

# Adapting a Hands-On Youth Development STEM Program in the Age of COVID-19: The LEAH Knox Scholars Program

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**ABSTRACT:** In 2020, the COVID-19 pandemic changed the landscape for out-of-school-time STEM programs. The LEAH Knox Scholars (LKS) program is a five-week, in-person molecular biology research experience for low-income high school youth of color who are underrepresented in the sciences. The program is organized and implemented by Health Resources in Action, a nonprofit public health organization in partnership with Massachusetts Institute of Technology (MIT). In response to the pandemic, all 2020 LKS program activities shifted from in-person to virtual engagement using the Zoom platform.

To assess program implementation, qualitative data and quantitative data were collected through four virtual focus groups with youth participants and six key informant interviews with LKS staff, as well as pre-and post-surveys. Discussions explored program successes, challenges, opportunities for improvement, and perceived program impact. Key findings from these discussions identified several successes of the virtually adapted program including: relationship building between youth and staff, the teaching of life skills via a workshop format, and the implementation of a hands-on research curriculum. Barriers to program implementation included technological challenges such as limited internet capability and “Zoom fatigue”; and limitations in assessing student engagement via the virtual format.

Key learnings from this case study have relevant applications for STEM initiatives that need to adapt to the new environment post COVID-19. The findings of this experience demonstrate that “at-home” research experiences are not only possible in a pandemic but can be effective in preparing high school youth for STEM-based careers through hands-on experiences in the sciences in a virtual format. Such efforts are important, especially in adverse circumstances, to actively eliminate disparities and promote equity and inclusion in STEM fields.

## INTRODUCTION AND BACKGROUND

The novel coronavirus (COVID-19) pandemic dramatically changed the landscape of STEM-based, youth development programs in 2020. On March 10, 2020, the Governor of Massachusetts issued an emergency order announcing actions to address COVID-19 including school and business closures, as well as limitations on gatherings (Massachusetts Department of Public Health, 2020). These public health directives also prohibited in-person laboratory experiences for high school students, resulting in many STEM programs in the Greater Boston area significantly adjusting or cancelling their activities.

The LEAH Knox Scholars (LKS) program is funded by the National Institute of Health-Science Education Partnership Award. It is a compensated, five-week molecular biology research experience for low-income, high school youth of color underrepresented in the sciences in the Greater Boston

area. The program has been organized and implemented by Health Resources in Action; a nonprofit public health organization based in Boston, in partnership with Massachusetts Institute of Technology (MIT) since 2017. Each year, the program is comprised of a cohort of twenty-four high school youth who are engaged in dynamic lab-based programming, empowering them to pursue STEM education and career pathways. Prior to the COVID-19 pandemic, Scholars participated in an intensive, in-person program at MIT over five weeks to build laboratory, leadership, and communication skills that provide a foundation for success in STEM fields.

The program provides an enriching summer research experience to prepare youth for post-secondary education and careers in the STEM fields. A pillar of the program is its positive youth development approach, which recognizes and utilizes the strengths of young people to create positive

community change and ensure successful futures. Practitioners of this approach leverage strategies that promote resiliency (Benson et al., 2006). These strategies include being a caring and supportive adult, setting and communicating high expectations for youth, providing opportunities for meaningful participation, increasing bonding and connectedness, and teaching life skills. By the implementation of these, youth attain positive developmental outcomes such as: problem-solving skills, autonomy, and a sense of purpose (Benard, 1987). Program staff are trained in these youth development techniques and intentionally embed these core strategies in the planning and implementation of the program.

Due to COVID-19, the program could not continue in summer 2020 as it had in previous years. For youth to experience meaningful STEM activities over the summer, the team adapted the in-person curriculum to be delivered virtually. This case study describes how the program successfully adapted to online programming and overcame challenges presented by the current pandemic to offer an innovative and engaging summer research experience for young people across the Greater Boston area.

## METHODS

To assess program implementation, qualitative data were collected through four virtual focus groups with youth participants (n=22) and six key informant interviews with staff (n=8). The goals of these discussions were to assess perceived program successes, challenges, and opportunities for improvement. Discussions were facilitated by trained qualitative researchers from Health Resources in Action using a semi-structured moderator guide. Interview and focus groups were recorded digitally with consent from participants and transcribed. Qualitative data were then coded and analyzed by a trained data analyst using NVivo qualitative data analysis software. Key themes from the focus group and interview discussions are integrated throughout the case study description to highlight perceived successes and challenges.

Scholars also completed a pre- and post-survey to measure attitudes towards STEM topics, 21st century skills, and general lab skills. For each construct, participants were presented with a series of statements and asked to indicate their level of agreement on a 5-point scale (strongly agree to strongly disagree). Participants mean composite scores for math, science, and general lab skills were higher at the end of the program compared to the start of the program (ranging from 3.8 to 4.3). While not statistically significant—likely due to the small sample size—youth participants reported more positive attitudes towards these competencies following their internships (Appendix B).

## THE LEAH KNOX SCHOLARS PROGRAM, PRE-PANDEMIC

In years prior to the pandemic, twenty-four youth were selected to participate in summer programming each year after completing an online application and participating in in-person interviews. These youth worked thirty hours a week for five weeks at the MIT research facility engaging in a multifaceted curriculum. During the first week of programming, youth participated in an orientation week and were introduced to the program in a series of workshops to build their confidence in the sciences, facilitate relationship building within the cohort, and prepare them for program expectations.

Following orientation week, youth were given their primary task of the summer to identify an unknown bacterium from the Charles River in Cambridge, MA. Through this hands-on approach, youth learned various lab techniques such as: pipetting, conducting a polymerase chain reaction, running gel electrophoresis, heating and cooling lab materials, and performing laboratory calculations. In addition to their lab time, youth also attended weekly life skills workshops in accordance with the positive youth development approach. These skills included: identity, leadership, communication, and career readiness. The program concluded with a two-hour, in-person research symposium where youth presented their research to their families and MIT faculty.

## TRANSFORMING A STEM-BASED, YOUTH DEVELOPMENT PROGRAM DURING THE PANDEMIC

The COVID-19 pandemic affected nearly every aspect of the 2020 program structure, requiring a full virtual program delivered via Zoom. Staff decreased the hours per week of youth programming from thirty to twenty hours to prevent student disengagement on Zoom. Adapting a program centered around a hands-on summer curriculum posed opportunities and challenges, as staff sought to provide programming that offered the same rigor and engagement as previous summers. Additionally, developing strong interpersonal relationships has been a key element to youth engagement and the success of the program as affirmed in the literature (Benard, 1987; Benson et al., 2006). To achieve these goals, key modifications to the virtual 2020 program included 1) **translating the positive youth development approach to a virtual format**, and 2) **developing a virtual science curriculum for at-home participation**. The following section describes these adaptations as well as their perceived successes and challenges according to youth focus group participants and staff interviews.

**Translating the Positive Youth Development Approach Virtually.** Due to the stressors caused by COVID-19, staff were committed to creating intentional spaces where young people could acclimate and thrive among a “new normal.” Qualitative findings show that these intentional programmatic efforts facilitated strong relationships and comfort among youth and staff. Specific elements that focus group participants identified as effective included: *virtual interviews and an orientation week; informal check-ins and check-outs; and life skills workshops*, which are further described below. According to youth focus group participants, these programmatic adaptations facilitated an environment where **young people were comfortable and could connect on a personal level despite challenges** that may arise when trying to build authentic relationships in online settings.

**Virtual Interviews and Orientation Week.** Intentional opportunities to increase bonding and connectedness were integrated in the LKS program as early as the application process and youth interviews. In past years, this was facilitated through an icebreaker activity and teambuilders with candidates. Staff wanted to preserve the collaborative aspect of the interviews as it transitioned to Zoom, so Scholars from previous years were invited to lead a virtual icebreaker activity to make applicants comfortable in the virtual space. After the icebreaker, staff and Scholars reviewed program expectations and addressed questions. Applicants were put in virtual breakout rooms with one staff person and a Scholar from a previous year. The Scholars facilitated conversations with youth applicants to promote peer connection. According to youth focus group and staff interviews conducted for the evaluation, the icebreakers and breakout spaces were effective in developing rapport between the staff and the youth. One focus group participant shared:

*I was nervous because [the interview] was completely new because it's over Zoom. But when I found out [we would] be split into three people per group, not only did it make me feel more comfortable because there's other students, but one of the LKS staff — he was very open, and I felt welcomed [by] him. It made me a lot more comfortable to present myself.*

Like previous years, twenty-four youth were selected and invited to join an orientation week prior to the virtual program launch. Most youth selected to participate in the 2020 program identified as female (75%). Youth identified as Asian (38%), Black (29%) or LatinX (17%). Over half of participants (62.4%) reported their caregivers having less than a bachelor's degree. A full list of demographic characteristics of the 2020 selected scholars can be found in Appendix A.

Orientation week included several teambuilding activ-

ities to help new youth become comfortable in the virtual space. These teambuilders included “creating their toolbox”, where youth enumerated the skills and talents they possess; “sharing the story” of their own names to build community; and “create a scientist”, an exercise where youth created collages to envision how they see scientists to begin envisioning themselves as one. All orientation week activities encouraged youth to participate in meaningful ways and share aspects of their diverse identities with their peers.

**Informal Check-Ins, Check-Outs, and Office Hours.** To encourage youth to deepen relationships with others in the program, staff reserved time where they could connect with Scholars on an informal basis. These informal spaces primarily occurred through weekly “check-ins” and “check-outs”. “Check-ins” took place on Monday mornings to forecast weekly programming. “Check outs” were scheduled on Fridays as the last part of programming for the week. It consisted of debrief activities, like “plusses and deltas”—a method of collecting feedback by asking youth to identify what they like and areas for improvement about the program. Additionally, office hours were held for once a week for one hour. During this time, staff would have virtual lunch with youth with the goal of having unstructured time to build rapport and connect on a more personal level. One focus group participant commented:

*One thing I thought was really cool was on Wednesdays we would do lunch hours. It was something that connected all of us and got us together and it was just overall a fun experience. I liked how the staff was very open, very understanding. Throughout the entire program, [everyone] made learning online fun, but they also just seemed like nice people overall.*

**Virtual Life Skills Workshops.** Life skills workshops were an important component of the program to address non-academic aspects of participants' lives. In 2020, greater emphasis was placed on workshops that focused on social and emotional well-being during heightened times of stress such as in the pandemic. Youth focus group participants consistently highlighted these workshops as strengths of the program. They also indicated that the workshops equipped them with workforce skills and helped them build rapport with each other and the staff, affirming that this program component facilitated community-building, communication, and interpersonal skills in the LEAH Knox Scholars cohort. One focus group participant shared that “[d]uring the [topic] workshops [LKS staff] try to help us get out of our comfort zone, especially being over Zoom. It's our first time being online, so I felt that was great.”

**Virtual Science Curriculum for At-home Participation.**

Since many students joined the program to gain hands-on lab experience, LKS staff adapted the curriculum that was typically implemented on-site to an **at-home lab curriculum** that was both informative and engaging. There was also the need to develop a virtual space for youth to present their research at the end of the summer as participants had in previous years. Converting the previous in-person symposium to a **virtual symposium** was an essential aspect of the adapted LKS program. Key themes from the qualitative data describe the success of the at-home curriculum and virtual symposium to support a more authentic research experience.

**Hands-On Virtual Lab Sessions and Symposium.** Staff organized supplies youth needed to participate in at-home lab experiments in “**Bags of Science**” that contained: pipettes, agar, reagents, and other materials necessary for DNA extraction and bacterial identification. These “bags” were delivered to the youth before programming began.

With these supplies, youth and staff worked together to identify an unknown strand of bacteria. Staff at the MIT research facility physically handled the microbiological materials and performed experiments, while youth would perform similar experiments from home using their “**Bags of Science.**” Youth were supervised in groups of six by four graduate level teacher’s assistants (TAs) who helped recreate experimental conditions. The teaching staff at the MIT lab then carried out the experiment and collected data based on the experimental conditions the youth developed. These adaptations ensured youth built similar lab competencies they would in an in-person lab, while being supported by their instructors. Youth then analyzed their data to present their findings at an end-of-summer virtual research symposium. In preparation for the event, Scholars prepared a presentation about what they had worked on during the summer program. Over 70 people attended the youth’s virtual presentations.

There was consensus among all interview and focus groups participants that **the take-home science bag and virtual symposium were among the most successful aspects of the 2020 program because they enabled students to have a more authentic lab experience.** Youth who participated in focus groups expressed enthusiasm for being able to physically work with pipettes and other science equipment from home. One focus group participant shared:

*I just loved the labs. It was really fun to pipette and create a DIY Jell-O electrophoresis. Even though we didn't get to work with all the lab equipment, we got to see [staff] do it virtually and that was the next best thing. It was a little simulation game where we get to tell her and give her instructions and then we*

*just see the outcome. It's not the ideal situation, but it's the best thing that we have so far. The labs are the highlight for me.*

**VIRTUAL PROGRAM CHALLENGES**

Although the LEAH Knox Scholars program was able to implement an engaging STEM-based youth development program, interviewees and focus group participants in the evaluation identified several challenges as part of program adaptation during the pandemic, specifically **technology needs and student engagement.**

**Technology.** In terms of technology, one gap identified in staff interviews was the need for youth to have a second camera to better support lab experiments. All youth had access to one web camera that was positioned toward their face, but according to staff interviewees, it would have also been helpful to have an additional camera positioned toward students’ at-home “lab bench” so instructors could monitor science activities. One staff interview participant explained:

*Online work is hard. Everyone has their camera focused on their faces so it's impossible to see what they are doing right or doing wrong with their hands. For example, we spent more than five minutes trying to figure out why something wasn't working for a student, trying to troubleshoot over [Zoom]. It wasn't until a long time that we realized the student was just holding the wrong pipette. It's something we would have instantly been able to see in person and correct the problem in one minute. It's hard to do that online.*

Another technology need that arose in staff interviews was consistent and stable internet access. According to staff interviewees, there were several instances during the summer where some youth were difficult to see or hear due to unstable internet connection. Inconsistent internet access also contributed to the challenge of student engagement, according to staff interviews.

**Student Engagement.** Qualitative findings showed that another challenge that arose during both lab sessions and topic workshops was the ability to **assess student engagement virtually, especially among quieter and more introverted students.** Although program staff decreased the hours of the internship from 30 hours a week to 20 hours a week, youth focus group participants **indicated fatigue due to screen time despite the shortened curriculum.** Staff interviewees also noted it was more challenging to pick up on nonverbal cues, which is easier to observe during face-to-face interactions. A staff interview participant explained:

*It's always harder to gauge what students are thinking and feeling. Usually, you can see them in front of you and you catch the exact moment when someone loses interest or when their minds start to wander. It's really hard to gauge that [online]. Then you're trying to catch the ones that are either getting bored or those who are not as engaged and it's a real challenge.*

Despite these challenges to the program, impact evaluation data show promising results. As seen in Appendix B, pre-post tests show that the participants' mean composite scores for math, science, and general lab skills were higher at the end of the program compared to the start of the program (ranging from 3.8 to 4.3). While not statistically significant—likely due to the small sample size—youth participants reported more positive attitudes towards these competencies following their participation.

## DISCUSSION AND IMPLICATIONS

The COVID-19 pandemic affected nearly every aspect of the 2020 LKS program structure, requiring a fully virtual program and abbreviated hours. Despite these changes, youth focus group participants expressed a high degree of satisfaction for the program overall. Qualitative and quantitative evaluation data demonstrate that although the format of the program was virtual, youth still had a positive experience that will help them be laboratory professionals in the future.

Key learnings from this case study have relevant applications for STEM initiatives that may need to adapt to the new environment post COVID-19. This case study demonstrates that “at-home” laboratory experiences are not only possible in a pandemic but can be effective in preparing high school youth for STEM careers through hands-on science experiments conducted in a virtual format. Studies show that hands-on lab experiences in secondary institutions tend to be greater predictors of retention in the research fields (National Research Council, 2006). Efforts to implement “at-home” research opportunities are important to eliminate disparities and promote equity and inclusion in STEM fields.

This case study also illustrates the importance of addressing social-emotional needs during adverse circumstances for vulnerable communities. Many youth underrepresented in STEM, particularly Black and Latinx youth, are disproportionately affected by COVID-19 (Dyer, 2020). Through the inclusion of key elements of the positive youth development approach such as: the presence of supportive and caring adults in programming, the communication of high and realistic expectations, allowing for youth participation, creating spaces for increased bonding, and the teaching of life skills; it is possible to foster spaces for youth to not only endure

adverse circumstances, but to thrive despite them (Benard, 1987).

## CONCLUSION

The purpose of the LEAH Knox Scholars program is to increase youth representation from communities underrepresented in the sciences by preparing youth for post-secondary and career pathways in STEM. It is imperative for such programs to continue providing programming for youth even amongst extraordinary circumstances, like a pandemic. For programs that seek to diversify the STEM pipeline, there is a responsibility to deliver engaging curriculum that not only increases youth skills in labs but also enhances their resilience through a positive youth development approach.

## ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this the manuscript.

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## ABBREVIATIONS

LKS: LEAH Knox Scholars; MIT: Massachusetts Institute of Technology; TAs: Teacher's Assistants

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