Exploring Multiple Stakeholder Experiences and Impacts to Develop a Framework for Bioscience Industry Internships with Underrepresented Youth

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Abstract: Through a qualitative case study approach, this study examines the pedagogical context of training and mentoring students to undertake STEM internships. This paper explores the learning conditions and outcomes of Biotech Partners (BP), a nonprofit organization working at the intersections of bioscience/biotechnology workforce education in collaboration with public high schools and professional experts and organizations in a range of STEM industries. Incorporating multiple stakeholder perspectives (youth, industry partners, mentors, biotech educators), the study unpacks the nature and impacts of these 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?

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1. Introduction

This paper explores the pedagogical context and potential impacts of Biotech Partners (BP), a 27-year-old nonprofit organization working at the intersections of bioscience/biotechnology workforce education in collaboration with public high schools and professional experts and organizations in a range of STEM industries. With a mission to mentor young people from groups underrepresented in biotechnology, BP facilitates students' personal, academic, and professional development experiences through in-classroom, often laboratory-based, instruction, personalized learning supports, and paid professional internships.

Industry and government leaders recognize that "the need for a more diverse and well-prepared STEM workforce is expanding." (NAS, 2016). Unfortunately, women and people of color remain disproportionately underrepresented in STEM careers (NSF, 2017). A growing body of research indicates that internships and hands-on professional experiences increase persistence for underrepresented populations (Linn et al., 2015). Pragmatically, internships give youth young people exposure to environments and professionals to whom they would likely otherwise not have access, and provide an entrance to educational and professional pathways and potential future employment. There is a need for more research on frameworks, organizational strategies, and instructional approaches for conducting internships from the perspectives of internship mentors, partner organizations, and students.

While emerging studies have indicated that authentic research experiences can bolster high school students' interest and persistence in pursuing STEM educational goals and careers, (Thiry, Laursen, & Hunter, 2011; DiLisi, McMillan, & Virostek, 2011; Holden et al., 2014), the prevailing evidence has consisted of student self-reports. Research has seldom defined a theoretical framework oriented to programs for underrepresented youth. The role and qualities of effective mentoring are also relatively undefined in the literature, particularly for youth from economically disadvantaged backgrounds who may face complex challenges in their pursuit of STEM education, and may have different needs than youth from more affluent backgrounds.

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

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

The current study, funded by the National Science Foundation's Innovative Technology Experiences for Students and Teachers (ITEST) Program, supports development of an evidence-based framework for conducting high-quality internships with underrepresented youth. Examining the pedagogical conditions of training and mentoring students through multiple stakeholder perspectives (youth, industry partners, mentors, biotech educators), the research project pursues an overarching question regarding 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?

2. Conceptual Framework

BP's intervention model connects high school students to bioscience/biotechnology professionals and organizations through both school-based academic and workforce preparation and industry-based mentored internships in diverse STEM institutions. Combining academic and career technical education programming with extensive wrap-around support, BP cultivates the "Psychosocial Factors Shaping STEM Career Development," in the context of a model that largely reflects the "ITEST STEM Workforce Education Helix" (Figure 1). (Maylyn-Smith et al., 2017). In building and maintaining relationships with schools and STEM industry partners, BP creates personal-professional connections between individuals and institutions that do not frequently collaborate without an intervention (Austin & Seitanidi, 2012; Seitanidi & Ryan, 2007).

Although education research and policy often 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). BP rejects deficit models of learning that situate underachievement solely within individuals' choices and behaviors. Instead, BP tackles the socioeconomic obstacles and educational conditions that enable or constrain student achievement (Ladson-Billings, 2006). BP incorporates culturally-responsive and trauma-informed practices to create supportive learning environments, as well as wrap-around services to help students overcome hardships influencing access and participation.

Unpacking the preparation, execution, and impact of the industry internships on BP's multiple stakeholders necessitates focused attention on the mentorship practices that unfold differently across the school and professional sites. To begin to conceptualize BP's approach to STEM mentorship, the research team explored the underlying assumptions, both from the standpoint of BP leadership and staff, as well as existing literature.

Broadly speaking, BP's STEM mentorship model entails the development of cross-sector collaborations with biotech organizations and experts for the purpose of conducting industry internships with young people disproportionately underrepresented in bioscience education and career paths. Through professional learning relationships aimed at exposing youth to diverse opportunities in the biotech field, educators, industry mentors, and students "work together over time 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), which can help a young person to address social or psychological factors that may be impeding engagement at school, home or work.

High quality mentorship supports students' development as emerging STEM professionals. playing a key role in apprenticing novices into academic and professional fields. Mentorship interactions can promote transformative learning experiences for both the mentor and mentee. Despite the critical nature of mentorship in practice within academia and industry, it has received less scholarly attention than the role of teaching and research experiences.

Mentorship suggests a reciprocal relationship, based on social or economic exchanges, which respond to the personal strengths and interests of the parties involved. For this reason, our study closely attends to the contributions from and impacts on both mentors and mentees. By exploring the interplay between adult professionals and students, this research assumes that all participants play active parts in enabling or inhibiting positive mentoring relationships.

A small but growing body of research examines the role of mentoring programs in preparing youth of color through STEM internships (Girves, Zepeda & Gwathmey, 2005; Russell, Hancock & McCullough, 2007; Sanchez, Esparza & Colon, 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% female, and 85% from low-income families.

Mentorship takes place within specific organizational contexts (Allen et al, 2006), including public high schools shaped by differing district policies, budget constraints, and community constituents, as well as biotech industry partners with particular company priorities, policies, and sector expectations (Ostroff et al, 2013). For this reason, the study accounts for the role of educational and business organizational practices on people's beliefs and behaviors.

3. Methods

Using a mainly qualitative case study approach (Yin, 2009), the study employs ethnographic methods to understand the characteristics of successful internships and the implementation of program activities. The research is led by an independent team collaborating with BP leaders and in consultation with an external evaluator. During the study's first year (AY 2019-2020), the teams refined and piloted instruments. We reviewed the project goals, research questions, and data collection methods in light of anticipated program and event scheduling. Utilizing an iterative process, we developed and implemented a multi-stakeholder interview protocol with program staff, high school teachers, students, industry partners, and mentors. Researchers examined BP archival materials to explore underlying program theory, identify critical components, and organizational mechanisms related to the creation and maintenance of internships.

The research uses a purposive sampling strategy to enhance the utility of information from small sample sizes (Cook, 2005). All sites and research subjects have direct knowledge and experience participating in BP's internship model. A case study approach is well-suited to investigate the phenomenon of mentored learning through internships, as "the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p. 18). Cases facilitate exploration of organizational dynamics and decision-making across school communities and networks of biotech and STEM institutions.

In analyzing the multiple data sources listed below, we draw on constant comparative method (Glaser & Strauss, 1967), which obligates the researcher to stay close to the empirical evidence throughout the iterative stages of research. The team listens carefully to the voices, stories, and questions that emerge, using memos to reflect on analytic decisions to create or apply certain codes, the evolving definitions and descriptions of codes and categories, and how a specific code relates to its context.

4. Data sources

We are collecting passive and participant observations of program and partnership development, in-school activities, school and community events, BP curriculum, participant-made artifacts, and work-based learning interactions. In-depth interviews are conducted annually with program administrators and staff, classroom teachers and other school staff, industry partners, STEM mentors, and students. In early 2020, COVID-19 shelter-in-place provisions made it challenging to collect end-of-year data. Some typical program features were constrained. However, this allowed researchers to study what happens when forced to rapidly adapt programming for a distance learning context in the midst of a global pandemic.

The primary data source comes from semi-structured stakeholder interviews. Annually, researchers speak with students, BP staff, classroom teachers, as well as industry partners and mentors from a range of backgrounds, industries, and years of experience mentoring youth. For each interview conducted, a research memo summarizes the participant's perceptions and feedback on their experiences. Transcripts are verified by two researchers and using member checks.

5. Results and Conclusions

Theory of Change: Critical Components

Based on initial reviews of archives, observations, and in-depth interviews, the core elements of program implementation were synthesized as a starting point to develop a potentially generalizable intervention model. The outcomes below reflect preliminary indicators of successful internships and stakeholder benefits from varying perspectives. These components have distinct, overlapping elements for students, teachers, and mentors.

BP assumes that when culturally competent bioscience educators collaborate with school learning communities and STEM industry partners to:

1. Engage underrepresented students in lab-based academic training, individualized tutoring, and career technical readiness preparation in the biotechnology field, by embedding a full-time biotech program coordinator in each high school,
2. Recruit underrepresented students for four semesters of specialized biotechnology courses, focused on mastery of laboratory techniques and skills, led by licensed teachers and developed in collaboration with industry representatives,

3. Provide one-on-one and group advising, role modeling, and collaborative learning activities to develop students' essential 'soft skills,' as well as students' awareness and understanding of STEM workplace practices,

4. Facilitate individual student access to relevant 'wrap-around services' to address economic, social, or interpersonal factors impeding school or internship participation,

5. Prepare students for internship eligibility requirements and necessary steps to select, apply for, secure, and successfully complete paid 6-to-8-week internships with STEM professionals,

6. Provide orientation training for current/potential industry partners and mentors in order to introduce the program, past internship projects, weekly BP student assignments, safety protocols, expectations for student participation and behavior throughout the internship,

7. Offer individual support, as needed, for mentors to design job description(s) and hire intern(s) to engage in meaningful work for student and mentor (team/department) through on-the-job experiences, corporate training activities, professional development, supervisory meetings, informal discussions, and/or shadowing.

8. Culminate the internships with a judged competition of student poster presentations that communicate their internship placement, workplace activities, learning outcomes, and (if applicable) scientific research conducted under the guidance of supervisor-mentors,

Then, this will result in:

1. Collegial interactions supporting students' execution of job-related functions, plus personal and professional growth. These interactions provide interrelated benefits for interns, mentors, and partnering organizations, leading to a growing network of collaborators across secondary education and biotech-focused STEM sectors,
2. Enhanced student understanding of industry expectations and professional cultural norms through mentored experiences in a workplace context aligned to students' educational and occupational aspirations, thereby increasing student academic and professional motivation and science identity, all of which help students persist in STEM education and careers (Hill, Corbett, & St. Rose, 2010; Vincent-Ruz & Schunn, 2018).
3. Enhanced mentor understanding of underrepresented students' academic and career interests, STEM competencies, and lived experiences thereby decreasing unconscious bias and increasing the likelihood of recruiting, hiring, and retaining a biotech workforce that reflects the regional diversity.

Promoting a more culturally diverse biotech workforce that reflects the local and regional demographics, requires the intentional intervention of equity-oriented strategies that help provide opportunities and relevant supports for underrepresented students to explore STEM educational and career pathways. Building sustainable opportunities, in the face of persistent social or institutional barriers, necessitates a philosophy that seeks to build on the knowledge and prior experiences of participating students and to foster more inclusive learning environments (Sanchez et al, 2014). Our research draws on the voices and experiences of demographically diverse young people and industry mentors to better understand ways to support learning interactions that are equitable, effective and relevant to both students and partners.

Preliminary Findings

In 2019, 48 high school students completed internships, working with 37 mentors at 21 different STEM organizations (see Figure 2). In 2020, 42 students completed mostly virtual internships, including projects related to coding, bioinformatics, and offsite data analysis. Interviews indicate that internships provided mutual benefits to students and mentors. One mentor said, “Students learn something valuable in a lab setting…and we get useful help.” While on-the-job training was labor-intensive, consuming up to 25-50% of the internship period, mentors reported that the time invested was worthwhile, offering tangible and intangible rewards. Preparing projects for interns, fielding their questions, and supervising their progress deepened mentors’ own grasp of their work. As a result, youth assumed increasing degrees of responsibility and independence over the course of internships. In some cases, internship projects created lasting organizational value. For instance, one student team developed an online dashboard to organize and visualize data that continues to be used by the organization.

Hosting interns built rapport and understanding between STEM professionals and youth. Mentors perceived students as engaging and ready to learn, bringing a different, “refreshing” perspective to the workplace. Mentors also gained insight into students’ backgrounds, experiences, and interests. A long-time industry partner believes that mentors gain social awareness by getting to know youth who they would not otherwise encounter, helping to break down social barriers, creating a “line that connects schools to STEM institutions,” and diversifying the local workforce by building “access to real opportunities to participate in the economic vitality of your own community.”

BP staff functions as guides for students into the largely unknown territory of the STEM industries. In preparing students for their internship, BP creates assignments and experiences that expose students to STEM professional practices. As one classroom teacher put it, BP educators closely attend to the question, “*How do you prepare students for a trip to the other side of the moon*?” There are both institutional and cultural boundaries that exist between the school/community and STEM industry contexts. During the internship, this boundary ideally begins to collapse, as students and mentors interact around work activities and professional development.

Implementation: Pivoting During the Pandemic

Every year, BP coordinates industry internships for students based at diverse STEM institutions across the Bay Area. For over 25 years, during the summer before their 12th grade, BP students travel each day to work private or public sector organizations, such as Alameda County Public Health, Bayer, Buck Institute for Research on Aging, East Bay Municipal Utility District, and Lawrence Berkeley National Laboratories (LBNL). Often working in a biotech research lab or manufacturing role, students have the opportunity to directly apply and expand their skills and understanding of biotechnology and bioscience topics within a professional setting.

In the winter of 2020, things changed dramatically. As the region and the nation reeled from the medical and social impacts of the COVID-19 pandemic, BP staff responded to the rapidly shifting conditions. Confronting school shutdowns that halted suspended in-person learning in March, BP staff worked closely with the classroom teachers to develop virtual learning plans. For some students living in challenging circumstances, stay-at-home orders and remote schooling meant the loss of a conducive learning environment. For others, the pandemic presented opportunities for youth to work "under the table" or in essential jobs, which elevated the stakes and the challenges of BP's student mentorship. By maintaining regular communication with youth, BP supported students to remain engaged and meet the requirements for internship participation.

As companies dealt with the repercussions of the pandemic, almost all past industry partners cancelled plans to participate in the 2020 internship. Organizations scaled back business activities not deemed essential services. Between late March and May, BP led conversations with key partners to begin contingency planning while continuing to recruit new mentors. Facing the risk of interrupted summer programming, BP staff forged ahead and managed to secure internship placements for all eligible students. Doing so required extraordinary efforts to quickly design remote internship solutions and modify past expectations.

Preparation for Internships

Although most sites cancelled their involvement in the 2020 program, notably, three new organizational partners offered student internships: Agenus West, BioMarin Pharmaceutical, and Data Carpentries. BP staff had engaged in long-term recruitment efforts with representatives from two of these organizations. In one case, an executive and long-time BP supporter advocated for participation for years but failed to garner adequate company backing. Ultimately, the new partners were in large part compelled to participate as a means to take positive actions in the wake of civil unrest following the death of George Floyd. In addition, the introduction of remote internships helped enable the participation of mentors located outside the Bay Area and without the physical space to host interns. Only one site in 2020 offered in-person internship placements for 6 students, compared to 21 sites offering 48 in-person placements in 2019.

In previous years, BP staff played mainly supportive roles for industry partners, orienting mentors and students to the expectations of participation and providing internship supports when necessary. In other words, once youth were successfully hired for an internship position, mentors and interns were responsible for most of what happened. However, the transition from in-person to remote internship programming, while simultaneously navigating a global health disaster, necessitated expanded leadership roles for BP. Host sites needed assistance to envision ways to structure and implement internships virtually.

For the first time students had the opportunity to enroll in what was informally called the "Coding Track." In collaboration with Data Carpentry, BP developed and co-led this new internship track in coding and bioinformatics. This assistant data scientist internship consisted of two coding-based learning programs: a) CodeHS led by BP staff and b) data science workshops led by Data Carpentry volunteers. Students learned essential data practices and coding in Python, followed by a 2-week exploratory project mentored by scientists at BioMarin or Data Carpentry that examined publicly-available real time datasets related to COVID-19 or other topics.

Mentor and Student Internship Experiences

The duties and responsibilities of interns working in remote internships also had to shift in response to California's stay at home order rules. 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. A BP student who completed the data coding track 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 in 2020 included learning and studying industry Standard Operating Procedures, business operations, communications, and technical skills like analyzing microscopy data, liquid chromatography, mass spectroscopy, breast cancer AMPK path research, and peptide mapping.

The students who had the opportunity to work in-person for the summer had work experiences more in line with previous internship implementations. Their 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 BP mentor reported:

> "It was really clear that the person we had 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. In particular, there was one lab skill that the group taught her, packing these little disposable columns that we used for purifying samples. There's a lot of manual dexterity involved, and usually people don't manage to get it right the first time, but she did it. So she learns quickly, and she seems to have really good physical skills."

Throughout their internships, students were required to attend professional workshops led by BP and complete weekly assignments to ensure they would receive academic credit. This work culminated in the BRAVO presentations, hosted virtually for the first time in 2020. At BRAVO, students presented via Zoom to a panel of volunteer judges about their internship experiences. Many highlighted both the social and technical aspects of their work. Mentors appreciated and enjoyed the opportunity to see interns share their learning outcomes at this culminating event, as well as presentation sessions hosted by individual internship sites. During one internal presentation, a mentor commented that, with significant assistance from the BP intern, their 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.

Another mentor remarked at the satisfaction of "watching their end of internship presentations and seeing for all of the interns, just how excited they were and how much this…meant to them. One of the interns said something like, "Oh, I was really excited that I had my own desk because it made me feel like a real employee." And it killed me. I was like, oh my God, that's your standard? Well then, this was fantastic for you. I'm so glad."

Mentors commented on the level of students' preparedness for their remote and in-person internships. While most students in 2020 were not able to take advantage of their hands-on biotech lab skills training during the internships, the material covered by Biotech Academy coursework meant they were more prepared for the content addressed in many of their positions. Mentors also noted their social and professional preparedness, and specifically highlighted the types of skills emphasized in BP professional workshops including demeanor, attire and commitment to time management and communication. 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, and they behaved very professionally. There's a lot of things going on in kids' lives, and so sometimes the schedule doesn't work out the way they plan… I was really pretty pleased with their professionalism as well as how much knowledge they came in with."

> "The interns also were superbly prepared by…Biotech Partners, so that I was really impressed with. But you know, they had very clear expectations and guidelines and yeah. I mean, I felt that all seemed like a well-oiled machine."

For students, the experience provided by BP in the classroom and the internship is both novel and exciting. In the classroom, Biotech Academy coursework allows youth to explore hands-on laboratory techniques and practices that are not available to most high school-level students. The opportunity to learn PCR testing to assess genetic material and practice micropipetting with industry-standard equipment are not just novel in the high school context, but directly translate into the lab-based summer internships. The lab internships themselves are unique for high school students who generally do not have access to these kinds of organizations or equipment before post-secondary education. The additional incentive of payment for their internship experience sets the experience apart even further, taking the pressure off of many students who want or need to earn money during the summertime.

Making Internships Meaningful and Manageable

Stakeholders perceived success and quality in terms that related to their role and experiences in the internship program, as well as their own background and interests in STEM education and industry-based learning. In general, when students enter the program in the 11th grade they have limited or no direct professional experiences in STEM industries. What students know and think about the biotech/bioscience sectors primarily derives from their interactions and learning in Biotech Academy (BA). Through hands-on, lab-centered curriculum and professional development workshops, students are prepared for the technical expectations and organizational cultural contexts they will encounter during summer internships. One student explained:

> "Biotech Academy is really an in-depth science program that reinforces the science-based curriculum while diving deeper into those concepts and bringing forth further laboratory requirement. With a normal science class, we won't be doing labs every week, but in Biotech we get to do a lab almost every single day…In addition, I'd say that Biotech really focuses on college and career prep. They give you the opportunities to have the internships."

One long-time industry partner identified three rules of thumb that help to establish conditions for successful, high-quality internships. Specifically, the overall internship experience should aim:

1) To be meaningful for the students,
2) To be manageable for the mentors, and
3) To train the next generation of scientists and other STEM professionals.

Each of these components rely on the active communication from, to, and within the Biotech Partners organization, as well as within the partner organizations. Setting and maintaining meaningful and manageable goals for the internship largely depend on the collaboration of BP staff, mentors, and students. Effective communication serves as a precursor or mitigating variable to establishing constructive relationship between mentors and students.

All three parties play roles to ensure that the placement process, mentor supports, and job milestones align with the needs and strengths of the students and the industry partners. For example:

- BP staff define the roles, responsibilities, and requirements of internship participation,
- Industry partners and supervising mentors establish the professional context, internship parameters, and work responsibilities for the intern(s), and
- Student mentees adhere to basic expectations of participation and commit to work with their mentor(s) to interpret and perform their work and learning duties.

Students enter the Biotech Academy and their summer internships with a range of talents, skills, and nascent interests in biology, chemistry, technology, engineering, mathematics, and health care. Students are often drawn to the program by the prospect of hands-on learning, frequent laboratory-based work, and the opportunity to complete paid professional internships. One student explained:

> "Biotech Partners has helped me along on that path significantly because Biotech Academy is going to look great on college applications. It shows that I've cultivated my interest for science and have pursued that in my high school at a more advanced level, so I think that it certainly helps me gain a broader perspective of science-related topics, giving me more information and more practical experience."

Mentorship interactions can leverage these student-level resources to promote their deeper engagement. Simultaneously, students are not passive recipients of mentoring, but expected to actively participate in the experience.

While industry mentors bring diverse expertise in laboratory research, development, manufacturing, and/or business practices, they have varying levels of experience apprenticing high school-age students. New BP partners sometimes have no background mentoring youth, or personally knowing young people from underrepresented demographics. BP staff periodically need to remind mentors that most BP youth participants are not "AP students" with polished academic knowledge, and still they are capable of high achievements. Mentors described being impressed by students' eagerness to tackle ambitious work. One mentor advised others not to shy away from challenging students: "They're capable of doing more than you think they can. So be a little ambitious about what you give them…If you challenge them then they really rise up to that occasion."

Nevertheless, BP recognizes the potential presence of institutional, cultural, or interpersonal factors that can create obstacles to effective communication and positive interactions between students and mentors. Yet, this divide ideally begins to collapse during the internship, as the student and mentor get to know one another, negotiate work tasks, engage in training activities, and discuss professional interests.

Although relevant prior mentoring experience helps to consistently establish conducive learning environments, mentor and student interviews suggested that their sense of success is largely contingent on the student's and the mentor's overall interest in participating, as well as their desire to learn and grow. As a veteran mentor said, "On the industry side, I think if you make the commitment generally, the employees are enthusiastic about the relationship." Mentors said that students also tend to be enthusiastic and deeply appreciative for the opportunity to get paid to learn new skills, use high-tech equipment, meet scientists and other professionals, and work for a biotech or STEM organization. Students usually arrive on time, ready to work, and willing to ask questions when they don't know something. "For the most part, I think that the students who do this Biotech Partners program, I think they're quite independent…and quite responsible," explained one mentor.

Several BP components serve as both self-selection and student preparation processes that limit problems during the internships. For instance, student applications are required for acceptance into BA and for semi-competitive selection to internship positions. Prior to and during the internship, students engage in various mentoring experiences with their BA teacher and BP Program Coordinator, such as in-school or after-school tutoring, academic and career advising. The BP curriculum helps to foster students' educational and career interests, while in turn building their essential soft and hard skills that facilitate productive internship participation.

Throughout the program, the Program Coordinator plays a key role advising and guiding students as they embark into the largely unknown territory of a biotech institution. High-quality mentorship from BP staff plays a critical role in supporting students' development as emerging STEM professionals. Mentoring helps apprentice novice learners into academic and professional STEM fields. Participating in career-oriented mentor interactions can create transformative learning experiences for both the mentors and mentees (NAS, 2019).

BP facilitates the transition from Biotech Academy to the summer employment through one-on-one student conversations and professional workshops that teach practical skills critical to secure and complete the industry internship, such as, how to compose professional emails, job searching, conducting background company research, interviewing tips, and professional dress and behavior. During the summer, weekly check-in meetings with BP staff and all students allows for continued workshop topics and informal discussions to address challenges facing students in a timely manner.

Our interviews painted a picture of success built on mutually beneficial relationships in which students collaborate as part of a team, examine scientific and technical topics with mentors and peers, and explore various career and educational questions. Through the development of mutual respect and open communication, students have opportunities to accomplish authentic goals in the lab or the office. Mentors and students often describe Collegial and collaborative interactions as interns take on increasingly independent tasks and explore. As a result, students increase their understanding of the biotech industry and STEM education and career pathways.

6. Scientific or scholarly significance of the study or work

By exploring these cross-sector relationships, this study has implications for youth mentorship and STEM workforce development. The research will help to unpack workplace expectations, scientific thinking, and the provision of dynamic work- and lab-based learning experiences applicable to disciplines beyond STEM. Through examination of stakeholders' learning experiences and professional relationships, we articulate strategies used to conduct STEM internships meeting diverse constituent needs. As industry partners and mentors enhance their understanding of underrepresented students' capabilities, interests, and experiences, they may learn first-hand what it means to be "at promise." These professionals may become more acutely aware of societal inequities, and practical steps that individuals and companies can take to counter barriers to youth participation in college and career pathways.

Figures

Figure 1: ITEST STEM Workforce Education Helix

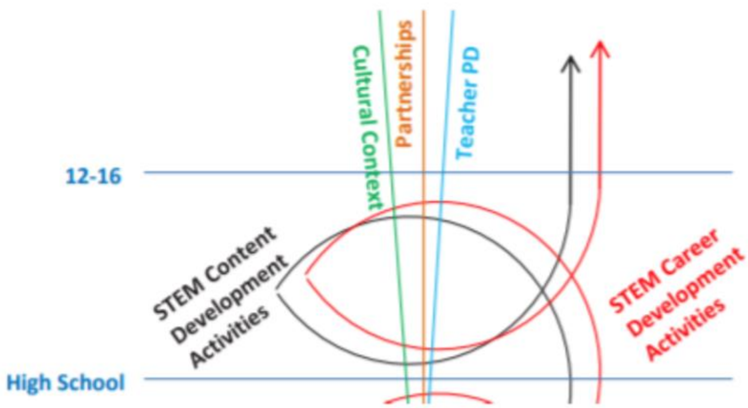

Figure 2: Biotech Partners Sample Internships

Host Institution	***Types of activities/skills utilized***
Arduro Biotech	Conducting experiments related to oncology research
Alameda County Public Health Lab	Extraction, isolation, and quantification of DNA and RNA through Polymerase Chain Reaction and gel electrophoresis. Students learn to identify communicable diseases through use of specific primers in their PCR reaction.
East Bay Municipal Utility District (EBMUD)	Utilization of Piezometers in the geotechnical engineering departments to measure water pressure at their site visits to numerous reservoirs and tanks in the district.
Joint Genome Institute (JGI)	Genotyping plant hyrbids (brachypodium) using creation of primers, gel electrophoresis, PCR and tissue collection.

Microbiology & Quality Associates	Sterility testing of environmental samples from facilities like hospitals, pharmacies, labs etc. Efficacy tests of disinfectants. Qualify in pipetting, plate counting, aseptic technique, sanitizer and sporical efficacy studies.
UC Berkeley	Maintenance of fruit fly vials, make yeast plates, sort embryonic stages, collect and harvest embyros, fix embryos. Assist with research project.

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