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Learning Lab:

A Hands-On Way for Future Scientists to Engage with CRISPR

Amanda Hewes, MS; Sarah LaTorre; Mak Sisson, MA; Deirdre Hake, MBA

Gene Editing Institute, ChristianaCare

Abstract

The Learning Lab serves as a resource for students to come into a laboratory space and work with genomic scientists on cutting-edge CRISPR research. This opportunity was created to reach students with fewer resources in their classroom. We hope to expand this program further in the coming years throughout all of Delaware to further our mission of inclusion and equity in education.

Committing to equity in workforce development is a lofty promise for most companies. A hiring manager can make changes in their screening process, an initiative can sponsor vocational programs in schools, and a lab team can even donate their time and resources to a college for a career preparation event.

But do these solutions provide lasting impact? In biotech and biopharma companies, there's still an extreme deficit of diversity. African Americans represent only 6% of the workforce, people of color make up 24% of executive teams, and women are still subject to a glass ceiling from entry-level to the C-suite of biotechnology companies headquartered across the U.S., only making up 31% of executive teams and 23% of CEOs.[1] While 56% of workers say focusing on diversity, equity and inclusion is good for their company, companies still struggle to find the best way to build a strong workforce with new perspectives and diverse talent.[2]

At the Gene Editing Institute, we believe that the key to a new generation of talented scientists with diverse perspectives is demystifying gene editing and providing students with guidance and tools to shape their own pathway through STEM. That was part of the reason behind our creation of the CRISPR in a Box™ education kit, a kit designed to teach high school and college students how to perform a gene transformation with CRISPR in a short three-hour experiment. This kit could be brought into a classroom and integrated into a gene editing curriculum, allowing students to see a blue-to-white color change on a bacterial plate due to a simple cut and edit in a synthetic gene within a plasmid. The hope was that this reaction would give students a clear-cut example of a changed genome and drive their curiosity forward. If a color-change reaction was possible right in front of their eyes, what else could CRISPR do? How could it benefit the worlds of healthcare, agriculture, and environmental science? What would they be able to do with these tools in their hands?

After CRISPR in a Box™ was launched and made widely available through our partnership with Carolina Biological, we began to see positive results. Teachers who brought the kit into the classroom started providing feedback about some of the hurdles they were facing. We had designed this kit within our fully stocked laboratory, where CRISPR, centrifuges, pipettes, and bench space were all readily available. A high school laboratory, even a great one, may not have the necessary equipment to run something like this. In some cases, through our initial work bringing this to schools, we had to bring our own lab equipment out to high schools to ensure the experiment would work. This was no fault of the teachers, but it made us acutely aware that any

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teachers who had purchased our kit and had run into the same problems wouldn't be getting the most out of the experiment.

We also looked back at our mission statement: 'ChristianaCare's Gene Editing Institute seeks to empower, inspire, and engage the next generation of scientists committed to advancing gene editing technology.' If we weren't including new perspectives in our lab because of missing materials or lack of space for this experiment, we weren't fulfilling our mission. Nothing discouraged us more than a student who sought to perform an experiment but didn't feel as if their class had the capability to do so for reasons outside of their control.

So, we thought: why not bring students to our own lab space? Why not create a field trip experience where students could learn what we do where we do it?

There were certainly advantages to doing this. Students on fields trips sharpen their skills of perception by utilizing multiple senses: sight, hearing, and touch.[3] They develop a positive attitude for learning, motivating them to develop connections between the theoretical concepts in the classroom and what they've experienced.[4] A field trip with a single focus impacts students' cognitive skills, knowledge, interests, and future career.[5]

With all of that in mind, we began the process of creating a field trip experience for students. We found space within the building that houses our lab that could be renovated for our purposes, and soon lab benches, extension cords, and vinyl decals were being placed in a classroom right in front of the doors to our lab entrance.

We began reaching out to teachers who had joined us previously for different workshops where CRISPR in a Box™ was taught. We worked with their schedules to bring their students into our lab space (which we dubbed our Learning Lab) for an in-depth look at CRISPR's ability to edit a genome, along with the opportunity to tour our lab and meet our scientists. We chose two schools to do a small pilot study in spring 2023: St. George's Technical High School and Delcastle Technical High School. Each had a vocational program that specialized in biotechnology, giving us an ideal class to perform the experiment and test the program model. We anticipated that we'd teach those two pilot sessions, gather some student data about their experience, and launch the program more fully in the fall of 2023.

Then, more schools became aware of our program. Suddenly, we were filling seven learning labs. Then, four more, then three more, for a total of 14 Learning Labs. We saw our number of students increase from 30 to over 150 in the first three months of the program's pilot, with four different schools taking an interest over the school year and an additional two in the summer. We were astounded as requests for Learning Labs continued from long-time supporters and teachers entirely new to our program.

With the aid of pre- and post-lab surveys, we gained insight into how the pilot program resonated with students.

- **50%** of students reported feeling **more confident in a lab setting.**
- **60%** of students **increased their confidence** in micro pipetting and basic lab skills.
- **68%** of students **maintained or increased** their interest in STEM subjects.
- **71%** of students **maintained or increased** their interest in pursuing careers in STEM.

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- **2 out of 3** students **gained a more positive attitude** toward how CRISPR and how gene editing could be used to help advance healthcare.

Teachers, likewise, were incredibly receptive to our programming and the opportunities it presented for their students.

> "The best part was getting to hear from a group of accomplished women who found so many different paths to this place in their careers," said Dave Eroh, Brandywine High School teacher and supporter of the program. "I think they saw themselves in all of them."

Given the positive feedback we have received thus far in our student and teacher survey data and interest in repeated Learning Labs from previous attendees, we plan to expand this program across the state in the upcoming years. We currently have ambitious goals to engage 25 schools by the end of spring 2024, expanding the program to students in Kent and Sussex Counties, and engaging 1,000 students in Gene Editing 360™ programming by the end of the year.

We are committed to bringing CRISPR in a Box™ to as many young people as possible. We are also open and eager to engage with other youth-serving organizations who want to bring a novel gene editing experience to their constituents. Our partnerships continue to grow our program further and support the next generation of scientists entering the world of biotechnology, and we hope to continue to grow and expand through the state of Delaware.

And who knows? Maybe as soon as 2028, the Gene Editing Institute will hire a Learning Lab alumnus, fulfilling our mission statement to fill our lab with determined, talented scientists with an interest in CRISPR supported by our own scientists.

Amanda Hewes can be contacted at Amanda.m.hewes@christianacare.org.

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