

Using What's at Hand: The Creation of an Online Microbiology Outreach Program

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INTRODUCTION

This tips and tools article is intended for anyone involved in outreach programs and is specific for an online environment. The major goals of outreach programs for precollege students in health and biomedical sciences are to expose students to academics and provide a sense of belonging (1–4). Moreover, these programs enhance the desire of student participants to pursue careers in science fields following graduation (5–8). Until recently, these programs were typically held in person at universities or community sites. With the advent of the COVID-19 pandemic, many outreach programs, including ours (9), were redesigned to be offered online. Online outreach programs that focus specifically on microbiology and related topics are uncommon, but those that are reported in the literature indicate that student engagement is beneficial for reinforcing microbiology concepts (10).

To expose high school students to biomedical sciences and medicine in the face of the ongoing pandemic, we created the Online Enrichment Program. The Google Classroom and suite of online apps were utilized to allow faculty to collaborate on components of the program, interact with students, and enable students to access materials with ease. Students were recruited via a descriptive e-brochure sent to local schools and community organizations and via personal networks (Appendix 1). The program was offered during the summer of 2020 and the spring of 2021. Below, we outline the program structure, content, and design, discuss the importance of feedback in the design process, and report on the students' perceptions.

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PROCEDURE

Program structure

When first considering the program's design, we utilized best practices of instructional design and online learning. The program was structured around "The Seven Principles of Good Practice," a teaching model originally published for undergraduate education (11, 12). The framework emphasizes instructor-student and student-student interactions, active learning techniques, prompt feedback, and respecting diverse learners. It is utilized in higher education and K-12 environments and as a model for designing and assessing the effectiveness of online learning initiatives (13, 14). Moreover, we incorporated best practices for promoting faculty-student interaction in an online setting: videos to introduce the content and the instructors, open communication, frequent interaction with faculty, and instructor feedback (15).

Daily program design and content

The program included four days of sessions with each day's theme and objectives mapped to the program objectives (Fig. 1 and Appendix 2). The program objectives were developed to introduce learners with different levels of preparation in the subject matter to medical microbiology, antibiotics and issues in treatment, and careers in medicine and biomedical sciences. Moreover, the spread of pandemic misinformation highlighted the importance of learning objectives for evaluation of literature sources and media commentary (16, 17); thus, a module on media literacy was included. The first 2 days were developed to prepare all students for more advanced materials on days 3 and 4. We consulted the Michigan 6th to 8th grade standards (18) and selected materials for the first modules related to cell structure that should be remedial. This allowed us to ensure that all students received the same preparation before moving to more complex content.

OUWB Online Enrichment Program



FIG 1. Program and daily objectives for the OUWB Online Enrichment Program. The overall objectives for the 2 programs were linked to each of the four daily objectives. Each of the 4 days also had themes, which related to the educational content as well as the listed learning objectives.

Due to the need for rapid program development and other demands on faculty time, the program was primarily asynchronous. Each day of the program began with a 1-h synchronous session where the daily schedule was introduced, difficult content was reviewed, and small and large group discussions were initiated. Providing recurring interactive sessions helped students address concerns and allowed faculty to identify gaps in understanding. The final day included a synchronous wrap-up session to review the students' overall experiences.

Students also participated in small group discussions with experts and peers to discuss course content and career advice. Prerecorded closed-caption videos introduced the asynchronous content for the day with accompanying written instructions. The asynchronous format allowed students to interact with the content best suited to their schedule, which was especially important in light of the pandemic, as many students experienced additional responsibilities at home related to financial and familial obligations (19, 20).

TABLE I
Tips for program success juxtaposed with student comments suggesting that these tips were employed

Program tips for success	Quotes from students that suggest that these tips were employed ^a
Setting expectations: syllabus and stated objectives	The course was also a lot less confusing and the work was more organized than regular classes.
Feedback: utilize in real-time, respond quickly to student issues/concerns, formative assessment	... the people would actually explain what work they were putting out during the virtual calls. Which led me to understand the concepts a little bit more.
Timing: asynchronous and synchronous sessions and short modules	I felt more independent in this program. Everything was incredibly flexible so I could complete things at any time of the day and still accomplish tasks at home. I feel more comfortable with taking online classes (due to COVID) when school resumes.
Timing: "white space" to allow students to explore, reflect, and recharge	I think this online program was mostly self-driven and the benefits of this is I get to learn how I can research about a specific topic by myself. Other online education programs have teachers who normally will teach the material in class and this doesn't really encourage or force someone to go out and learn this material.
Discussion: peer-to-peer small group and large group	I found that this program was much more engaging than online learning at my high school; I especially enjoyed discussing key questions with my peers in Breakout Rooms. My high school did not provide many opportunities for discussion when we were online, so I missed that interaction with other students.
Diverse teaching modalities	I liked how even the asynchronous learning was interactive; the varieties of learning styles (videos, articles, games, comics, simulations) were very helpful and I felt like I learned a lot (unlike my online learning last spring, which felt stagnant and slow paced).
Multidisciplinary and diverse faculty	Was really great to be exposed to so many different professionals in different careers.

^aQuotes from students were taken from the end-of-day and end-of-program evaluation forms.

Each day consisted of several modules. The materials were acquired mainly from publicly available literature, closed-caption videos, and interactive activities. Faculty-developed instructional videos and assessments were also included (Appendix 3). Each module ended with formative quiz questions that mapped to the daily objectives to assess student learning and track progress. Most quizzes were designed to provide learners with feedback regarding their answers (Appendix 4).

Importance of feedback in the program

Student feedback regarding the program was utilized extensively for continuous program improvement. For example, synchronous sessions were modified in real-time during the first morning session by creating break-out rooms for discussion upon student requests for more interactivity. At the beginning of each day, students were provided with the faculty contact for content-related questions; moreover, students were given an email and phone number to contact in case of access issues. We addressed students' technical problems and provided immediate feedback in a blog-like discussion space accessible on the home page. We learned that this constant and

accessible communication was instrumental to the success of the program.

Daily and overall program evaluations captured students' experiences, satisfaction, and perceptions regarding the quality of instruction and information included in each module. Narrative questions solicited student views on what was most valuable to their learning, suggestions for improving sessions for the program in the future, and students' acquired knowledge. Students could also ask for additional learning materials related to topics and were provided additional information within 24 h. Additional tips for program success are shown in Table I.

Safety issues

There are no safety issues, as this is an entirely online program.

CONCLUSION

Accommodating multidimensional abilities from different educational systems and various academic achievements (n = 69) was a program success. The content and learning

environment challenged students, as nearly half found that their effort exceeded their expectations. Still, it was not prohibitively difficult and did not deter participation, with 88% of students completing all required components and 93% reporting on the program evaluation that they attended each day ($n = 41$).

The daily content inspired students to learn more about microbiology; on average, 83% (standard deviation [SD] of 10.67) of students indicated being inspired or strongly inspired over the 4 days. Daily reflections also revealed that students rated the quality of content in the learning modules highly, with 81% (SD 1.7) rating them excellent or very good. Ninety-three percent of students reported on the program evaluation that they felt more confident about educating themselves about scientific topics because they participated in the program and that the program helped them develop learning strategies that they could apply in the future ($n = 41$). One unexpected problem identified early was that students given Chromebooks by their districts could not access the Google Classroom due to permissions installed by the schools. As a solution, we created a document with all of the content and instructions for these students.

While there are benefits to face-to-face learning, it is not always possible. This program demonstrated an effective way to expose students to microbiology online. Moreover, this program illustrates that programs can be created using publicly available resources.

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, PDF file, 0.01 MB.

SUPPLEMENTAL FILE 2, PDF file, 1.8 MB.

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