The Dayton (bio)Manufacturing Awareness and Discovery Experience (DaytonMADE) program was hosted by UES, a BlueHalo company, with funding from BioMADE. Formal and informal partners included Biopharmaceutical Technical Center Institute, Wright State University, and Primient, along with various industry and academia support. Below, we summarize the first two years of the program (2023-2024) and provide observations, insights, and tips from our experience. We hope this guidance can help others in establishing similar programs, in biomanufacturing or other fields.

For questions, please email DaytonMADE@bluehalo.com
More program information can be found at www.ues.com/DaytonMADE
Additional curriculum resources available at www.ues.com/dminfo

General Observations/Notes/Tips:

- The DaytonMADE program served 39 unique students over the two years, including 5 two-time participants. At least 3 graduated seniors have committed to relevant undergraduate programs at Ohio schools. Generally, based on pre- and post- camp surveys, we achieved our goals of (1) enhancing biotechnology and biomanufacturing awareness in local, underserved communities, (2) educating high school students on related career and education opportunities, and (3) bridging the gap between current curricula and industry-relevant skills, all while increasing self-efficacy in STEM fields.

- Every group is different. In most of the sessions, the majority of the students meshed incredibly well and we formed a “DaytonMADE” family very quickly. In one session, the general energy was much lower and we needed to adjust the teacher style accordingly.

- Use dedicated teaching/lecture time to introduce concepts, reinforce concepts, build on previously covered concepts, and tie everything back to the overall biomanufacturing process to ensure students were able to connect ideas and see the big picture. In the first year of the program, this was an area that needed improvement. In the second year, we developed more teaching materials for the classroom to supplement the lab manual. This mainly included powerpoints (with YouTube videos) and hands-on demos. While feedback from students was to do some of these discussions in the lab, due to our facility set up we had to focus much of the “lecture” time in the classroom. However, having these visual teaching aids definitely made a difference in 2024 compared to 2023. During these discussion times, we were able to provide more guidance for the students as well, so they knew what to expect for the rest of the day/week/etc.

- Start off well with a good introduction to both the program and the staff. In 2024, we included a powerpoint presentation about what the program was, why it existed, and what the students could expect throughout their time at camp. Use the first day to establish expectations early, build a good rapport between staff and students, and establish a safe space that students can learn, explore, and ask questions (even if this ends up not being the field for them!). Discuss expectations regarding safety and respect for staff, other students, equipment, facilities, and guest speakers.

- It's important to *consistently and frequently* stress and enforce safety standards, including but not limited to: keeping hair back, closed-foot shoes, no earbuds, safety glasses, buttoning lab coat, glove etiquette (re: touching phones/faces), washing hands before leaving lab. In year two, we dedicated an interactive powerpoint presentation on this on the first day, which helped a lot in setting expectations.

- Communication – We attempted to have regular communication with families and participants leading up to and throughout the camps, although there was a range of interaction and response. Currently, our best mode of communication during the camps was texting students directly, but another solution may be optimal. In the second year, we made sure to directly invite parents and teachers to the Demo Day, however more communication could be useful there as well (e.g., providing more context/background to the teachers).

- Guest speakers – There was a range of professional etiquette from the students with regards to guest speakers. For the second camp in our first year, we developed a form for students to fill out to aid with engagement which appeared to help. In the second year, we set strong expectations ahead of time, discussing professional etiquette with the students with regards to guest speakers. While we had the worksheet available if necessary to keep students engaged, the students in both cohorts that year were professional and participated with the speakers without the need of a worksheet.

    - We had a range of formats for the speakers – some in person and some virtual. The in-person speakers were received slightly better by the students, but in the second year we prepared the virtual speakers to have content more appropriate to the level of the audience and include more pictures and videos/tours which helped engagement.

    - We aimed to have diversity in speakers. In the first year, all speakers had PhDs, but in the second year we improved to include speakers without PhDs and speakers from a larger variety of organizations (e.g., start ups, CMOs, military) and backgrounds (e.g., using soft skills to be involved in STEM fields without a STEM degree). The topics from the speakers ranged from vignettes through a career path (e.g., "lessons learned") to more in-depth introductions to companies. Students enjoyed seeing video tours. For future speakers, we would like to showcase scientists at various levels and highlight the multidisciplinary nature of biomanufacturing. We would also like to continue showcasing different environments visually, whether through in-person or virtual tours. For example, the students tour a very large-scale industrial plant in person, which can be off putting to some, so having them see other environments that they could work is beneficial.

- Review and discussions – In the second year, we focused on having review discussion every day to ensure students understood the concepts and bigger picture. Most mornings, we used interactive apps (e.g., Menti) to review previous concepts or facilitate

deeper discussions. This worked well with regards to review and discussion, however there could be some more optimization to bring the energy level up in the mornings. We attempted a different app to add a competition factor, but it didn't work well due to being anonymous and a lack of question type variety, so we switched back to Menti.

    - In addition to morning discussions, we included more targeted reflection/observation/discussion questions throughout the manual protocols that allowed students to think about the concepts individually. These questions also provided the basis for group discussion in the lab. This seemed to be effective, although could still be improved upon.

    - For quieter groups who may not be asking questions, it's important to still engage with the participants and ensure they aren't getting lost in the material. Don't assume that more experienced students know what they are doing because they aren't asking questions – have informal discussions to ensure students understand what they are doing and how it fits in the big picture.

- Planning and preparation – We suggest running through experiments in the camp space to find any hiccups or missing pieces. We tested most kits or protocols ahead of time, especially for the second year, which influenced the final schedule of activities. We also used custom protocols previously optimized by partners that solved some issues with the commercially available kits. By testing out kits ahead of time, we learned more about the intricacies and potential hiccups of each brand's protocols. There were some instances where the experiments weren't tested or vetted ahead of time, which sometimes led to unexpected results, but still facilitated useful discussions. To ensure student engagement and enjoyment, we suggest doing as much pre-testing and vetting as possible. Even so, some results can still be unexpected. For example, when we tested the DNA digestion in another lab, the results were slightly different than in the teaching lab.

- Physical preparation – We suggest having multiple "prep days" before each camp where the staff prepares all the materials that can be prepared ahead of time (e.g., pouring plates, making solutions, labeling and preparing aliquots), organizes the supplies by day, and goes through the schedule day-by-day to ensure everyone is on the same page before students arrived. We also had a prep document to refer to each day which included the remaining prep work that had to be done throughout the camp.

- We found that minimizing excessive downtime in the schedule worked better than scheduling in extra "buffer" time. This drastically helped with keeping students on track and engaged. Each group worked at a different pace; however, we had a number of unscheduled activities that we were able to use to fill holes in the schedule when needed. At times, students were happy spending time during incubations practicing pipetting (pipette art) or doing puzzles we provided (e.g., biomanufacturing crossword, biotech word search, science sudoku). Other times, we would fit in other activities or

discussions like touring a research facility or discussing different academic degree. Other downtimes we filled with more fun team bonding activities.

- Swag – Students love free stuff! We made sure to supply students with a drawstring bag to carry their manual between camp locations, a pen, and a t-shirt. We also maintained a stash of pens, pencils, and sharpies for use in the classroom and lab. The students also received items from Wright State University and Primient.

- Demo Day was a huge success. Students worked in groups of 1-3 (mainly groups of 2) to present about something they learned about during the camp, such as bacterial transformation, downstream processing, and biomaterials. The students created a poster and had a prop or hands-on demo (e.g., teaching visitors how to use a pipette and load a gel). We had the students set up around the laboratory and visitors were invited to join for an open house style event. For most sessions, about half of the students had family members join, however for one session all participants had visitors join. Visitors included parents, grandparents, siblings, and friends. We also had employees from BlueHalo, Wright State University, and Sinclair Community College attend. In the second year, we specifically invited teachers of the participants, however none attended. In the future, we can include more personalized invitations to the teachers. During the event, it was great to hear the students' excitement about the topics and to hear how well they retained information. It was even more amazing to talk to the family members and hear how the students talked about the camps at home and how the experienced shaped their career outlook. Having some families visit for a second year was very special as well.

- Closing ceremony – Immediately following the Demo Day open house, we held a closing ceremony. Refreshments were provided. The ceremony consisted of a short presentation/introduction to UES/BlueHalo, some speeches, handing out individual folders, and a final group photo. This was a great time to explain more to the families about the history of the program and our company and reiterate how important these types of experiences are. The families were all incredibly proud, and we made a "graduation" of sorts, inviting each student to the front to receive their folder from the staff.

    - We experimented with the closing ceremony location. Initially, we held ceremony in a large auditorium to add a special feel to the day, however the room was a bit too large. We then tried a smaller auditorium, and it worked ok. Finally, in our last session we had to hold the ceremony in the classroom. While it was a tighter setting, this ended up having a much higher energy level since families were closer together and it took place where much of the camp activities also took place. We'd likely stick to that plan in the future.

    - The final folders contained a signed certificate, printed photos from throughout the camp, staff contact info, a skills checklist, and student stipend. In some sessions we also found it useful to include a printout of the College 101 session

and/or some flyers related to biomanufacturing concepts and examples that they could share with family or teachers.

- Staff – We had a high staff:student ratio with 5-6 staff to 10-12 students. Camp instruction was mainly led by a lead teacher and a co-teacher. In the first year, the lead teacher was a high school teacher; in the second year, the lead teacher was an industry scientist. The co-teacher was a professor from Wright State University. We also had two assistants that were current students or recent alumni in local programs (ideally from two different schools, but in the second year both assistants were from Wright State). These assistants helped with material preparation, answering student questions, having informal discussions with students, and helping with logistics such as snacks and lunches. We also had a camp coordinator helping with communication and logistics. One of the biggest roles the coordinator ended up serving was as a high school liaison. As a high school Career Tech teacher, our coordinator had a presence in the schools and an essential knowledge of details like Work-Based Learning paperwork as well as experience working with high school students and their families. By having a wide-ranging staff with various career paths and backgrounds, we were able to provide a well-rounded experience for the students. Additionally, the high staff:student ratio aided in student engagement and success in the camps.

Location

- Wright State University provided us with lab space and classroom space. Ideally these locations would be very near each other to facilitate easy back and forth movement. In our case, they were in neighboring buildings with a ~5 minute walk. Therefore, we designed the schedule to minimize transit back and forth.
- With our lab set up, we paired students at benches and allowed them to remain with the same partner throughout the camps. This set up worked out well for almost all groups, however this is very group specific and we did discuss the possibility of rearranging partners mid-session. In most cases, students were very flexible with the situation and willing to rearrange as needed due to absences as well. For the 2024 Trailblazers program, we did make a conscious effort to partner new and returning students. We believe this helped the group get out of their shells even quicker than expected.
- The lab space was outfitted by WSU with basic equipment such as micropipettes, pipette aids, glassware, hot plates, vortexes, centrifuges, tube racks, a plate incubator, a shaking incubator, a thermocycler, water baths, and UV spectrometers. We supplied gel electrophoresis equipment purchased in 2023 (blueGel kits by miniPCR bio).
- We suggest exploring different locations whenever possible. For example, for most sessions we moved to a separate building on campus for the soft skills activity, however for one session the facilitators came to the classroom, which resulted in much lower student engagement. Students also requested some outdoor activities on their feedback forms. Variety of setting would help with engagement.

Manual:

- We provided binders for the students that included a 1-2 page general introduction to each section, most of the lab protocols, reflection questions, observations, and profiles of the guest speakers.

- In the second year, we reformatted the protocols into a standard design and incorporated other elements of Standard Operating Procedures to mimic more of the biomanufacturing process and ensure accuracy with lab activities compared to commercial protocols. We also added a checkbox element to help the students keep track of the steps within each procedure, which received positive feedback.

- Students were able to take home the binders at the end of the camps. The majority of students took their binders home, and all of the students in the second year said they found the camp materials to be a useful resource in the feedback survey.

Food Notes

- Lunches were supplied from a different restaurant each day to give a variety of food options. Based on student and staff feedback, we changed a couple restaurants between sessions, which was met with positive feedback.

- We attempted to solicit donations, however had little success with only one donation per camp.

- Dietary restriction information was collected in the application process, however there were also times that students informed us of a new or different restriction once the camps started.

- By having many staff members, we were able to have someone pick up food and/or meet the delivery person and set up lunch while the rest of the staff kept the schedule going.

- Snacks and drinks were supplied in a cooler throughout the day.

Transportation Notes:

- We hired a commercial limo/transportation company to provide transportation. We were very fortunate that they were highly flexible leading up to the camps with our evolving plans. We had the same driver every day for all four sessions. She shared her cell number with the students and there was great communication between the driver and our camp coordinator.

- We set 2 or 3 central locations for students to meet for transportation pick up/drop off, including schools and libraries. In the case of there being one student at a location, we worked with the student/family to find a suitable location. There were also some changes

in locations and use of the camp transportation after camp started, and the company was very flexible with us.

- We suggest having a staff member involved with the transportation on the first day. On the first day of each camp, our camp coordinator met the students at the first pick up location and traveled on the van to meet all of the students (and sometimes parents) and establish transportation expectations.

- Providing transportation was a major contributor to our success. About half of our participants overall utilized the service, although it varied session to session.

Applications and Advertising

- Application – Have flexibility in your application process. We used an online application hosted at a dedicated website, however we also provided a pdf document for a printable version. We did have a significant number of students submit the printed version via our camp coordinator. We also had a sponsor form we could send to teachers to provide supplemental information for the student's applications. We attempted to use these forms in the first year to partial success. In the second year, we digitized this form, but ended up not using it. However, it is a useful option for the future if feedback is needed to make a selection decision.

    - One issue we ran into with almost every session is at least one student not showing up on the first day or dropping out after camp starts due to personal reasons or other commitments. We are currently looking at options for mitigating this issue, especially given the increased interest and needing to turn applicants down.

    - Our application was composed of an application form gathering demographic data and asking about the students' experiences, along with a short answer essay question. The application also including a permission and expectations form that both the student and guardian had to sign, a photo release, and a medical form including a waiver, allergy information, and dietary restrictions.

- We hired a media team in the first year to create some videos for us in order to highlight the camp success and to be used for advertisement and student recruitment for future camps. The video crew filmed for a few hours for 5 days over the span of the two camps. They captured footage of a variety of lab activities, the campus tour, the soft skills session, interviews with students and staff, and the demo day. We now have a 5-minute video showcasing the camp as well as a shorter ~1-minute cut as well as a 30-second teaser trailer. It's great to have these for future recruitment, and the student interviews were also useful feedback for program development as well.

- We took photos throughout the camp and staff posted daily updates on social media, especially LinkedIn. We were able to hit a sizable audience and got a large amount of engagement, specifically for posts tagging industry to universities. In the future, we

would also explore using Instagram to hit a student audience. We had parents sign photo releases as part of the application.

- Wright State published press releases each summer, and UES/BlueHalo shared some posts on social media as well. In the future, we'll try harder to bring in local news media outlets to cover the event.

- Advertising – We cast a wide net to gain applicants. We used social media, email, and word of mouth to reach out to teachers, school districts, guidance counselors, and community organizations. We provided a website and a detailed brochure, with an additional one-page flyer in the second year. In the application, we asked the students to share how they heard about the program. We received a wide range of responses, although most heard about it from a teacher or family member. In the first year, we received 27 applications from 8 schools. In the second year, we received 42 applications from 23 schools, including schools from over an hour away and a homeschooled student. We're proud that our reach extends throughout the Dayton region, and hope it continues to grow.

Evaluations

We gave students pre and post surveys on the first and last days of camp to assess camp efficacy in hitting our goals of increasing knowledge of the field, knowledge of education and career opportunities, and self-efficacy. To additionally measure knowledge gains throughout the program, we used daily "clicker questions" and informal observations and discussion. We also used a word association activity to see the shift in responses from day 1 to day 10. Finally, we had students fill out feedback surveys about camp features on the last day.

Curriculum

The overall curriculum and schedule are set up to mimic the biomanufacturing process and cover many general biotechnology techniques that could be applicable in other fields, although presented through a biomanufacturing lens. The Explorers program covers general techniques and concepts, while the Trailblazers camp dives a bit deeper into biomanufacturing concepts and more advanced techniques and experiences. Both programs also include industry and military guest speakers, exposure to various higher education programs (including a campus tour and "College 101"), an industry field trip, a soft skills workshop, and a final presentation open house. The schedule for future programs will continue to evolve and morph based on optimizing activities, new activities, different guest speakers or non-lab sessions, and feedback from students. Protocols, activities, and teaching materials were either created or adapted by DaytonMADE staff from the following sources: Edvotek, Bio-Rad, Minipcr, Amino Labs, Carolina Biological Supply Company, BioPharmaceutical Technology Center Institute (BTCI), Shoreline Community College, Miami University faculty, and North Carolina Association for Biomedical Research (NCABR). ChatGPT was also used for inspiration.