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Conducting STEM Industry Internships while Sheltering in Place: The Biotech Partners Experience

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ABSTRACT: Before the shelter-in-place orders began, Biotech Partners (BP) was already engaged in contingency planning with its school and industry partners in an effort to mitigate potential disruptions caused by the looming health crisis. For 25 years prior, BP had successfully mentored and prepared underrepresented high school students to complete professional internships at diverse STEM institutions. Often working in a laboratory or pharmaceutical manufacturing setting, the internships allowed students to apply bioscience, biotechnology, and professional career skills developed in school within the context of a professional workplace. The promise of paid internships in a cutting-edge industry creates an incentive to motivate and maximize student learning in rigorous academic training and workforce preparation. As the COVID-19 pandemic unfolded, most industry sites cancelled their 2020 participation, putting the summer internships in jeopardy. BP rapidly shifted. Collaborating with new and longstanding industry partners, the internship program was modified from in-person to remote work and learning environments. This case study examines the pedagogical challenges and opportunities of conducting remote STEM internships amid a global pandemic. This paper illuminates the role of industry partnerships, student outreach, personalized mentoring, and wrap-around support services to broaden students' awareness of, interest in, and preparation for careers in the STEM workforce.

INTRODUCTION

When the school shutdowns and stay-at-home orders began in March 2020, Biotech Partners (BP) was already engaged in conversations with industry partners about the public health crisis and potential impacts on school-based learning and summer internships. For 25 years prior, BP had successfully coordinated industry internships for high school students predominantly underrepresented in STEM to work at private or public sector STEM institutions, such as, Bayer Pharmaceuticals, Buck Institute for Research on Aging, East Bay Municipal Utility District, and Lawrence Berkeley National Laboratories. For six to eight weeks each summer, rising 12th graders enrolled in a BP Biotech Academy, based at one of four Bay Area high schools, have the opportunity to apply for paid positions, working 20 hours per week for 6-8 weeks, usually in a research lab or pharmaceutical manufacturing role. The internships allow students to expand their emerging biotechnology lab skills, knowledge of bioscience subjects, and professional career skills developed in school through on-the-job training under the guidance of a professional mentor.

Throughout the school year, students participate in BP's hands-on curriculum that embeds biotechnology content in career technical education, preparing them in molecular biology, microbial cell culture, biochemistry, lab tools and equipment, computer and other skills, including over 40 Good Laboratory Practice (GLP) labs. The curriculum is reviewed annually by participating teachers and industry partners to ensure core biotech concepts align with evolving industry standards and science education frameworks. BP staff collaborate closely with the classroom teachers to prepare labs and curricular materials, provide instructional support in the classroom, and offer students personalized mentoring and tutoring in a range of subjects to support their academic learning and social-emotional development. The incorporation of paid industry internships helps engage youth and motivate them to persist in rigorous academic training and professional preparation for the workplace.

In the winter of 2020, things changed dramatically. While the region reeled from the immediate medical and social impacts of the COVID-19 pandemic, BP rapidly shifted to con-

ditions on the ground. As the pandemic unfolded, most past industry sites began cancelling 2020 participation. Facing the prospect of interrupted summer learning opportunities, BP responded early, collaborating with new and longstanding industry partners to rethink and expand the internship program. BP managed to secure internship placements for all students who applied. Doing so required quickly designing new internship solutions. Host sites needed assistance to structure and implement internships virtually.

Students applied for mostly remote/virtual internships that extended their academic learning to professional practices within life science/biotech fields. One partner site (Agenus West LLC) hosted in-person internship experiences for a small cohort of students. Working closely with scientists across three organizations (BioMarin Pharmaceutical, Data Carpentry, and The Jackson Laboratory), BP developed and led a data science internship track consisting of virtual bootcamp workshops in data science concepts, Python coding, and bioinformatics, followed by mentored projects exploring data related to cancer research, immunology or COVID-19 in real-time.

Pivoting to support students' distance learning and pilot virtual internships for the first time required BP staff to increase its direct support for youth participants and industry partners. Host sites needed assistance to structure and implement internships using digital and remote learning strategies. For many students, socio-economic uncertainties, emotional and mental health needs, and family financial obligations expanded during the pandemic, creating pressures on some students to work "under the table" or essential jobs. Despite continued restrictions on in-person learning, BP maintained regular communication with students and provided wrap-around services when needed to address housing and food insecurity or mental health issues. This case study reflects on the unique challenges and opportunities of transitioning from in-person STEM internships to virtual learning environments. With a focus on the pedagogical context of training and mentoring high school students, we present multiple stakeholder perspectives through extended interviews with youth, industry partners, mentors, and biotech educators. By assessing the complex constraints of conducting remote internships in the midst of a pandemic, this paper illuminates the importance of industry partnerships, individualized student support, and other promising strategies to motivate students to become aware of, interested in, and prepared for careers in the STEM workforce.

Conceptual Framework: Industry Internships with "At Promise" Youth. BP's biotech workforce training model combines academic and career technical education programming with extensive wrap-around student support. The program connects high school students, predominantly youth from demographics underrepresented in STEM fields, to bioscience professionals and organizations through both school-based academic and workforce preparation and industry-based internships. By building relationships across public schools and STEM industry partners, BP creates personal-professional connections between individuals and institutions that do not frequently intersect without intervention (Austin and Seitanidi, 2012; Seitanidi and Ryan, 2007).

Through laboratory-based coursework, personalized supports, professional learning workshops, and paid industry internships, students develop interpersonal, academic, and career-oriented learning experiences in and out of school. Key constituents of BP's internship program include:

- Culturally and socio-economically diverse students at partnering high schools and community colleges who apply to participate in specialized biotechnology coursework and industry internships,
- Classroom bioscience teachers who design and lead coursework and engage in teacher learning to support students' preparedness for internships,
- Industry professionals at biotech and science institutions across private and public sectors who volunteer to create or supervise student internship experiences, and
- BP program coordinators and administrative staff who collaborate with and support participating students, teachers, and industry mentors.

BP program coordinators play especially critical roles to understand the unique needs and strengths of the students and the school community. With one or more program coordinators embedded in each school, these educators provide key supports to build and maintain student engagement through BP's rigorous school-year academic programming and the summer internship placements.

In contrast to educational research and policy that frame underrepresented students and communities as "at risk," BP intentionally views young people as "at promise," capable of great things when given the opportunity and adequate support for personal and academic growth (Drake, 2017; Whiting, 2006). As one BP administrator explained, the notion of youth as "at promise" reflects a conscious language choice and conceptual focus on the resilience, persistence, and potential of all learners when they are supported appropriately. Rejecting deficit models of learning that situate student achievement solely or primarily within individuals' choices and behaviors, BP tackles the socioeconomic obstacles and educational conditions that enable or constrain student achievement (Ladson-Billings, 2006). BP educators create supportive learning environments and provide wrap-around services to help students overcome obstacles that affect access, readiness, and participation in education.

BP's mentorship approach relies on the development of

cross-sector collaborations with biotech organizations and experts. Conducting biotech industry internships with young people disproportionately underrepresented in STEM college and career pathways exposes youth to diverse learning opportunities with biotech educators and industry mentors working together "to support the personal and professional growth, development, and success of the relational partners through the provision of career and psychosocial support" (National Academies of Sciences, 2019, p.37).

A growing body of research examines the role of mentoring in preparing youth of color through STEM internships (Girves et al., 2005; Russell et al., 2007; Sanchez et al., 2008). While BP does not turn away students from socially or economically advantaged backgrounds, the program primarily targets and recruits high school students from groups underrepresented in STEM. Most students meet at least one demographic criteria of underrepresentation. The result is a diverse mix of youth along lines of gender, race, ethnicity, and social class. Approximately, 75% of BP's students are youth-of-color, 50% are female, and 85% come from low-income families.

RESEARCH METHODS

Funded by the National Science Foundation's Innovative Technology Experiences for Students and Teachers (ITEST) program, this project builds intentionally on institutional knowledge and experiences gained from BP's long-standing program structure and practices related to industry internships. In 2019, BP received an ITEST grant to fully implement the program across four high schools, collaborating with Rockman et al (REA) to conduct research on the implementation and impact of the high school student internships. This overarching study employs a case study approach (Yin, 2009), using qualitative, ethnographic research methods to explore the characteristics of successful internships, program implementation, and multiple stakeholder impacts. A case study approach facilitates open-ended inquiry of the organizational dynamics and decision-making behind BP's internship model. The study aims to inform leadership and program practices in youth STEM mentorship.

Examining multiple stakeholder perspectives (e.g., youth, industry partners, mentors, biotech educators) on training and mentoring students through STEM internships, the project pursues an essential question about conducting cross-sector partnerships: *In what roles and in what ways do bioscience educators and business and industry workforce members motivate students from diverse underrepresented populations to become aware of, interested in, and prepared for careers in the STEM workforce?* This article discusses preliminary findings and implications observed in making the shift from on-site to virtual internships.

We started our research in 2019 by exploring BP's yearly cycle of pre-internship planning and preparation, summer internships, and post internship follow-up. We spent time getting to know the BP community so they would feel comfortable sharing their experiences. In our first seven months, we interviewed BP staff, classroom teachers, students, and industry mentors, and attended staff meetings, class sessions, and public internship events. We had just wrapped up one round of interviews and were about to observe BP's process for recruiting industry internships when the Bay Area announced its shelter in place orders. This placed us in the unique position of watching BP staff, classroom educators and industry professionals immediately reconsider how best to support students that spring and in the months to come. We continued our online observations and interviews, but with an eye toward documenting on-the-spot changes, and offering advice and resources of our own. In keeping with our commitment to culturally-responsive and equitable research and evaluation practices, we shared interview transcripts so individuals could reflect on and modify anything they had said, and presented our emerging findings to BP staff to help us interpret what we were learning.

The research team listened carefully to the diverse stakeholder voices, stories, and questions that emerged, using memos to reflect on interpretive decisions, to create or apply certain analytic codes, to negotiate evolving definitions and descriptions of codes and categories, and consider how a specific code relates to its context. In analyzing the project's multiple data sources, we drew on the constant comparative method (Glaser and Strauss, 1995) throughout the iterative stages of research.

RESULTS

Pivoting During the Pandemic. All aspects of BP's regular program practices were impacted by the COVID-19 pandemic and required rapid contingency planning. The school shutdowns forced BP to quickly transition to maintain learning with students during the normal academic/training period in advance of the internships. BP staff worked with school-day teachers to salvage academic programming, shifting to online learning support and sustain learning, even in the absence of accessing the in-school, state-of-the-art labs. In the face of school closures, students attended biotech classes and tutoring sessions online, and were supported through in-class and one-on-one tutoring to complete assignments electronically. Through persistent communication and personalized support, BP program coordinators helped students to remain engaged during spring semester distance learning, to meet the internship eligibility requirements (e.g., complete career technical workshops, maintain a grade of "B" or better in the biotechnology course, and "C" in other classes), and to successfully complete the internship work and learning assignments. As one administrator explained to incoming BP families:

We call this a "no fail class," but there is serious work to do... You should know that if your child wants to do an internship and is motivated to do the work, we will make sure they get the help they need to meet the requirements.

While BP routinely provides tutoring and social-emotional support across the year, student and family needs grew dramatically in the wake of COVID-19 economic fallout. As a result, BP increased wrap-around support for youth, offered on a case-by-case basis, to help participants access mental health services, counseling, and direct support for food, housing or transportation needs. By building individual relationships with students and paying attention to their lives in and out of school, BP was able to identify potential issues and help directly address economic, social, or interpersonal factors that present obstacles to in-school engagement or internship participation.

Operating across three Bay Area counties in four school districts, each adopting a different model of direct learning, required nuanced coordination. BP program coordinators met weekly with classroom teachers to adapt the curriculum content and instruction. Although COVID-19 interrupted in-person learning, BP identified ways to amplify the existing science curriculum through hands-on virtual activities, which BP has found to be instrumental in engaging students and preparing them for industry internships. Staff helped to assemble, deploy, and implement at-home lab kits for students to conduct experiments from home on their own, modeled by the instructor, and facilitated during virtual class.

To prepare young people for the professional expectations of STEM internships, students participated in presentations online with industry professionals to share college and career paths and to teach study skills, email etiquette, resume building, cover letter writing, professional attire, interviewing techniques, mock interviews, and remote work practices. In general, student class attendance became variable and decreased during distance learning. However, students tended to show up for internship-related workshops and caught up on missing assignments, required to be eligible for an internship. Although the schools significantly relaxed academic expectations and witnessed drops in daily student attendance after switching to pass/fail course grading, BP incentivized higher participation standards with the promise of a paid professional internship.

Most industry sites cancelled their participation at the start of the pandemic, dropping from 21 internship host sites in 2019 to 8 in 2020 (see Table 1). The number of volunteer mentors also dropped precipitously as people and businesses reeled from the crisis. Notably, BP launched new collaborations with three industry partners offering student internships for the first time, including one partnership with an organization not previously linked to BP's network. As industry partners dropped out, REA researchers essentially stepped into the narrative in order to introduce BP to Data Carpentry, a volunteer-driven nonprofit that develops workshops, usually with adult learners, to teach fundamental data science skills needed to conduct research in a variety of fields (Data Carpentry, 2020). In collaboration with instructional leaders at Data Carpentry, BP co-designed and co-led a new internship track in coding and bioinformatics, drawing on two coding-based learning programs: a) CodeHS online curriculum led by BP staff and b) data science workshops led by Data Carpentry volunteer instructors. Students learned techniques to clean, organize, and analyze data sets, focusing on computational biology applications. Students learned the basics of coding in Python, using Jupyter Notebook to practice writing and iterating on Python code for data analysis. Following this data science bootcamp, students were organized into small teams to conduct exploratory projects, mentored by scientists at BioMarin Pharmaceutical, Data Carpentry, or The Jackson Laboratory, examining publicly-available real time datasets related to COVID-19, cancer research, or other topics.

Two new industry collaborations grew out of longer-term relationships. Long before COVID-19, BP leaders were engaged in ongoing outreach efforts with organization representatives. In one case, the company had served as an anchor funder to BP but, given regulatory constraints and space limitations, they never hosted interns in-person. Launching a virtual internship program with students learning bioinformatics created an opportunity to participate directly. In another case, an executive and long-time BP supporter had advocated for the company to participate for years but failed to garner adequate backing. Ultimately, the biotech companies and volunteer mentors were in large part compelled to participate as a way to take positive actions in the wake of pandemic disruptions and civil unrest following the death of George Floyd. In addition, the introduction of remote internships helped enable the participation of industry mentors located outside the Bay Area and without sufficient physical space to host interns.

Table 1. *Biotech Partners' Internship Program Data.*

	Biotech Partners in 2019 (Pre-Pandemic)	Biotech Partners in 2020 (Pandemic Pivot)
Total number of students in Biotech Partners	204	295*
Number of internship sites	21	8
Number of internship mentors	37	24
Number of students placed in internships	48	45
Internship completion rate (as measured by time logs and completion of BP assignments)	100%	96%
Senior graduation rate	100%	100%

** The increase in total student numbers from 2019 to 2020 was due to the expansion of BP programming that took place at one high school site prior to the pandemic.*

Internship Expectations and Assignments. While the internship sites varied in 2020, the student requirements remained the same. During in-person or remote internships, students worked 20 hours per week, and completed workforce-related homework assignments (Table 2). Tasks included writing about personal education and career goals, investigating the internship host company, interviewing a scientist or STEM professional about their educational and career trajectory, developing a professional resume, and creating a scientific poster. The assignments helped establish a common thread that runs through all student internship experiences.

Table 2. *BP Homework Assignments for All Interns.*

BP Homework Assignment	Assignment Description
All about You – Student Profile	Autobiographical essay addressing significant events, people, and accomplishments in the student's life, challenges they have faced, how have these events shaped them, and their goals for the next 3-5 years.
Company Profile	Short report detailing company information, such as name, logo, company size, organizational structure (e.g., for-profit or non-profit; private, government, or university program), mission and goals, description of the host department's purpose and processes, and description of intern duties.
Conduct Informational Interview	Schedule and plan an interview of supervisor or another member of host company to better understand their background, the nature of their role and work, organization, and industry trends.
Informational Interview Write-Up	Report that explains who the student interviewed and why they were selected, provides a transcript of the conversation, and reflects on what the student learned
Draft of BRAVO! Poster	Draft of slide deck, to be presented at BRAVO! celebration, that highlights the job responsibilities, work environment, internship highpoints, work-related challenges, lessons learned, and key accomplishments during the internship.
Updated Resume	Students revise their resume developed earlier in the year with new work experience and skills acquired during the internship. Internship mentor and BP staff provide critical feedback.
Reflection of Internship Experience	Written reflection on the internship experience outlining the host company and department, the intern's learning goals and objectives, the nature of the remote or in-person work experience, work-based challenges, skills or lessons learned, and how the internship relates to future goals.
BRAVO! Poster	Completion of the final draft of slides and supplementary content for the BRAVO! presentations for review and feedback by BP staff.

During the first week of the internship, students worked with their mentor to complete an agreement form that articulates the intended learning objectives. The process, established before the pandemic, was used as a way to help interns and mentors focus on what should be learned during the internship and to determine if interns are successfully meeting the expectations of the job. Each day, interns were expected to keep a work journal or lab notebook to document daily tasks, new terminology or skills learned, materials and equipment used, challenges encountered, and key takeaways. During virtual internships, BP transitioned from using paper-based journal entries to a Benchling digital notebook, which gave BP staff real-time access to students' progress and perceptions of their work activities.

In the final weeks of the internship, BP program coordinators conducted virtual site visits with the interns and their mentor, using a structured protocol to promote stakeholder reflection on the internship experience. For example, intern questions included: "What does your company do? What does your department do within the company? With whom do you interact and how do you support the work of the department? What skills or qualities have you learned during your experience?" Sample mentor questions included: "Are you happy with the performance of the intern? How can you be better supported as a mentor? How can Biotech Partners better prepare/support the intern?" BP used this information formatively to monitor and improve its programming. BP defined and measured individual intern success quantitatively with timesheet logs and assignment records. If students worked the required number of hours per week, and finished all of their weekly assignments on time, they successfully completed their internship and received high school credit.

Mentor and Student Internship Experiences. The duties and responsibilities of interns working in remote internships had to shift in response to federal, state and regional shelter-in-place mandates and social distancing requirements. Very few students were able to physically be in a lab environment, and as such many had duties and responsibilities that were limited in scope to what could be completed remotely. Biotech Partners re-envisioned the internship structure in a new world of remote work. Based on industry trends and feedback from partners, the program sought to improve the computing and online skills of student interns so that they could offer useful assistance to the industry mentors related to data processing and analysis. A BP student, who completed the data coding track and then participated in a mentored internship project to explore trends in data related to COVID-19, explained:

> *For me it's a bit different because I wasn't in a physical lab... When you're in our biotech classes, we learned mostly physical kinds of skills... We learned other skills but mostly hands-on lab stuff and so when you're on a computer screen, you can't really do that. But I would say that a lot of the knowledge I learned about viruses and proteins and the cell structure and so on, really helped me during [the exploratory project] phase in my internship and really understanding documents and figures.*

Student responsibilities varied by internship site and included learning and studying industry Standard Operating Procedures (SOPs), business operations, communications, and technical skills like collecting and analyzing microscopy data, liquid chromatography tests, mass spectroscopy results, supporting breast cancer research, conducting peptide mapping, or analyzing publicly available COVID-19 data sets.

For students placed in remote internships, their day-to-day work experiences were largely shaped by their individual mentors and host site needs. At most sites, interns and mentors checked in at least once per day one-on-one or in small groups to discuss the work objectives, reflect on learning outcomes, or address issues. Interns worked asynchronously on administrative tasks and independent project work. One intern explained:

> *It was really unstructured at first and we kind of did everything independently. Twice a week I'd have a meeting with our mentor or our whole group would meet and we'd kind of go over what we needed to do for the week. It was beginning of the week and at the end of the week we went over what we had to get done that day to get turned in deadlines.*

At one company that hosted multiple interns for the first time in 2020, the mentors and students convened every day for an hour in meetings that focused on group discussions and analyzing research papers and scientific articles. Daily intern schedules were organized by each mentor. One mentor noted that the daily check-in meetings usually addressed organizational matters and then concentrated on ways to critically read a scientific paper and how to ask probing questions:

> *I had three mentees in my group, and we covered certain topics within the bigger umbrella of COVID-19. I was meeting with them whenever we had to prepare something for the bigger full group meetings. Or I met with them one on one to help them understand scientific articles or prepare [sic] the presentations.*

Other mentors in remote internships found it challenging to strike a balance for interns between office tasks and scientific endeavors in the virtual environment. One mentor reflected on the importance of providing independent project work alongside administrative duties:

> *If I had to do it over again, I would be better prepared on our end of things with a more discreet project for the interns. Just keeping in mind how short their time is and then the difficulties of working remotely. With interns in the past, in the office, what we've tried to do is give them a mix of work that's... Some of it's more creative or requires research on their end. Some of it's more just like office-y duties, even really boring things like scanning. I think that is a good mix for an in-office intern but there's not really a good equivalent to the boring office-y tasks virtually.*

The timeframe and difficulty of the pivot to remote work was a major factor in how mentors structured their interns' time. An experienced mentor explained:

> *Part of [the challenge] was just me having time… to develop a project for them and part of it was the framing, because I think, [our organization] was just trying to make this work. Trying to pivot really quickly to this virtual program, and they didn't want to make it seem like a big lift for the sponsors or the supervisors who were hosting the interns... I just wish I could have given them more of an experience.*

Students responded positively to the opportunity to work with pertinent scientific data. One intern described the significance of exploring issues related to COVID-19 during the pandemic:

> *My kind of favorite part of my internship was...the two main projects I did at the end. We were talking about COVID-19, which was obviously so prevalent in everyone's life and is still really prevalent. And so it was fascinating to break down all aspects of it, its impact, what it's made of, how it affects cells and vaccine development, and so on. And I feel like coming out of it, I learned so much more about this disease.*

The six students who had the opportunity to work in-person for the summer had experiences more in line with previous internship implementations. Duties included working with manufacturing-scale machinery and calculations, buffer and mobile phase production and protein purification. Students placed in lab settings demonstrated proficiency in basic lab techniques and acquired new skills quickly. A first-time industry mentor reported, "[The intern] had a really great time, and she felt like she learned a tremendous amount every day that she was there. I was impressed also with how quickly she picked things up."

One evening per week throughout the summer, students attended professional workshops led by BP on a range of topics, such as financial budgeting, taxes, biotechnology career pathways, presentation skills, and self-care practices. Zoom breakout rooms were used for small group check-ins where students shared internship experiences, raised questions, and discussed challenges they were facing, which ranged from

administrative paperwork or technical computer glitches to communication issues or struggles with assignments. This informal meeting time was crucial for interns to identify and process issues in the moment and to get support from BP staff and peers. Using Benchling digital notebooks, all students completed the aforementioned weekly BP homework assignments.

The internships culminated in BRAVO!, a judged competition of student presentations to share aspects of their work experiences and outcomes. In past years, students made a trifold poster board and presented it in a large conference room. Volunteer judges would circulate the room, asking students questions and evaluating the participants on the quality of educational content, oral presentation, and creativity. Due to social distancing guidelines, the 2020 intern presentations were conducted virtually for the first time, where students presented online to a panel of judges in Zoom breakout rooms. Students highlighted the social and technical aspects of their work. Mentors appreciated the opportunity to see interns share their learning outcomes at BRAVO!, as well as presentations hosted by individual internship sites. During one internal presentation, a mentor commented that the BP intern contributed significantly to a breakthrough, that the team "may have solved the world's problem with nutrient removal," further joking that they would need to split any future royalties with the intern.

Internship Reflections. Mentors praised the interns for their content knowledge and general preparedness. While most students in 2020 were not able to take advantage of their hands-on biotech lab skills training during the internships, the BA coursework related to the content addressed in many of their positions. Mentors also noted student maturity and professional readiness, highlighting the types of skills emphasized in BP workshops. Two mentors said:

> *"Watching the kids perform, not only were they knowledgeable when they came in, but they also seem to have pretty good discipline...I was pleased with their professionalism as well as how much knowledge they came in with."*

> *"The interns also were superbly prepared… [BP] had very clear expectations and guidelines...that all seemed like a well-oiled machine."*

For students, the BP classroom and internship experience was both novel and exciting. BP coursework allowed youth to explore specialized content in molecular biology, cell culture, biochemistry, and professional career skills, as well as hands-on laboratory techniques and practices not available to most high school-level students. For instance, in the in-person internships, the opportunity to learn PCR testing to assess genetic material and practice micro-pipetting with industry grade equipment were not just novel in the high school context, but directly translated into the lab-based internships. In the remote internships, most students were introduced to the foundations of computer science and basic programming in Python, with an emphasis on developing reasoning and problem-solving skills applied to bioinformatics. Thus, students got the opportunity to use and refine STEM skills and knowledge learned through their in-school classes and to gain additional skills by studying new techniques, standard operating procedures, and high-tech equipment on the job. Additionally, the incentive of payment set the experience apart, taking some pressure off those students who needed to earn money during the summer.

Students were generally prepared to handle the content knowledge and soft skill requirements of the internships. Mentors described students as self-motivated and ready to learn, bringing a "refreshing" perspective to the workplace. Interactions with interns helped mentors get to know students' capabilities and developed their own teaching skills. Preparing projects for interns, supervising progress, and explaining the basics of how to do a task helped to deepen mentors' own grasp of their work and spark new ideas. Mentors benefitted from the opportunity to create space within their existing work environment to connect with younger generations, specifically youth underrepresented in the biotech field, developing greater social awareness by working with youth who they would not otherwise meet. One mentor said, "I just think the experience working with interns helps me refine my approach and make it more very much defined." Another mentor described being more "open minded" to the idea of having "young and inexperienced youth spend the summer [in the lab]." Another mentor explained, "It's enjoyable working with somebody who's young and enthusiastic and full of energy."

The internship experience gave students exposure to a professional workplace. Students developed their essential "soft skills," such as building their professional networks, communication, teamwork, and time management that are crucial to the work environment and everyday life. Two students said:

> *"I gained a lot of professionalism talking to adults. I learned that I couldn't just talk to them how I talk to my friends, I can show some responsibility too, with managing my time and assignments."*

> *"I gained a lot of connections and responsibility. During the summer, we did a lot of Zoom calls and we were expected to dress appropriately and show up on time, show your face on camera. And then when school started, I was already doing these things, the other students weren't really doing these things, because they haven't practiced Zoom etiquette like we did over the summer."*

Although virtual internships created certain constraints on hands-on experiential learning, students gained exposure to the biotech industry, meeting and connecting with scientists and other STEM professionals. For some youth the internship solidified their desire to pursue a biotech career path, giving youth an opportunity to learn from the biotech field directly. One intern in a remote position shared, "While there are still things I want to explore, I think the internship really helped get me interested in biotech and actually want to work in that field." Another student had already decided to pursue a career in medicinal chemistry, but highlighted that their internship work analyzing COVID-19 vaccine data sets strengthened their commitment to that path. The ability to promote the exploration of students' educational and career interests was prefaced on establishing rapport between the mentors and interns. One mentor described the significance of relationship building and what they learned about the interns along the way:

> *The most satisfying part is actually getting to know the students…They're at a point in their life where they can make a decision on what career path to take. Letting them know that [biotech] is an option and that it's a very rewarding job, it's a very rewarding career, if they choose to take this path.*

Students also found value in their mentor relationships:

> *[Our mentor] gave us her email at the end. She was like, "You guys need any advice or anything, let me know." So I really appreciated that... I kind of thought it would be...awkward, she's like a scientist and we're still high school students, but she never really treated us like that. She treated us like colleagues and if we ran into problems, she'd make sure that she solved it. She also told us that she learned stuff from us too. I don't know how truthful that was, but that's great.*

Social interactions with mentors gave students the opportunity to see scientists as normal people in a professional workplace and to see themselves as part of that professional community. At one site, the group of interns attended the weekly all-team meeting where the scientists discussed current issues and trends in the field as, company updates, as well as informal conversations. Students said these gathering gave them a window into the everyday work life and helped to reduce the perceived distance between themselves and the scientists. Two students who worked in data science internships explained:

> *"We got to participate in the weekly department meetings...where all the scientists would gather together and they would discuss the current projects that they were working on and some of the challenges that they faced and how they planned to resolve them, as well as just seeing the different presentations from companies who came in that were trying to market their products for the new advanced. I thought that was particularly interesting."*
>
> *"The way that the scientists were talking to each other [during team meetings], they were very laid back, they were trying to educate one another rather than competing with each other. That was really cool. They would call each other out if they said something wrong, rather than just listening to what a person would say and believing it as true. They would ask questions and get more information… that definitely changed my perspective on [scientists]."*

One student based in a virtual internship described the significance of being included in the department's professional meetings, which also sometimes strayed outside of science topics. Following the George Floyd protests, the company came together as a whole group to process what was known, how people were feeling, and what next steps individuals or the organization could take. During that meeting, the intern spoke openly about the history of violence against African Americans. The student explained, "[George Floyd's death] is not something that was just random. This is something that's been going on for years and years. I was able to really talk about it during my internship, and I felt good talking about it." While this particular experience was not the norm, it underscored the unanticipated benefits of students socializing professionally during the internship.

Navigating the Challenges and Possibilities of Virtual Internships. Taking the internships online allowed BP to sustain summer programming through the varied restrictions of the COVID-19 shutdowns. Participants were not limited by geographic boundaries for the first time in program history. In previous years, students at two of the participating high schools in particular, based in counties with fewer biotechnology companies, tended to face greater transportation obstacles. BP paid for interns' public transportation costs, though travel times across multiple connections could take three or more hours each day. During the summer of 2020, remote internships were placed nationally and internationally for the first time, with mentors hailing from Nevada, Illinois, Maine, Iceland, and other locations in addition to the San Francisco Bay Area. The opportunity to meet and network with scientists living abroad was a highlight for many interns. For these and other reasons, virtual-only or hybrid internships are likely to continue into the foreseeable future.

Adapting the internships from an on-site to remote learn-

ing context demanded creativity and flexibility. BP had to operate on a tight timeframe, at the same time that the organization faced staff capacity issues complicated by the pandemic. They asked mentors to rethink and redesign the implementation of internships in a period of great uncertainty and anxiety. Successfully transitioning the program to virtual learning was not without challenges. BP faced numerous obstacles that threatened equitable student participation through the remaining school year and summer internships. When the school shutdowns took effect in March 2020, students and teachers were initially informed the closures would last two to three weeks. These deadlines were regularly extended, requiring a longer-term planning process. Fortunately, at that point in the school year, students had completed most of their biotech lab activities and professional training. BP worked with the classroom teachers to maintain coursework online and expand the curriculum to focus student learning on the biology of SARS-CoV-2 and the implications of COVID-19. Suddenly, many aspects of their biotech curriculum were on display in the daily news media. The appearance of this deadly new virus shed light on the relevance and importance of biotechnology innovations. Students were empowered with information and understanding about the structure of viruses, how they originate and evolve, mechanisms for infection and reproduction, the diseases that result, scientific procedures to study viruses, and public health strategies to slow the spread and mitigate their impacts. As one staff member put it, "Our students can play important roles to counter misinformation about the virus they may encounter in their own communities."

Despite the efforts to maintain continuity of learning during the spring semester, many students were not showing up consistently for online class. BP aggressively implemented student and family outreach to communicate with each student. Staff used email, text messages, phone calls, and in a few cases, 1-on-1 visits outside students' homes to understand their specific barriers to participation and devise support strategies. Gaps in access to technology devices and reliable internet prevented some students from participating regularly. Others lacked a suitable work space from home or juggled responsibilities caring for younger siblings, disrupting their attention or schedule. Some young people increased work hours or found "under the table" employment as essential workers. The social, economic, and health stressors magnified by the global pandemic created significant obstacles to distance learning.

BP strove to better assess the students' technology needs, purchasing laptops, software, and internet connections, so that students were prepared for the basic online communication and programming requirements of the virtual internships. The data science internships necessitated laptops with enough processing power in order to run Python and Jupyter notebooks. Chromebooks, which the school districts had provided to students in need, were insufficient. In many cases, students needed assistance to get familiar with and configure the technology. The orientation week scheduled prior to the start of internship job placements proved crucial to troubleshoot issues, address concerns, and fix problems on the fly. A small number of students also incorrectly indicated that they had access to a working computer and internet connection, requiring last minute purchases. For some youth, the fear, embarrassment, or shame associated with asking for financial assistance or self-identifying critical personal or family needs can pose significant obstacles to receiving the help they genuinely need.

While BP provides social-emotional support to students every year, youth and family needs grew dramatically in the face of the COVID-19 economic fallout. Student socio-economic and mental health needs both expanded and deepened. As a result, BP increased its provision of wrap-around youth support services. As one of multiple examples, at the start of shelter-in-place orders, one high-performing student's grades started to drop. After the BP program coordinator inquired multiple times as to why, the student revealed that her mother had recently lost her job and was spending days away from the home, causing the girl and her sibling to seek food at the home of their grandparents who were also struggling. Having to walk to and from school, she was missing lunch and operating without proper sustenance. The family perceived the only viable option was for the girl to quit school in order to work full-time. At this stage, BP intervened, and was able to provide the student with food and transportation support, thus enabling the student to remain engaged and focused on school. Despite continued constraints on in-person interactions, BP maintained regular communication with students and provided support services when needed to address housing and food insecurity or mental health issues. In spite of numerous family health challenges, the impact of the deaths of loved ones and neighbors, and the uncertainties experienced within their communities due to local and global civil unrest, all but two students successfully completed the internship responsibilities and gave final presentations at the culminating BRAVO! poster competition.

However, students and first-time mentors did not necessarily have clear expectations at the outset of the internships for how to assign and supervise work that fulfilled BP's program goals. There were many steps in the communication process that accelerated during the pandemic. While the learning curve was steep, it was understandably less problematic for mentors who had one or more years of experience volunteering in the BP program, which gave them ideas about coordinating beneficial internship activities, periodically monitoring students' weekly BP assignments, and offering feedback or coaching on students' BRAVO! presentations. For some new mentors, communication issues arose from the fact that mentor recruitment extended until shortly

before the commencement of the internships, given that so many host sites had cancelled 2020 participation. All students found placements, though some were confirmed only a matter of days before the job started, leaving very little time to onboard mentors or students. The scramble and time crunch created challenges for mentors to understand the scope of their role. A few new mentors acknowledged that they did not fully read the BP mentor handbook ahead of the internship. Several students shared that the beginning of their remote internships was dominated by confusion about tasks and scheduling:

> *When I did start out in the internship, I was working in the coding track and it was really confusing at first with the scheduling, when things would be... What we were actually supposed to do. It was pretty confusing. So I think knowing our task was a little weird because we wouldn't really know when to do them.*

Mentors shared similar observations about their students:

> *The overall organization was a bit like from day to day. The students were often not clear what they were supposed to do and they were often like, " We don't know. We have to ask Biotech Partners how this works." And I was also not sure.*

Beyond confusion about the expectations for students, the mentors themselves were sometimes left wondering about the relevance of the content they provided to their interns:

> *I wonder the entire time of what we are doing, letting them read scientific papers and presenting them if that was just even something that Biotech Partners considered as helpful? I wasn't sure. Is that really something that we should be doing? How much does this help them?*

The process of critically reflecting on the value of the internship task design allowed for retooling activities along the way to improve participants' experiences. Establishing conditions for successful, high-quality experiences entailed careful attention to develop work tasks and objectives that were meaningful for the students, manageable for the mentors, and focused on training the next generation of scientists and STEM professionals. Negotiating and maintaining meaningful and manageable goals for the interns depended on the collaboration of stakeholders.

BP staff, mentors, and students played key roles to ensure that the placement process, intern and mentor supports, and job milestones are aligned with the needs and strengths of the students and the industry partners. BP primarily defined the roles, responsibilities, and requirements of internship participation. Industry partners and supervising mentors established the professional context, internship parameters, and work responsibilities for the interns. Students navigated the basic expectations and worked with their mentor(s) to interpret and perform their work and learning duties. Stakeholders' perceptions of success derived in large part from the experience of participating in shared responsibilities. Success was defined not through predetermined outcomes, but engagement in a process in which students collaborated as part of a team, examined scientific and technical topics with mentors and peers, and explored various career and educational pathways.

CONCLUSION

Biotech Partners, its industry partners, and students adapted to distance learning and remote work. By reengineering the summer program during the pandemic, students were given the opportunity to directly apply their emerging scientific and technical knowledge and professional skills in the context of a public or private STEM industry institution. Through patience and persistence, BP maintained its annual commitment to broaden youth participation in STEM career pathways through paid, professional internships with high school students from demographics disproportionately underrepresented in biotechnology fields. This paper highlighted the role of industry partnerships, youth-adult relationships, personalized forms of outreach and support, and technology considerations that can motivate students to become aware of, interested in, and prepared for careers in the STEM workforce. While there is no no-one-fits-all approach to design and implement virtual internships with high school students, BP's experience suggests promising practices that may support effective and equitable learning experiences with young people.

Foster Open Lines of Communication. The implementation of the virtual internships relied on the active communication to, from, and within the Biotech Partners organization, the internship host sites, and the student interns, often placed in pairs or small teams at one site. Establishing effective communication between the industry mentors and youth served as a precursor to creating constructive relationships between mentors and students. If ongoing communication is not established early on or poor communication patterns go unchecked, the program risks alienating interns, especially those experiencing uncertainty or self-confidence issues. When work gets busy, an intern may assume their mentor is inaccessible or that questions pose a nuisance. Mentors can remind students that they should speak up when they have questions and discuss specifics on preferred modes of communication (e.g., email, phone, text message, Zoom, Slack).

In-person internships in 2020 and in previous years allowed BP staff and industry mentors to convey key infor-

mation through face-to-face individual meetings and daily informal exchanges. These interactions served to keep youth informed while helping them to develop a sense of connection to and understanding of the workplace culture and people. Shifting to remote work and learning contexts created obstacles to basic communication, for example, reducing the amount of unscripted moments together where adults could share just-in-time communication and students could ask emerging questions. BP staff stayed in touch with interns through regular email updates, as well as text messages or phone calls, when necessary, to remind participants about schedule changes, important due dates, and all-group meetings. Pre-internship BP workshops introduced students to email practices and communication strategies, including how to pose good questions and to ask for help. Young people required on-the-job training on how to make the most of virtual communication tools and specific software or learning management platforms utilized at the host site.

Ensure Equitable Technology Access. The remote internships depended heavily on all participants having fast internet access and computers with adequate processing power, functioning microphones and cameras. It is crucial that educators and mentors do not make assumptions about students' technology access and clearly communicate the necessary technology specifications. Despite surveying students prior to internships to assess technology needs and explain basic requirements, a handful of young people started the summer program without an appropriate device or stable internet connection. In a few cases, students did not communicate an accurate picture of their gaps in technology access. Feelings of embarrassment or shame can push youth to downplay the extent of their financial needs, even with educators they know and trust.

Discrepancies between the basic requirements of distance schooling and remote work also led to misunderstandings. For instance, although Chromebooks were sufficient to utilize online collaboration tools, such as Zoom and Google, students needed a more powerful laptop to run Juptyer Notebooks and other software used in the data science internships. At one host site, students experienced unanticipated compatibility issues between home computers and the company's learning management system, which caused initial delays to intern onboarding and training. Mentors devised creative work arounds to get students on the training platform. While having reliable technology alone did not guarantee high-quality internship experiences, it was a prerequisite for participation and success.

Help Students to Set Up a Conducive Workspace in the Office or at Home. Digital technology tools and infrastructure make working and collaborating remotely possible. However, the mere presence of functioning technology does not mean that individuals or teams can achieve productivity while working from home. When interns work in-person, many factors of the workspace are determined by the physical environment that was ideally designed with performance and productivity in mind. Host companies typically provide in-person interns with a desk or cubicle in the office, which helps youth feel a sense of connection and place within the organization. BP staff, mentors, and students confronted numerous challenges of establishing conducive workspaces remotely.

Adults must not draw assumptions about where students will be working or that students will have a viable workspace. Remote internships introduced a range of distractions for participants. The pandemic forced families to shelter in place, often dramatically increasing the number of people normally at home. While some interns had the benefit of designating a private or semi-private room as their virtual office, others continually contended with siblings and other family members entering their workspace. For some, the notion of turning on their camera in a group Zoom meeting created feelings of self-consciousness or anxiety about publicly sharing the sights and sounds from home.

Prior to and during the internships, BP staff talked with the young people about where and how they would set up their physical work environment and brainstormed ways to mitigate distractions. Some youth needed guidance to communicate why they may need to turn off their camera or microphone. Interns learned how to configure Zoom or other communication platforms using virtual backgrounds or filters that were appropriate for a professional setting. By seeking to understand the challenges that youth were experiencing, the adults were able to support students with strategies that fit the actual conditions on the ground in order to set up their own work environment at home.

Set Clear, Manageable Goals that Communicate High Expectations. BP students were treated as young professionals entering the workforce. Before the internships, students completed two semesters of specialized laboratory-based courses in biotechnology during their junior year. This coursework provided students with fundamental content knowledge and lab skills. However, for most students, this marked their first work experience in a scientific professional setting. They needed guidance and support to understand the nature of the company, their role, team norms, collaborative structures, and the organizational culture. Given the scope of new information students must absorb, they benefitted from internship placements with clear delineation of expectations. Internship objectives needed to be broken down into short-term tasks that mentors discussed with interns and checked for understanding. New skills or techniques needed to be explained and modeled before interns attempted to implement independently. Mentors observed intern activities and as-

sessed work products, providing critical feedback for youth to reflect on and improve their performance.

In addition to daily work responsibilities, BP interns were responsible for attending professional workshops led by BP and completing weekly homework assignments that related to, but went beyond, their work duties. Youth needed clear descriptions of the assignment expectations and time to think through their ideas with BP staff and peers. In prior years, weekly BP check-in meetings took place in person and provided opportunities for students to frequently stay late to ask their questions and get help from staff. While the context of online meetings empowers some students who feel shy in large group face-to-face encounters, the virtual space can allow others to assume passive roles. It was crucial for mentoring adults to conduct regular check-ins with interns about their process and progress in managing their own schedule, workflow, and deadlines.

Structure Opportunities for Professional Socialization. Through the industry internships, students were exposed to STEM professionals and a professional workplace. Youth had the opportunity to use and refine STEM skills and content knowledge they learned through their Biotech Academy classes (e.g., pipetting, experimental design, data analytics) and to gain skills by observing and practicing new techniques in a real-world setting. Equally important, youth developed essential "soft skills," such as building their professional networks, communication and collaboration strategies, and time management skills. While remote internships posed limitations on hands-on STEM learning, due in large part to the loss of direct laboratory access, youth got access to the biotech industry and benefitted from meeting and connecting with scientists and other STEM professionals.

Alongside cognitively engaging work projects, virtual internship programs need to build opportunities for students and mentors to get to know one another. Conducting virtual internships solidified the importance of relationship building to support youth learning. Through the act of socializing professionally, interns became better integrated into the company and gained insight into the organizational culture. While these activities are more difficult to implement remotely, there are creative ways to promote informal conversations within the context of the workplace. Consider how to recreate work conversations around the watercooler or the lunchroom through informal meeting time or themed discussions online. Persuade mentors to schedule time for coffee or lunch with interns. Encourage interns to request informational meetings with staff throughout the organization. Companies can send home company-branded swag or other office artifacts to help remote interns establish psychological attachment to the professional workplace.

For BP, building strong relationships between young people and their school-year educators and summertime mentors operates like a secondary curriculum. Securing basic levels of mutual trust is foundational to creating an inclusive and supportive climate in the classroom or the workplace. While not insurmountable, the physical distance of the remote work context increased the challenge of establishing trusting youth-adult relationships. When youth feel connected to their teachers, student motivation often increases and behavioral issues subside. When interns feel connected to their mentors, supervision and monitoring work tasks is more likely to be experienced as a nurturing learning process. Having regular opportunities to interact meaningfully with STEM professionals offered interns the chance to explore professional work culture, industry norms, and possible educational and career pathways to pursue.

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ABBREVIATIONS

BP: Biotech Partners; GLP: Good Laboratory Practice; ITEST: Innovative Technology Experiences for Students and Teachers; REA: Rockman et al; SOP: Standard Operating Procedures

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