEM peers (71 percent vs. 48 percent).

Conclusion

Suffolk County Community College has successfully leveraged local, state, NSF, and business and industry partnerships/collaborations over the last 10 years to serve a region with high-technology research and industry requirements and some of New York's largest communities of individuals underrepresented in STEM. Partnerships and collaborations have sought to provide authentic student research and presentation opportunities with student-identified civic engagement themes so that minority and nontraditional student involvement in STEM is increased. Such initiatives strengthen the workforce pipeline by bolstering student recruitment, retention, graduation, and transfer, thus working to fulfill local and national workforce needs in STEM.

This focus aligns with SUNY's effort to require applied learning for all of its graduates. The future of higher education is tied to its relevance to authentic skills, and early student research opportunities—with their strong network of partnerships and collaborations—are among the best vehicles to provide such experiences. 

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