"So, We Found a Way:" How Changing Modalities Affected a Year-Long Mentored Research Experience for Associate's Degree Students

Ron Nerio†*, Veer Shetty‡, and Effie MacLachlan§

†CUNY Research Scholars Program, Office of Research, ‡CUNY Research Scholars Program, Office of Research, and §Office of Research, City University of New York, New York, NY 10017

ABSTRACT

The CUNY Research Scholars Program (CRSP) has provided year-long mentored research experiences for 1678 associate's degree STEM students since 2014. The pluralities (32%) of mentors, all of whom are full-time faculty, have been biologists. Other represented disciplines include, but are not limited to, chemistry, engineering, mathematics, environmental science, linguistics, and psychology. The research experiences take place at all 10 associate's degree-granting colleges within the City University of New York system. Our previous assessment demonstrated that CRSP students are significantly more likely than their counterparts in a matched sample to remain in STEM programs, graduate, transfer to research intensive institutions, and report a stronger sense of belonging in college. The Covid-19 pandemic challenged the program, as colleges shuttered laboratories and other facilities. Some mentors worried that lab-based research experiences would not be possible under such conditions. The first full-year pandemic cohort, however, demonstrated the resilience of the program and its participants. To assess the ongoing impact of CRSP and how it adapted using new modalities, we interviewed college-based directors, surveyed students and mentors, and held focus groups with mentors. Directors described how their colleges adapted to preserve all prepandemic components of the program. Mentors detailed their strategies for engaging students in authentic research experiences in virtual and other formats. Students reported that, along with scientific and technical skills, the program deepened their self-confidence and prepared them for transfer to baccalaureate programs. Our findings show how virtual platforms can be utilized to preserve the most beneficial aspects of undergraduate research experiences for associate's degree students.

INTRODUCTION

Community colleges play a central role in the national effort to expand and diversify the science, technology, engineering, and mathematics (STEM) workforce. During fall 2020, community colleges enrolled 41% of all undergraduates nationally, including 53% of Hispanic and 43% of Black undergraduates (Juszkiewicz, 2020). Community colleges are often the first step to earning a bachelor's degree, as they are generally more affordable and have more open admissions policies than their four-year college counterparts. Morest (2013) writes, "community colleges bridge cultures and educational gaps by offering students a chance to become college students regardless of past academic performance and family background." First-generation college students comprise 29% of the community college student population, while 15% are single parents, and the average age is 28 (Hensel, 2021).

Because community colleges have traditionally been viewed as teaching institutions instead of research institutions, they often lack sufficient institutional resources or facilities to sustain a research culture (Brown *et al.*, 2007). At the City University of

New York (CUNY), community colleges are adopting research cultures similar to CUNY's eight senior colleges and three comprehensive schools (Caplan and MacLachlan, 2014). As undergraduate research takes root in community colleges, the number of practices for broadening participation in research grows (Hewlett, 2021; Petersen *et al.*, 2021).

Faculty-mentored undergraduate research experiences (UREs) have a positive impact on persistence and completion in STEM, particularly for students from historically underrepresented groups (Nagada *et al.*, 1998; Cejda and Hensel, 2009; Graham *et al.*, 2013; Rodenbusch *et al.*, 2016; Nerio *et al.*, 2019). UREs are designed to provide students with applied skills and to engage them in the process of scientific discovery and knowledge creation (Lopatto, 2004; Russell *et al.*, 2007; Linn *et al.*, 2015). Under the guidance of a mentor, students develop a disciplinary identity and begin to engage with the larger scientific community. Several studies have also documented numerous noncognitive benefits ranging from increased self-confidence (Russell *et al.*, 2007; Fechheimer *et al.*, 2011; Garner *et al.*, 2018), to self-efficacy (Carpi *et al.*, 2016; Ritchie, 2016) to greater feelings of belonging in college (Eagan *et al.*, 2013; Wilson *et al.*, 2015).

Mentor–student relationships are fundamental to successful UREs (Hunter *et al.*, 2006; DeFreitas and Bravo, 2012; Prunuske *et al.*, 2013; Gallup–Purdue University, 2014; Haeger and Fresquez, 2016; Hayward *et al.*, 2017; Robnett *et al.*, 2018). Mentorship can also play a role in diversifying the sciences and the STEM workforce. Both mentors and mentees have reported more productive and rewarding relationships when they feel they have similar beliefs, values, and interests (Byars-Winston *et al.*, 2015; Shanahan, 2018).

Haeger and Fresquez (2016) distinguish between instrumental mentoring, socioemotional mentoring, and culturally relevant mentoring. The first helps students gain new scientific and professional experience; master skills, methods, techniques and/or instrumentation involved in research; and communicate their research findings. Socioemotional mentoring communicates care and concern for the student as a person. This type of mentoring may involve good listening skills, serving as a positive role model, and creating a sense of community and shared purpose in the research group (Haeger and Fresquez, 2016; Robnett *et al.*, 2018). Culturally relevant mentoring attempts to understand how students' race, ethnic, gender, and socioeconomic contexts shape their experiences before and during college and strives to provide a supportive environment (Haeger and Fresquez, 2016).

The CUNY Research Scholars Program

The CUNY Research Scholars Program (CRSP) provides year-long mentored research experiences for students at ten associate's degree-granting colleges throughout the CUNY system. The Covid-19 pandemic induced major changes in the ways that students are trained in research practices and altered the standard modality of in-person, face-to-face interactions between students and mentors. This paper examines the impact of these changes on the program's operations and participants. During the period of greatest uncertainty, directors and faculty feared it might not be possible to continue running the program. Given the closures of laboratories and the discontinuation of field research, students thought they might be unable to complete projects, compile data, and present findings to the CUNY-wide community. But as one mentor stated during a focus group held amidst the disruption, "So, we found a way."

CRSP launched in 2014, with funding from the New York City Mayor's Office as part of a larger effort to meet the city's growing need for a workforce with advanced scientific and technical skills. The CUNY Office of Research (OR), located within the central administrative offices of the CUNY system, designed the program to offer authentic research experiences to students at all seven of the university's community colleges and its three comprehensive schools (which provide both associate's and bachelor's degrees). During the program's first year, each of the 10 colleges selected 15 students to participate. As the program took root, funding levels increased and the number of students expanded each year until the Covid pandemic began in 2020. The Covid crisis induced numerous adjustments, including the conversion of all in-person activities to virtual formats, a reduction in the size of student stipends, and a decline in overall funding. We conducted this assessment to understand the impact of these changes and to learn how directors, students, and mentors at each college adapted. Does a shift from in-person to virtual formats affect students' connections with their mentors or students' perceptions of benefits derived from the program? What kinds of creative strategies develop among mentors and students to adapt projects, gather data, and prepare research presentations when faced with obstacles? What do mentors and students view as the strongest aspects of the program?

CUNY operates on a federal model, which means that each college retains its independence in most day-to-day operations. When CRSP launched in 2014, the provosts at each of the 10 associate's degree-granting institutions appointed directors to oversee the program at the college level. In some cases, directors were recruited from the faculty while in other cases directors were full-time administrators, such as deans or directors of undergraduate research. The CUNY OR developed a centralized set of guidelines, which standardize the student and mentor stipends, set a minimum number of hours required for research, and require each college to develop biweekly professional development programs for students. The federalized nature of the university, however, provides directors at each college with the freedom to adopt their own procedures for recruiting students. This assessment, therefore, offers perspectives on programmatic aspects that can be adapted to many different types of college and university settings.

The OR convenes meetings with directors once per semester, during which they share best practices, including strategies for recruiting candidates and matching them with mentors. Some colleges have preferred to select only students with the highest grade-point averages or who have demonstrated other indicators of prior success, while other colleges have opted to select promising but struggling students whom they believe will benefit from the guidance of mentors.

CRSP directors organize, and students are required to attend, biweekly student professional development (e.g., resume writing, grant writing, public speaking) and scientific training (e.g., lab safety, scientific reading and writing, poster preparation) workshops. Other than laboratory safety and responsible conduct of research workshops which are mandated by the guidelines, directors are free to develop and offer workshops that they believe will best benefit CRSP students at their

- Laboratory Safety*
- Responsible Conduct of Research*
- Being a Professional
- Navigating STEM Course Basics
- What Does it Take to Succeed in a Research Lab
- The Importance of Keeping Laboratory Records?
- Conducting a Literature Review
- Stress Management
- Building a Career: Communication, Funding and Networking
- Resume Writing
- You Like STEM – Now What? Exploring Advanced Studies, Career Paths and Job Opportunities
- How to Write Abstracts
- STEM in Art and Popular Culture
- Women in Science: Advancing Gender and Racial Diversity in STEM
- The Physics of Black Holes

*Required at all colleges

FIGURE 1. Representative list of college-based CRSP professional development workshops.

colleges. Workshops typically last 2 h, with time for students to interact with each other in order to strengthen their sense of belonging to a cohort. Figure 1 provides a representative sample of such workshops.

During the first 6 y of the program, students received $5000 stipends and were expected to devote 400 h working with their mentors on research projects over the course of a full year (two semesters and a summer). Mentors received a nominal stipend of $1200 for each student (with a limit of three students each), which they typically used to purchase research supplies or to fund research activities. During academic year 2020–2021, the economic shock induced by Covid-19 forced New York City to reduce funding for many programs, including CRSP. Faced with the choice of reducing stipends or drastically cutting the number of students, the OR decided to lower the student stipend to $4000 and the mentor stipend to $1000 and to make only a small reduction in the number of students enrolled. Accordingly, the number of hours that students were expected to dedicate to research was reduced from 400 to 320.

Most CRSP students conduct their research exclusively with their mentor and, in some instances, one or two other CRSP students. In some cases, two or three CRSP mentors from the same college collaborate to provide a CRSP experience for one or more students. Several CRSP mentors each year involve their students in research at laboratories or other facilities in other CUNY colleges or at institutions such as the Brookhaven National Laboratory, the Lamont-Doherty Earth Observatory at Columbia University, and the Population Council at Rockefeller University. In these instances, students may work with teams of researchers consisting of faculty, postdoctoral researchers, doctoral students, and other undergraduate students.

The program guidelines do not specify how or whether mentors should be trained. Mentors are faculty who volunteer to work with students in the program. Because they work with students over the summer, in addition to the academic year, we do not ask mentors to attend training workshops that would require them to work additional hours. New York City College of Technology, a comprehensive CUNY school that is part of CRSP, has developed a mentor handbook that is widely disseminated as an open educational resource (OER) across the CUNY community. This handbook identifies the benefits of mentoring, describes mentor roles and styles, provides strategies for effective mentoring, and offers best practices for mentoring women and underrepresented minorities (URM). CRSP mentors are encouraged, but not required, to consult this resource (Undergraduate Research Committee, NYCCT, 2016).

CRSP's enrollment reflects the diversity of the university. At all but one CUNY community college, URM enrollment exceeds 50% (with a range between 46 and 94% in 2019). Among CRSP students, 54% were URM in 2019 and 53% were URM in 2021. Likewise, women made up 53% of CRSP's total enrollment in both years. Table 1 summarizes information about overall college enrollment, URM representation, and number of mentors and students by college.

The first case of Covid-19 in the United States was reported in the State of Washington on January 20, 2020. By February of that year, New York City began experiencing its first cases. CUNY announced the closure of all of its buildings on March 11, 2020 and directed its faculty and staff to convert classes and research programs to fully online formats. All campuses and facilities would remain closed through the remainder of the academic year and through the summer. Most laboratories remained closed through the summer of 2021, but in a limited

TABLE 1. URM Breakdown

College	Total full-time enrollment	Total URM	% URM	CRSP Students	CRSP Mentors
Bronx CC	5592	5266	94	17	6
Borough of Manhattan CC	15,469	5266	34	32	14
College of Staten Island	9538	3416	36	18	5
Guttman CC	911	794	87	10	7
Hostos CC	3334	3416	36	18	16
Kingsborough CC	6854	3736	55	28	13
Laguardia CC	9179	5973	65	32	26
Medgar Evers College	3856	3649	95	15	8
NY College of Technology	9846	6104	62	28	11
Queensborough CC	7497	4264	57	32	26
Total	72,076	41,884	58	237	132

number of cases faculty were able to appeal for laboratory access. When access was granted, the total number of undergraduate students permitted could not exceed 20 across all laboratory facilities at any given college. As a result, the majority of CRSP students were not able to conduct research on-site. During the fall of 2021, some on-site classes resumed and greater laboratory access was granted.

The conversion from in-person to synchronous or asynchronous virtual research settings led some mentors to forego taking on new mentees during 2020–2021. Those who remained in the program–and the new faculty who joined–adopted innovative strategies. They developed simulated projects, sent equipment to students, conducted extensive literature reviews, analyzed preexisting data, or designed research protocols that enabled their students to collect data outdoors. Projects in some areas, such as computer science and mathematics, were only minimally affected. On the other hand, as a result of laboratory closures, the percentage of biology mentors relative to all other disciplines dropped from 32% during AY2019–2020 to 19% in AY2020–2021. Accordingly, the OR decided to expand the disciplinary reach of the program in the 2020–2021 academic year by incorporating the social and behavioral sciences. Each college was encouraged to invite two to five students to work on projects with mentors in those areas.

Before the pandemic, the program culminated each year with an in-person symposium during which students presented their findings on posters to a CUNY-wide audience consisting of directors, faculty, and students from all 10 participating colleges. The annual symposiums featured keynote speakers from STEM fields as well as panels of speakers who provided advice regarding STEM career opportunities. During the first full pandemic academic year, all aspects of the symposium were hosted on Zoom (Zoom Video Communications, San Jose, CA) and, to give each student a chance to present their material, the activities were spread across 3 d. To develop their science communication skills, students were expected to describe their research projects to a cross-disciplinary audience of nonspecialists. Students recorded presentations in advance but were present online to take questions from audience members. Graduate students and postdoctoral scholars from all disciplines and from across the CUNY system were recruited to serve as judges and to prepare questions and feedback in advance. Using a rubric developed by the OR, judges nominated students for CRSP awards, while a second set of judges selected two of the nominated presentations for top awards.

Zoom created new opportunities for cross-college programming to flourish. Directors invited students from other colleges to join their professional development workshops. Alumni of the program, now in graduate schools or in the workforce, put together panels to advise new students on how to transfer, find new UREs, and work with new mentors. The OR also developed a CRSP COVID-19 Town Hall series to provide students, their families, and communities with scientific and public health information as the pandemic evolved.

METHODS

This paper builds on our earlier mixed-methods assessment of CRSP by emphasizing director, student, and mentor experiences, especially as they relate to the shift from live and in-person to virtual and hybrid formats during and following the

advent of the Covid-19 pandemic (Nerio *et al.*, 2019). Our goal in this study is to focus on the ways in which these changes affected every aspect of the program. All surveys, interviews, and focus group protocols were submitted to and approved by the CUNY Institutional Review Board (protocol number 2015-1076). In all cases, the choice to participate in a survey, interview, or focus group was entirely voluntary and no participant received compensation for their participation. Each method is described below.

Interviews with Directors

Our first step was to interview all directors at the 10 participating colleges before the July/August symposium in 2021, as the program's academic year was nearing its end. Directors oversee the acceptance of students into the program, match students with mentors, and organize biweekly workshops on the campuses. They receive feedback regarding any programmatic issues or developments from students and mentors on a continuous basis. Directors were able to inform us about student attrition, especially as a result of the Covid-19 pandemic, along with the measures they took to replace students who left the program early due to illness, family emergencies, or other circumstances. Nerio conducted the interviews with each director separately on Zoom and each interview lasted ~45 min. Most colleges have one director, but at the three colleges with two directors both directors were present on Zoom during the interviews. Questions for the directors are included in the Supplementary Material.

Student Surveys

Following the 2021 symposium (July 26, July 28, and August 2), we administered an online survey to the students. The survey was hosted on a virtual platform, Formstack (Formstack, Fishers, IN) and was sent by email to all students who registered for the symposium. Students were assured that participation in the survey was voluntary and that no names or identifying information would be collected. Of the estimated 177 CRSP students who presented at the symposium, 94 (53%) completed the survey. It should be noted that 177 is significantly lower than the total number of students enrolled (237), suggesting that many students were unable to complete the program or to present final projects due to obstacles presented by the Covid-19 pandemic. Symposium participation in previous years has exceeded 95% of enrolled students. We did not administer the survey to students who did not register for the symposium, as participation in the symposium is a requirement for completing the program. A copy of the student survey is provided in the Supplementalry Material.

Mentor Surveys and Focus Groups

Likewise, we sent surveys to all 131 mentors whose students completed the program in 2021. Surveys were hosted on Formstack and mentors received links through email. Forty-six mentors (35%) submitted responses. All mentors received invitations by email to participate in in-depth interviews and/or focus groups following the symposium. Thirty-one mentors, representing nine of the 10 colleges, agreed to participate (a response rate of 24%). Due to scheduling constraints, not all mentors who volunteered at any given college could meet at the same time; in those cases, individual mentors were "interviewed"

TABLE 2. Ratio of Students to Mentors Sorted by Discipline

College	Discipline (student:mentors)							
	Biology	Chemistry	Computer Science	Math	Engineering	Physics	Behavioral Sciences	Other
Bronx CC	(8:3)	(3:1)	—	—	(3:1)	—	(3:1)	—
Borough of Manhattan CC	(4:3)	(4:1)	(3:2)	(5:2)	—	(5:2)	—	(11:4)
College of Staten Island	(5:1)	(2:1)	—	—	—	—	—	(11:3)
Guttman CC	(3:3)	(2:1)	(1:1)	—	—	—	—	(5:2)
Hostos CC	(5:5)	(2:2)	—	(10:4)	—	(2:1)	—	(6:4)
Kingsborough CC	(9:4)	—	—	—	—	(6:5)	(3:1)	(10:3)
LaGuardia CC	(12:8)	—	(2:3)	—	(8:6)	—	—	(10:9)
Medgar Evers College	(8:5)	(4:2)	(11:3)	—	—	—	—	(3:1)
NY College of Technology	—	—	—	—	(6:4)	—	—	(10:3)
Queensborough CC	(9:6)	(8:8)	—	(3:3)	(4:3)	—	—	(8:3)

with the same questions that would have been asked during a focus group. Nerio and MacLachlan conducted all focus groups and most interviews together; some of the interviews were conducted by Nerio alone. Because the surveys were anonymized, we suspect there was some overlap between the survey respondents and the focus group participants. But the focus groups and interviews enabled participants to provide more comprehensive feedback. Surveys and focus group questions are included in the Supplementary Material.

In both surveys and in all mentor interviews or focus groups, we assured participants that participation was voluntary and would have no impact on any other aspect of their participation in the program. We informed potential respondents that no names or identifying information (including college names) would be used in our reporting. We invited mentors to be candid and assured them that critical comments were welcomed.

We used a general inductive coding approach to the written portion of our surveys, as well as the focus groups and interviews. An inductive coding approach involves reading written responses and/or transcripts multiple times to identify themes and to capture key categories (Thomas, 2006). After each author read the material independently, we met together to agree on labels we attached to each response. The labels are described in the results section.

RESULTS

Below, we report the results of the 2021 surveys, focus groups, and interviews.

Interviews with Directors

Each college has a local CRSP director, who oversees the selection of mentors and mentees and arranges biweekly college-based workshops. They are sometimes mentors themselves, but their role offers them a bird's eye view of how the program operates. All directors reported that students are increasingly aware of CRSP's existence and speak about it to their peers, who have come to view it as opening doors to careers in STEM. This awareness, which has grown year to year, is important for recruitment into the program.

As with our previous assessments, directors unanimously emphasized that CRSP expands research possibilities for students and deepens research cultures on their campuses. One director stated that, "CRSP exposes students to research oppor-

tunities they never thought possible. It also breaks the stigma that only males do research." CRSP students, the directors told us, are not passive mentees: they become active contributors in the production of knowledge. A director at a comprehensive college noted that it was initially difficult to recruit mentors, given the required time commitment, but as the program developed over the years, faculty who were reluctant grew to appreciate its impact. "We now have faculty approaching us, asking us to be mentors," she exclaimed. "When the program started, we had to plead with people to be mentors. Now they are begging us to be part of the program."

Nonetheless, though all directors reported that CRSP operated successfully during its first full virtual year, the pandemic led to some strains on the program. Directors at seven of the 10 colleges said that they had encountered signs of burnout among some mentors and experienced difficulties with rerecruiting mentors in the 2020–2021 program due to pandemic conditions and the switch to virtual formats. Directors at two colleges mentioned that at least one or more students told them they had difficulty reaching their mentors at times. A few long-time mentors declined to participate in the program during 2020–2021. Particularly in biology, these mentors felt that it would be difficult to conduct research and generate new data without access to labs. To compensate for the loss of some STEM faculty, directors recruited from disciplines that had not previously been included in the program: anthropology, political science, and sociology. See Table 2 for a breakdown. Although biologists remained, the plurality of mentors during the 2020–2021 year, their proportion dropped from almost one-third (32%) during the previous academic year to less than one-fifth (19%).

All directors reported they found it more difficult to recruit full cohorts at their colleges during AY2020–2021 because the transition to fully online learning discouraged some students from joining. Before the pandemic, most directors relied on mentors to identify and select promising CRSP candidates from their classrooms but in fully remote conditions some mentors felt it became more difficult to build relationships and to discern suitable mentees. Eight of the 10 colleges ultimately recruited full-cohorts, while two of the colleges were unable to completely fill their cohorts.

During Zoom workshops, moreover, directors noted that students were hesitant to turn on their cameras. Eight directors

reported that the cohorting and bonding experience was therefore negatively impacted. Two directors, however, found that the online modality inspired students to be more collaborative and creative. One director stated, "We had the best retention this year, compared with any previous year. It may have been the flexibility of the virtual format. It is also because of the cohort we built on Zoom. Our students didn't want to leave our 2-h meetings when they are done. They have really enjoyed the extra support."

Student Surveys

Ninety-four students responded to our 2021 survey. As with our previous study (Nerio *et al.*, 2019), we were interested in understanding how the program affected students' sense of belonging in college. Covid-19 introduced a new sense of urgency: could the program and the virtual modalities it necessitated still lead students to feel a deepened sense of belonging in college given the virtual context? Twenty-one students (22%) told us that they felt a "strong" or "very strong" sense of belonging at their college before enrolling in the program, while 64% reported feeling a "strong" or "very strong" sense of belonging upon completion of the program. Most students (66%) felt they did not have a sense of what it means to conduct research before participating in the program, while 68% reported that after completing CRSP they were inspired to pursue a career involving research.

Student relationships with mentors are central to this sense of belonging and self-efficacy. Students were overwhelmingly positive about their mentors, with 81% reporting that their mentor genuinely cared about them as a person. They also indicated that their mentors sharpened their writing skills (74%), helped develop their scientific and technical skills (75%), helped them think through the next steps in their academic careers (68%), and deepened their sense of self-confidence (56%). Respondents were also well-disposed to college-run CRSP biweekly workshops, with 77% responding that they were "of high quality" and helped them develop their skills as researchers.

We included open-ended questions about the impact of the Covid-19 pandemic on students and their research projects. Seventy-one students (76%) responded to these questions. Using the inductive coding approach described above, we coded 31 (44%) of the written responses as "negative impact," 18 (25%) as "positive impact," 12 (17%) as "no impact," and 10 (14%) as a "mixed negative and positive impact." Positive responses included: "I learned how to work remotely and utilize remote internet technology to improve work communication with my mentor," "It opened a new perspective for me as to how research can be carried out. CRSP also allowed me a sense of enjoyment when I was working with my research project," and "It was a good experience, I love it!" Examples of negative impacts included: "The majority impact was on my lab skills and some presentations were cancelled due to the pandemic. I hope CRSP will have a course to help us build lab skills–even with videos or other resources–to help us with the skills we missed," and "There was no in-person research, so a sense of community and responsibility was lost." One student wrote: "Not being able to work in a lab setting since the beginning of the pandemic has truly made a huge impact on my mental health."

Mixed responses include: "Not being able to meet with my professor in-person was a burden at first but the convenience of meeting on Zoom is really nice. We didn't have access to any school facilities like the labs, but we were able to work around that for the project," and "It was quite a terrible experience. It made it difficult for me to focus on anything. But my mentor [name removed] was great. He was always patient and understanding."

When asked what they liked best about CRSP, 75% of respondents answered the open-ended question. Only three students mentioned the "stipend" or "money." A variation of "the whole experience," or "everything" was the most frequent response to this question (24%), followed by mentors (17%), self-confidence (15%), friends or community (7%). Others wrote "workshops," "resume building," and "public speaking." One student mentioned other students: "I learned how to do research, make a poster and decrease my fear when speaking publicly. I was fascinated by how students can be really creative and come up with all their brilliant ideas/projects. It was very educational." Another wrote about their mentor: "Great idea CUNY!! I really like to be able to have a mentor who guided me all the way. I am so thankful for that. My mentor is really helpful. Thanks to her. Unforgettable experience!!"

When asked what could be improved, (72%) of respondents offered written suggestions. The top response was a version of moving back to an in-person format (20%), followed by "nothing" (16%), an increased stipend (7%), fewer deadlines (7%), and more time for presentations at the symposium (7%).

Mentor Surveys

Of a total of 129 mentors, 43 completed the 2021 survey (a 33% response rate). Mentors' duration in the program varied from 1 to 7 y, with a plurality (13 of the 43 respondents) having joined for the first time during the first full-pandemic year (2020–2021). Table 3 enumerates the range of years that respondents participated in the program. The number of students they mentored since first joining the program varied from 1 to 25, with most (77%) having mentored fewer than 10 students.

In the 2021 survey, we added several questions specifically aimed at deducing the impact of the pandemic. Slightly more than half of respondents (55%) believed (agreed or strongly agreed) that while students made their best efforts to participate, emotional and/or physical conditions distracted from their full participation in the program. Nonetheless, all respondents (100%) agreed that their students had derived substantial benefits. An overwhelming majority (88%) also indicated that, as mentors, they had a satisfactory or very satisfactory personal experience in CRSP despite the pandemic. Most (88%) believed that their students were more likely to pursue careers involving research than they were before joining the program; 12% were unsure. Almost all (98%) would recommend the program to other faculty members.

Seventeen mentors (40% of our respondents) indicated that the pandemic had no impact on their research with students; an equal number indicated that although the pandemic forced them to make significant changes, they believed the quality of the research experience for students was equal to prepandemic years. The remainder (18%) reported that, even with considerable innovation, the pandemic had significant negative impacts

TABLE 3. Mentor years served

Mentor survey: number of years served among respondents	
Number of years served	**Number of mentors**
1	13
2	3
3	7
4	7
5	4
6	4
7	5

on the research experience. Nearly one-third of respondents (27%) told us that at least one of their mentees withdrew before the symposium, but in only one case did the student have Covid. The survey did not prompt mentors to indicate whether these departures were related to the pandemic in any way.

Responses to the open-ended question "Is there anything else you would like to tell us about CRSP?" were generally positive, including: "this is a CUNY treasure," "great design," "inclusive, inspiring, effective," and "I'm proud to be included." Others offered suggestions for improvements, such as returning the stipend to prepandemic levels, a better integration of the social and behavioral sciences (which were added during AY2020–2021), and the addition of workshops for mentors. A plurality (27%) wrote that the accountability imposed by the program's stipend played a significant role in successful research experiences.

Interviews and Focus Groups with Mentors

Following the survey, we sent an email to all mentors–including mentors who did not respond to the survey–with a Doodle Poll inviting them to join online focus groups for the purpose of more in-depth discussions about the impact of the program and the shift to a virtual format (see Table 4). Thirty-one mentors (24% of the total of 129 mentors) agreed to engage in the 2-h focus groups, although scheduling challenges meant that in some cases only one person was able to join a focus group during a given timeslot. In such cases, we proceeded with the same focus-group questions but treated these discussions as if it they were one-on-one interviews.

In our previous assessment, before the pandemic, mentors in focus groups most frequently cited the 1-y time frame and the student stipend as the most significant programmatic elements contributing to student success (Nerio *et al.*, 2019). During the

2021 focus groups, the stipend still emerged as a significant feature (55% of our total of 31 focus group participants), but other elements of the program gained in prominence: the role of the mentor in providing emotional, mental health, or crisis support (23%), interdisciplinary collaboration through Zoom (39%), and the program's role in supporting equity in education and the mission of community colleges (58%).

From the seven open-ended questions in our focus group instrument (see Supplementary Material), we coded and sorted responses into five categories: 1) perceived strengths and weaknesses, 2) role of and impact of/on mentors, 3) student challenges, especially during the pandemic, 4) contributions to student success, and 5) social justice.

Strengths and Weaknesses of the Program. Funding students to conduct research was the most frequently cited (55%) strength of the program in 2021. The stipend demonstrates to students that their research and time is valued and leads to a sense of commitment. When students are not funded, mentors told us, those who volunteer in labs often need to leave before completing a project because they find it necessary to earn income to support themselves and their families. College-based professional development workshops were the next most frequently mentioned strength (52%). "They are tremendously beneficial," one mentor remarked, "and really enhance skills and bring [students] together as a cohort: resume writing, the emphasis on giving a speech. Although the students may think it is hard to make time, they walk away with incredible benefits." Another mentor credited workshops for "showing the students how to do library research, getting them into CETL (Center for Excellence in Teaching and Learning), writing an abstract. I don't have to do the extra training–the program takes on some of the responsibility that a mentor would normally have to do."

The only mentioned "weakness" in the program was the amount of time some mentors felt they needed to devote to the program in order to prepare their students for research. Even some of the most enthusiastic mentors said the time commitment was taxing. Fifteen mentors (47%) noted that mentoring could place a burden on their already demanding schedules. "I had to constantly remind myself that my students are complete novices to research, and they are only now acquiring certain skills, including writing, exploring different theories, conceptual thinking, integrating information…The whole process was much more time-consuming than I expected," reported one long-term mentor. A first-time mentor replied: "I sometimes say

TABLE 4. Mentor feedback and satisfaction

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Mentor feedback regarding benefits to students					
Students received substantial benefits	0	0	0	10	33
Students developed significant understanding of research	0	0	0	12	31
Students more likely to pursue careers involving research	0	0	5	7	21
Students tried their best, but pandemic proved too distracting	5	7	8	14	9
Mentor satisfaction					
Was CRSP a satisfying experience	0	2	4	18	19
Were you satisfied with your student(s) performance?	1	3	2	14	23

I will not be doing this anymore. It is too much work–then I watch the symposium and I am crying, and I am so proud to see what the students have accomplished." Seven mentors (23%) suggested that course release or reassign time would alleviate the time burden. As one mentor phrased it: "A faculty's time commitment [in CRSP] is usually more than we spend on other institutional assignments for which we get reassign time."

Role of the Program and the Impact of/on Mentors. All participants voiced strong support for the program and indicated that they derived considerable personal satisfaction. They often emphasized that the program enabled them to contribute to student success (81%), knowledge production (16%), and the community college mission (23%). They also emphasized that mentoring enabled them to apply for grants and publish more than they might have without mentees (19%).

"What it does is support my professional core value," reported one mentor. "Any student who wants to be involved in research – I am happy to give the opportunity to. As a biologist, it really speaks to diversifying the scientific workforce. The open enrollment nature of community college–this supports a core value that I have always had." Another mentor told us: "CRSP allowed me to be the kind of research mentor that I want to be … it is rare that you would be able to have two completely different research projects going on without funding for serious course release time, but my CRSP students made that possible."

Five mentors (16%) pointed to what they called a "positive feedback loop" in which interactions with mentees support their research while also informing their own professional development. As they help students, the students help them. As one mentor phrased it: "With CRSP, I get to have students [working in my lab] in the way that I would at a research university. This is an opportunity to keep up my research chops. It makes me a better teacher in the classroom, too, because I have to think about what students need to go through to understand research." Another stated: "Having to articulate to students why I am studying something or why we are doing things a certain way forced me to understand and articulate for myself what I am doing. Students ask very good questions." Another added: "If you look at my last paper, there were at least eight students' data in there. It really makes a difference." At least six (19%) of the 31 mentors who participated in focus groups had published with their students.

The Impact of Covid-19. Mentors discussed the impact of the pandemic both on research projects and on student's lives. They provided concrete examples of how they pivoted, and how the shift from in-person to virtual participation created both difficulties and opportunities. All mentors agreed that, despite the hardship of laboratory closures, alternative projects offered their students significant benefits. One called the shutdown a "blessing in disguise."

Many CRSP mentors in interviews or focus groups told us that virtual formats positively changed the dynamic in mentor–mentee relationships. "The students taught me a lot," one mentor said, "We learned to be flexible–that yes, we are microbiologists, but sometimes situations arise, and we have to make the best out of it." Another mentor told us, "I can't even separate my research and my work with undergrads. It is a very holistic process – they keep me learning, they expose me to more, and in some cases, they directly take my research and go further with it."

Mentors described how they developed creative procedures for conducting studies at home or in the field when they could not access their laboratories. One mentor, along with their students, designed and developed a virtual reality physics lab application to simulate a laboratory experience. Another mentor–mentee team created an online classroom where users could meet in a virtual environment wherein each student had their own avatar. Another developed a hydroponics procedure their students could conduct at home to purify water by using herbaceous plants' physiology to remove impurities. Many guided their students to conduct research on dimensions of Covid-19 itself, including measuring the impact of the pandemic on sleep patterns, monitoring compliance with mask-wearing regulations in public places, investigating the management of PPE waste, and examining the effects of the pandemic on the mental health of community college students.

One biology mentor, who measures the impact of intoxicants on sea organisms, could no longer provide her students with an indoor laboratory experience. She provided one example of how mentors pivoted to other projects. "So, we decided to do air pollution," she explained. "We gave them meters and they developed their own projects…We never stopped doing research. We went into the field, we rented Citi Bikes, and we went everywhere [taking air quality samples]. So, we can always go back to the laboratory, but now we are able to return with a new twist and there will be additional side projects." Another mentor pivoted by teaching a student to "do amplifications of DNA using water at home creating their own centrifuge, creating their own detector."

"Some [students] have never seen a lab and that was a huge deficit this year," observed one mentor, who added, "Actually one of my students was one of the eight accepted into the microbiology initiative. He is concerned because he has never touched a pipette. We had more time to think about the bigger issues, though–how you think about a social problem, how you think about a research problem." Mentors said they were able to take more time to immerse students in scientific methods and literature and to enable them to practice scientific communication.

The most frequently mentioned pivot, cited by 15 mentors (47%), was to assign students intensive literature reviews. Mentors who pivoted to literature reviews noted that if they could not spend time with students in a laboratory, they were able to spend time deepening their students' exposure to scientific writing. Seven mentors (23%) reported that they felt students benefitted strongly from the time spent on close readings of scientific articles.

Mentors were split on whether virtual connections represented a net loss for their students (45%) or a net gain (55%). "Having this face-to-face contact on Zoom, I could just talk to them, pose theoretical questions," said one mentor. A plurality of mentors believed that it deepened the connections among their students and other collaborators. Many (26%) said they planned to continue some meetings on Zoom after laboratories fully reopen. Several mentors were both surprised and pleased at how, in the words of one participant, "students self-organized and supported each other online."

Student Success. Mentors weighed the complexities involved in determining whether and how the program contributes to student success–and what student success means. Transfer to a 4-y college, especially a research-intensive institution, was the most frequently cited (39%) immediate indicator of success. "I keep track of my students' progress," a mentor told us, "and you can tell the difference. You would be amazed at where they are now: Cornell, Columbia, Carnegie Mellon, it is a major impact on their lives…We have also had students go to Intel, RIT, Georgia Tech, Brookhaven. This is very encouraging. Imagine, a student from a community college going to Intel to do a technical summer internship. That is amazing."

Many offered nuanced ideas about success. "What student success means to the student I just spoke to means one thing–that student has very traditional views and wants a master's degree. But for others it means getting housing. I have had other students say what they are doing is modeling good behavior for their kids (especially while working on Zoom). They say, "I am working next to my child, they need to see what this is, what good work skills are," offered one mentor. Another reflected: "These are students at the beginning of their career…I guess if the students have expanded their horizons in some substantial way that is a measure of success."

Another provided this context: "There was one student who effectively became homeless as the result of a death of a parent. There was another student whose family was in a Central American country, and she became the primary provider here in New York City. Maybe these are not quite the experiences across CUNY–but certainly they are common at [college name removed]. You can provide emotional support. If the goal is to prevent the student from giving up on college, there are things you can do. It was a priority to make the [homeless] student realize it was still possible to be in the program and to complete the program despite their situation."

Social Justice and Community College Mission. As noted in our introduction, Haeger and Fresquez (2016) describe three types of mentoring: 1) instrumental, 2) socioemotional, and 3) culturally relevant. Many mentors in focus groups (25% of the 31 participants) told us that socioemotional support became as important as instrumental mentoring during the pandemic. They also emphasized (21%) the need for culturally relevant mentoring given the pandemic's differential impact on URM and low-income students.

More than one-third of the mentors (39%) stated they believe the program contributes to social justice. One mentor voiced it this way: "Our students themselves are usually members of marginalized groups, so social justice is always an important part of our discussions and research agenda. Students are very aware of how Covid amplified and deepened social injustice and are more than ever interested in challenging and addressing these issues." Another responded that "all of the benefits of research….have been extended to students who I am sure would not have had them otherwise…the majority I have worked with have been female students of color, but at least as important–and less talked about–is the class/socioeconomic aspect. The kind of students who are in danger of facing problems like homelessness, my guess is that nationally they tend not to be the kinds of students who get involved in research experiences in college. At least in my experience, in CRSP those

students do. That is a meaningful contribution to social justice, I think."

Overall Impact. Mentors used phrases such as "resilience" (13%), "perseverance," (13%), "critical thinking" (23%), "incentives" (26%), "structure" (45%), and "self-confidence" (48%) to describe the impact of the program on individual students. They mentioned the cultivation of scientific identities (16%). "I have seen incredible enrichment in terms of their thinking as scientists and scholars," said one mentor, "and I have seen changes in my students. For some of them it was a life-changing contribution. First of all, they saw parts of the world that they did not know before…By "the world", I mean how the world functions, going beyond lecture, homework, and more recently, Zoom. It enlarged or increased their world." They also observed that the program contributes to the overall environment of their colleges. "We are able to create a culture of students who attend presentations," said one mentor, "recognize other students who give those presentations, recognize the topics, and recognize mentors. It takes space away from talking about grades exclusively."

Another observed: "It also leads to collaboration among labs–I collaborate with chemistry and physics labs, and we all work together. This is very important for students to see this kind of collaboration." Fourteen mentors (45%) cited "interdisciplinarity" as a positive aspect of the program. "They have this opportunity to collaborate," came one reply, "to see how scientists work and how they form these connections to advance the goals of science." Several STEM mentors (23%) welcomed the addition of the social and behavioral sciences this year as a development that broadened their own students' understanding of research.

DISCUSSION

To evaluate the impacts of the Covid-19 pandemic–and the shift in modalities it necessitated–on a year-long mentored research experience for associate's degree students, we developed a mixed-methods assessment including surveys with students, interviews and focus groups with mentors, and interviews with college directors. Our aims were formative and summative; we wanted to both understand how the program might be improved while also discerning how the core strengths of the program might be applicable to other research programs for associate's degree students. Our research instruments enabled us to understand, from the perspective of participants, whether and in what ways CRSP was affected by a global health crisis and how the program adapted, with the use of new modalities, to meet students' needs. Participants identified which aspects of the program they considered to be its greatest strengths and how various pivots, including the use of virtual and hybrid technologies, contributed to student success.

Pivot to New Modalities

Chandrasekaran *et al.* (2020) explored the impact of transitioning student research from wet labs to virtual settings. Like many CRSP mentors, they found that literature reviews, analysis of existing data, and an emphasis on science reading and writing effectively kept students engaged. Sloan *et al.* (2020) discovered that faculty and students are expanding their skills in data analysis using digital tools. These changes, they suggest, are

also leading to more scientific collaboration. "After all," they write, "effective remote communication will be increasingly valuable as conferences, college courses, and scientific collaborations continue to shift online in the future."

Our study produced similar results. Despite challenges, virtual formats provided numerous benefits. Platforms such as Zoom, mentors reported, improved the dynamic between mentors and students by introducing more flexibility. Students and mentors could meet more frequently. Mentors related that face-to-face meetings on virtual platforms served to enhance their direct communication with students and also enhanced communication within the student cohort. They reported that students self-organized in ways that they were not expecting and were able to offer support to one another.

CRSP mentors, students, and directors agree on the importance of holding professional development workshops throughout the year. These workshops bring students together as a cohort and they enable students to work on skills such as resume writing, public speaking, and poster preparation. Mentors note the workshops relieve faculty of having to conduct such training for students themselves and freed them to concentrate on research with students. Hosting workshops on virtual platforms reduced obstacles related to timing and enabled more students to attend. Most notably, the conversion to virtual platforms permitted colleges to open workshops to broader participation from students enrolled at other colleges. Virtual platforms also enabled the OR to develop additional centralized programming, including a series of town halls that invited experts from across disciplines and from institutions in other parts of the world to update students on cutting-edge pandemic research. Given the high levels of attendance at these town halls, the office plans to further expand on such programming.

Pandemic conditions required creative solutions. Mentors reported that engaging students in more extended literature reviews provided many benefits. Students were able to practice reading scientific papers, deepen their understanding of their fields, and build the skills to write scientific papers themselves. When labs and other facilities were not available, mentors enabled students to develop virtual laboratories at home by sending them basic equipment and guiding them on Zoom. In some cases, mentors who were unable to engage students in labs developed alternative projects, such as purchasing sensors and asking students to measure air quality in in their own neighborhoods.

Student engagement remained high despite the use of virtual platforms. Students were far more likely to report a "strong" or "very strong" sense of belonging at their college after CRSP than they were before entering the program. They reported overwhelmingly positive feelings about the mentor–mentee relationship and believed their mentor had enabled them to deepen their self-confidence and to acquire both hard and soft skills. Virtual platforms, however, were not always a satisfactory substitute for in-person, face-to-face contact, especially in laboratories. Students worried that they had fallen behind in lab skills and some requested that the university hold workshops to make up for the lost time in laboratories. Most students indicated that they did not have a sense of what it means to conduct research before entering the program, while more than two-thirds indicated that they were inspired to consider careers involving research after spending a year in the program.

In focus groups, mentors emphasized that the meaning of "student success" in community college research experiences should be broadened. Programs like CRSP, they stressed, extend the benefits of research to students who often would not otherwise have those benefits. Success is often framed as graduation with an associate's degree, transfer to a 4-y program, and enrollment in graduate school. However, success can also be defined by enabling a student who is experiencing an emergency–unemployment or homelessness, for instance–to remain connected to a college and in communication with a mentor. Several CRSP students experiencing such crises stayed in touch with the program through WhatsApp groups, texting, and Zoom meetings and managed to complete the program. Attewell and Lavin (2007) noted that success in community colleges must sometimes be traced over the long term, such as years, decades, or even generations. The impact of research experiences, likewise, may be best measured over time.

Mentoring and Diversity

Mentorship can play a role in diversifying the sciences and the STEM workforce. Haeger and Fresquez (2016) found that students who are unfamiliar with "the academic and research culture, norms, and procedures clearly benefit from having a longer research experience and prolonged contact with a research mentor" and these students also report higher gains in skills, confidence, and research independence. Mentors and mentees report more productive and rewarding relationships when they feel they have similar beliefs, values, and interests (Byars-Winston *et al.*, 2015; Haeger and Fresquez, 2016). Members of underrepresented groups in particular benefit from mentored research experiences (Russell *et al.*, 2007; Hernandez *et al.*, 2018; Robnett *et al.*, 2018). Other recent studies show that mentoring practices can be employed to increase the number and success rates of underrepresented students specifically in STEM disciplines (Brainard and Carlin, 2013; Haeger and Fresquez, 2016; Shanahan, 2018).

The goal of CRSP is to extend research opportunities to CUNY community colleges and their diverse student bodies. At all but one CUNY community college, URM enrollment exceeds 50% (with a range between 46 and 94% in 2019); in CRSP the percentage is 53%. Likewise, women make up 53% of CRSP's total enrollment. The program's mentors emphasize that they derive satisfaction from providing year-long research experiences to students who might not otherwise have such access. More than one-third of CRSP mentors reported their belief that the program contributes to social justice. One mentor stated that the program speaks to her "core values" by enabling her to contribute to the diversification of the scientific workforce.

Limitations of the Study

While we invited all CRSP directors to participate in interviews, all mentors to participate in surveys and focus groups, and all students to participate in surveys, engagement with these research instruments was voluntary. Only in the case of program directors did we reach a 100% response rate. Slightly more than half of the students (94) who completed the program (177) completed the surveys (53%). Even smaller proportions of our mentors completed surveys (36%) or participated in focus groups (24%). As administrators in the CUNY OR who conduct several undergraduate research programs, we expect

such response rates for voluntary surveys and interviews with students and faculty. Nonetheless, reaching fewer than half of our students and a third of our mentors may raise questions about whether our results can be generalized to the full populations of mentors and students.

We validated our surveys by workshopping them in meetings with CRSP directors. Directors considered each question and provided feedback regarding whether the instrument would sufficiently and clearly elicit useful data. A more robust validation would have enabled us to draw stronger conclusions, especially regarding subjective concepts such as "belonging," "self-confidence," and "skills development."

A final limitation results from the federal nature of the program. Most record-keeping regarding mentor and student participation occurs at the college level, rather than at CUNY OR. Our only way to measure mentor attrition is on a year-by-year basis.

Despite these limitations, we are confident that our assessment captures: the breadth and depth of challenges to the program wrought by Covid-19; the innovative responses initiated by faculty, directors, and mentors; and the impact of shifting modalities on a year-long research program. Our results have enabled us to understand how technological developments such as Zoom and other online platforms may facilitate research mentoring and collaboration between faculty and students. CRSP mentors reported that the program contributes to their professional development and commitment to social justice. Students reported that mentors provided them with scientific training and increased self-confidence while caring about them as human beings. Even during a time of great uncertainty, the CRSP model of faculty mentored research experiences has demonstrated its resilience and value.

REFERENCES
Attewell, P., & Lavin, D. E. (2007). *Passing the torch: Does higher education for the disadvantaged pay off across generations?* (pp. 79–125). New York: Russell Sage.

Brainard, S. G., & Carlin, L. (2013). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education*, *87*(4), 369–375. https://doi.org/10.1002/j.2168-9830.1998.tb00367.x

Brown, D. R., Higgins, T. B., & Coggins, P. (2007). The increasing presence of undergraduate research in two-year colleges. *CUR Quarterly*, *28*(2), 24–28.

Byars-Winston, A. M., Branchaw, J., Pfund, C., Leverett, P., & Newton, J. (2015). Culturally diverse undergraduate researchers' academic outcomes and perceptions of their research mentoring relationships. *International Journal of Science Education*, *37*(15), 2533–2554. https://doi.org/10.1080/09500693.2015.1085133

Caplan, A. J., & MacLachlan, E. S. (2014). An overview of undergraduate research in the CUNY community college system. In Hensel, N. H., & Cejda, B. D. (Eds.), *Tapping the potential of all: Undergraduate research at community colleges* (pp. 9–16). Washington, DC: Council on Undergraduate Research.

Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H. (2016). Cultivating minority scientists: undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. *Journal of Research in Science Teaching*, *54*(2), 169–194. https://doi.org/10.1002/tea.21341

Cejda, B. D., & Hensel, N. (2009). *An overview of undergraduate research in community colleges. Undergraduate research at community colleges* (pp. 9–16). Washington, DC: Council on Undergraduate Research.

Chandrasekaran, A. R. (2020). Transitioning undergraduate research from wet lab to the virtual in the wake of a pandemic. *Biochemistry and Molecular Biology Education*, *48*(5), 436–438. https://doi.org/10.1002/bmb.21386

DeFreitas, S. C., & Bravo, A. (2012). The influence of involvement with faculty and mentoring on the self-efficacy and academic achievement of African American and Latino college students. *Journal of the Scholarship of Teaching and Learning*, *12*(4), 1–11.

Eagan, M. K., Jr., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Garibay, J. C. (2013). Making a difference in science education: The impact of undergraduate research programs. *American Educational Research Journal*, *50*(4), 683–713. https://doi.org/10.3102/0002831213482038

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students? *CBE—Life Sciences Education*, *10*(2), 156–163. https://doi.org/10.1187/cbe.10-10-0130

Gallup–Purdue University (2014). Great jobs, great lives: The 2014 Gallup–Purdue index report. Retrieved October 4, 2018, from www.gallup.com/file/services/176768/GallupPurdueIndex_Report_2014.pdf

Garner, P. W., Mahatmya, D., Jones, R. M., & Davis, S. N. (2018). Undergraduate research mentoring relationships: a mechanism for developing social capital for underrepresented students. In: Vandermaas-Peeler, M., Miller, P. C., & Moore, J. L. (Eds.), *Excellence in mentoring undergraduate research* (pp. 77–103). Washington, DC: Council on Undergraduate Research.

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, *341*(6153), 1455–1456.

Haeger, H., & Fresquez, C. (2016). "Mentoring for inclusion: The impact of mentoring on undergraduate researchers in the sciences." *CBE—Life Sciences Education*, *15*(3), ar36. doi: 10.1187/cbe.16-01-0016

Hayward, C. N., Laursen, S. L., & Thiry, H. (2017). "Why work with undergraduate researchers? Difference in research advisors' motivations and outcomes by career stage." *CBE—Life Sciences Education*, *16*(1), ar13. https://doi.org/10.1187/cbe.16-07-0229

Hensel, N. H. (2021). *Undergraduate research at community college* (pp. 1–10). Sterling, Virginia: Stylus Publishing.

Hernandez, P. R., Woodcock, A., Estrada, M., & Schultz, P. W. (2018). Undergraduate research experiences broaden diversity in the scientific workforce. *BioScience*, *3*(68), 204–211. https://doi.org/10.1093/biosci/bix163

Hewlett, J. (2021). Undergraduate research at community colleges. *Scholarship and Practice of Undergraduate Research*, *4*(3), 3–4.

Hunter, A.-B., Laursen, S. L., & Seymour, E. (2006). Becoming a scientist: the role of undergraduate research in students' cognitive personal and professional development. *Science Education*, *91*, 36–74.

Juszkiewicz, J. (2020). *Trends in community college enrollment and completion data, issue 6* (pp 3–19). Washington, DC: American Association of Community Colleges.

Kuh, G. D. (2008). *High-impact educational practices: what they are, who has access to them and why they matter* (pp. 13–23, 25–29). Washington, DC: Association of American Colleges & Universities.

Linn, M. C., Palmer, E., Baranger, M., Gerard, E., & Stone, E. (2015). "Undergraduate research experiences: impacts and opportunities." *Science*, *347*, 1261757. doi: 10.1126/science.1261757

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): first findings. *Cell Biology Education*, *3*(4), 270–277. doi: 10.1187/cbe.04-07-0045

Morest, V. S. (2013). From access to opportunity: the evolving social roles of community colleges. *The American Sociologist*, *44*(4), 319–328. www.jstor.org/stable/42635370

Nerio, R., Webber, A., MacLachlan, E., Lopatto, D., & Caplan, A. J. (2019). One-Year Research Experience for Associate's Degree Students Impacts Graduation, STEM Retention, and Transfer Patterns. *CBE—life sciences education*, *18*(2), ar25. https://doi.org/10.1187/cbe.19-02-0042

Petersen, J., Franco, M. M., Lall-Ramnarine, S., & Wang, S. K. (2021). Institutionalization and sustainability of undergraduate research across disciplines at a public, urban community college: successes and challenges. *Scholarship and Practice of Undergraduate Research*, *4*(3), 30–39. doi: 10.18833/spur/4/3/16

Prunuske, A. J., Wilson, J., Walls, M., & Clarke, B. (2013). "Experiences of mentors training underrepresented undergraduates in the research laboratory." *CBE—Life Sciences Education*, *12*(3), 403–409. doi: 10.1187/cbe.13-02-0043

Ritchie, L. (2016). *Fostering self-efficacy in higher education students*. New York: Palgrave Teaching and Learning, Palgrave Macmillan.

Robnett, R. D., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M. M. (2018). Research mentoring and scientist identity: insights from undergraduates and their mentors. *International Journal of STEM Education*, *5*(1), 41. https://doi.org/10.1186/s40594-018-0139-y

Rodenbusch, S. E., Hernandez, P. R., Simmons, S. L., & Dolan, E. L. (2016). Early engagement in course-based research increases graduation rates and completion of science, engineering, and mathematics degrees. *CBE—Life Sciences Education*, *15*(2), ar20. doi: 10.1187/cbe.16-03-0117

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). The pipeline. Benefits of undergraduate research experiences. *Science*, *316*(5824), 548–549. doi: 10.1126/science.1140384

Shanahan, J. O. (2018). Mentoring strategies that support underrepresented students in undergraduate research. In Vandermaas-Peeler, M., Miller, P. C., & Moore, J. L. (Eds.), *Excellence in mentoring undergraduate research* (p. 49). Washington, DC: Council on Undergraduate Research.

Sloan, V., Haacker, R., Batchelor, R., & Garza, C. (2020). How COVID-19 is affecting undergraduate research experiences. *Eos*, 101. https://doi.org/10.1029/2020EO145667.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Undergraduate Research Committee, New York City College of Technology (2016). A handbook on mentoring students in undergraduate research: proven strategies for success. Retrieved September 30, 2022, Mentoring Handbook Download – Undergraduate Research (cuny.edu).

Wilson, D., Jones, D., Bocell, F., Crawford, J., Kim, M. J., Veilleux, N., Plett, M. (2015). Belonging and academic engagement among undergraduate STEM students: A multi-institutional study. *Research in Higher Education*, *56*(7), 750–776.