

SUMMER STEM CAMP GOES VIRTUAL: IMPLEMENTING A MODULE ON INFECTIOUS DISEASE

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ABSTRACT

Due to the global pandemic of COVID-19, camp and program directors raced to make decisions about 2020 summer programming. Traditionally, Girl STEM Institute Summer Camp is a day camp held on a local university campus for four to six weeks each summer. Despite the disruption caused by the pandemic, the program staff decided to move forward with a six-week virtual experience for 45 upper elementary, middle, and high school participants. This article presents a description of the implementation of an infectious disease module during a virtual STEM camp.

INTRODUCTION

Informal STEM settings (i.e., museums, summer camps, and homes) have been found to have a positive impact on learners' interests and persistence in STEM subjects and STEM careers (VanMeter-Adams et al., 2014); especially programs rooted in students' social and cultural context (Martin, 2012). In a study of STEM-

related out-of-school programs, researchers found that informal learning activities that promote collaboration, community building, and ownership have the potential to cultivate STEM literacy among students (Sahin & Adiguzel, 2014). This article describes a thematic module on infectious diseases that was implemented during the Girls STEM Institute Virtual Summer STEM Camp. The Girls STEM Institute (GSI) is a year-round informal learning program aiming to increase access to various STEM experiences grounded in cultural relevancy and real-world context to upper elementary through high school students. Specifically, one of the goals of GSI is to “engage girls and young women in culturally grounded, inquiry-based STEM curricula through hands-on and minds-on experiences” (Girls STEM Institute, 2017).

Due to the global pandemic of COVID-19, camp and program directors raced to make decisions about summer programming. In Indiana, several programs were canceled, some were offered in limited capacities, and others were implemented virtually. Traditionally, GSI Summer Camp is a day camp held on a local university campus for four to six weeks. Despite the disruption caused by the pandemic, the program staff decided to move forward with a seven-week virtual experience for 45 upper elementary, middle, and high school participants. While an online environment is not necessarily ideal, this year was the first time that the camp could host students from four different states. Additionally, researchers have cited many benefits of online programs for K-12 students, including higher levels of motivation and engagement, expanded access, high-quality learning opportunities, flexibility for students and instructors, and administrator efficiency (Avgerinou & Moros, 2020).

PREPARATION

The module on Infectious Disease was selected due to the relevancy of the topic to families around the world. The goals and activities were aligned to Science and Engineering Processing (SEP) standards and most activities were adapted to fit an online delivery. The Indiana SEPs standards and weekly topics for this summer experience module are presented in Table 1.

Table 1

Infectious Disease Module Indiana Science Standards Alignment

Week	Topic	Science & Engineering Process Standards
1	Introduction to Infectious Disease	SEPS.1 Posing questions (for science) and defining problems (for engineering)
2	Washing Away the Germs	SEPS.3 Constructing and performing investigations SEPS.4 Analyzing and interpreting data
3	COVID-19 Design Challenge	SEPS.1 Posing questions (for science) and defining problems (for engineering) SEPS.8 Obtaining, evaluating, and communicating information
4	Modeling the Spread of Disease	SEPS.2 Developing and using models and tools SEPS.4 Analyzing and interpreting data SEPS.5 Using mathematics and computational thinking
5	Graphing a Sneeze	SEPS.2 Developing and using models and tools SEPS.4 Analyzing and interpreting data SEPS.5 Using mathematics and computational thinking
6	Wrap Up and Share Out	SEPS.4 Analyzing and interpreting data

Note. Science and Engineering Processing Standards are accessible at:

<https://www.doe.in.gov/standards/science-computer-science#ScienceAcademic>.

To prepare for the implementation of the Infectious Disease module, several current event sources on COVID-19, the Center for Disease Control Health Conditions and Diseases Unit, National Science Teaching Association (NSTA) listservs, and online resources at Makers Empire[®] were consulted. We drafted a plan of implementation that required participants to complete activities asynchronously and synchronously during daily meetings. Prior to the camp, a list of all materials necessary for participation in the activities was created and shared with program staff. Then, the materials were assembled as kits for the participants and delivered to their homes. Parents/caregivers and participants were also provided with log-in credentials and videoconferencing links before the start of the camp. Further, the camp logistics were discussed in the required virtual orientation meetings with parents/caregivers and participants.

FACILITATING THE EXPERIENCE

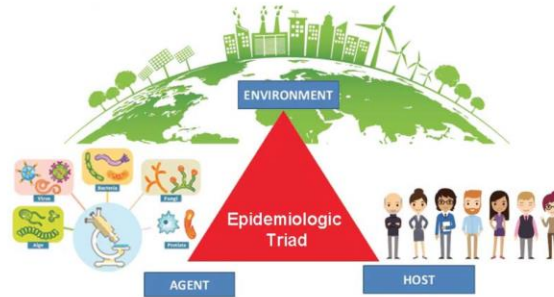
Facilitating the experience required clear and prompt communication. Video, phone, and learning management systems (LMS) were an integral part of managing the virtual experiences for camp participants. All participants and parents received an invitation to join the LMS. There, they found announcements, lesson topics, and links to camp materials. A page from one of the lessons is depicted in Figure 1. The camp met every morning from Tuesday through Friday. Meetings were held remotely via Zoom videoconferencing. Students were divided into two age groups and identified as junior scholars or senior scholars. Junior scholars represented students who were enrolled in third through sixth grade. Senior scholars were students in seventh through eleventh grade. The topics for both age groups were the same but modified slightly to adjust to the age differences. The module facilitator met with students approximately once per week in June and July. During the sessions, the facilitator introduced the participants to the week's objectives and led them through science activities on Nearpod and Zoom.

Figure 1

LMS Week 1 Topic Introduction

Welcome to GSI 2020 Infectious Disease Headquarters!

By the end of this summer, you will become expert epidemiologists--ready to conquer the world of infectious disease! Our first meeting will help you Understand Infectious Disease through the Epidemiologic Triangle.



What will you do?

- Describe what infectious diseases are and how they spread
- Explore your own family's experience with infectious diseases
- Describe the interaction and interdependence of agent, host, and the environment—the Epidemiologic Triangle
- Apply this concept to other diseases
- Describe how epidemiologists think about the causes and spread of an infectious disease

Note. The image included above is from Microbenotes: <https://microbenotes.com/epidemiologic-triad-agent-host-environment/>.

The 5E Instructional Model

Camp activities were selected and designed for their relevancy and alignment with the 5E Instructional Model (Bybee & Landes, 1990) and cognitive theories of learning. The 5E model consists of 5 phases of learning, including *engagement*, *exploration*, *explanation*, *elaboration*, and *evaluation* (Duran & Duran, 2004). Like Rodriguez et al. (2019), we approach this model in a non-linear fashion and apply select phases throughout the module. During the engage phase, participants' prior knowledge was obtained and shared. This typically occurred at the start of each session. The exploration phase provided student-driven opportunities to

observe, investigate, ask probing questions, and listen to others. Many of the lessons immediately followed up with brief teacher-directed integration of student observations and new knowledge. This phase is typically referred to as the explanation phase. Next, the elaboration phase challenged participants to apply the concepts discussed in our brief Zoom meetings to other real-world phenomena. The final phase of the 5E model is evaluation. While it is considered the final phase, the cycle allows us to interpret this as an ongoing process (Duran & Duran, 2004).

Retrieval Practice and Informal Assessments

According to the authors of *Powerful Teaching*, Patrice Bain and Dr. Pooja Agarwal (2019), retrieval practice is a learning strategy that allows students to pull out information that they know to boost learning in that area. The authors have highlighted several retrieval practice tools that can be used to implement retrieval practice in various settings and content areas, such as: using clickers, index cards, personal dry erase boards, and exit tickets. While most of these tools may be utilized in traditional, face to face settings, these tools and retrieval practice strategies can also be extended to informal settings. To modify retrieval practice techniques during GSI Summer STEM Camp, the module facilitator planned retrieval practice items for students to respond during each module. Retrieval practice exercises during camp activities served to provide the facilitator with feedback on how the activities prepared participants to meet the objectives of the module. Participants did not earn grades for participating or answering correctly on the items. Most retrieval practice items were implemented as Nearpod exercises, such as short answer quizzes, Time to Climb competitions, and Matching. Participants also responded to assessments in Google Docs and Google Forms.

Week 1 Activity: Introduction to Infectious Disease

During Week 1, the facilitator provided an introduction to infectious disease. The goal for this activity was to have participants describe the interaction and interdependence of the three sides of an Epidemiologic triangle—the host, the agent, and the environment—in order to gain an understanding of the role of

epidemiologists in society. Before explaining the concepts, participants shared what they knew about infectious disease and epidemiology. Students were interested in this topic due to its relevancy to the current COVID-19 pandemic. They were also aware of various agents of disease, such as the flu and the common cold. The first week's activities also provided an opportunity for the facilitator to "meet" the participants as they introduced themselves through pictures and descriptions on a Nearpod collaborate board. After introductions were shared and prior knowledge was assessed, the facilitator described the agents as bacteria, viruses, fungi, or protists thriving in optimal environments that enter and live within a host. Hosts can be humans or other animals. Smallpox was discussed in the application of these concepts. Participants were later able to extend the Epidemiologic triangle to the prevalence and occurrence of chickenpox in today's children compared to their parents. The session ended with a retrieval practice activity consisting of four selected-response questions aligned to the week's goals.

Week 2 Activity: Washing Away the Germs

The second week of virtual camp started with an engagement activity focused on eliciting participants' prior knowledge of the Epidemiologic triangle and the various agents of disease that were discussed during the previous week. The focus of the second week was to describe how environments could be altered to reduce the impact of the agent, highlighting the need for preventative care and actions. Hand-washing was identified as one of the ways that we could stop the spread of disease. To explore the concept of appropriate hand-washing, participants conducted a hand-washing investigation. With Glo-germ (an odorless lotion that glows when exposed to ultraviolet light) and small ultraviolet flashlights, participants were able to compare their typical hand-washing routine to the CDC 20-second rule for handwashing. The activity was followed by a brief discussion of the observations and ideas for extending the project at home. Some of the participants suggested trying this with their siblings and parents, further engaging the whole family in the learning experience. This week's retrieval practice also included an activity aligned to the major understandings of the week.

Week 3 Activity: COVID-19 Design Challenge

During the third week of the virtual STEM camp, participants were challenged to work in groups in order to design a solution to a challenge of their choice. To begin, participants were asked to describe what they knew about COVID-19. Next, they watched a video clip about community spread in common places. These activities provided engagement for the upcoming activity. The participants were sent to breakout rooms in groups of three or four to work together. We found that collaboration can be challenging with younger students in virtual settings. Several participants had issues with technology, and with only one host, it was difficult to troubleshoot these issues while visiting other breakout rooms.

Nonetheless, participants were provided a choice for challenges. These problems were adapted from Makers Empire. For example, two groups chose “Design a way for food to be delivered into your house in a way that the driver can stay in the truck.” They discussed several solutions to this problem in their groups and decided to focus on one. They used the Nearpod Draw-It tool to mock up a prototype of their solution. The prototype drawings were shared and discussed. The participants also provided feedback to the presenters. To extend this activity, participants could use Makers Empire to design a 3D image of the prototype.

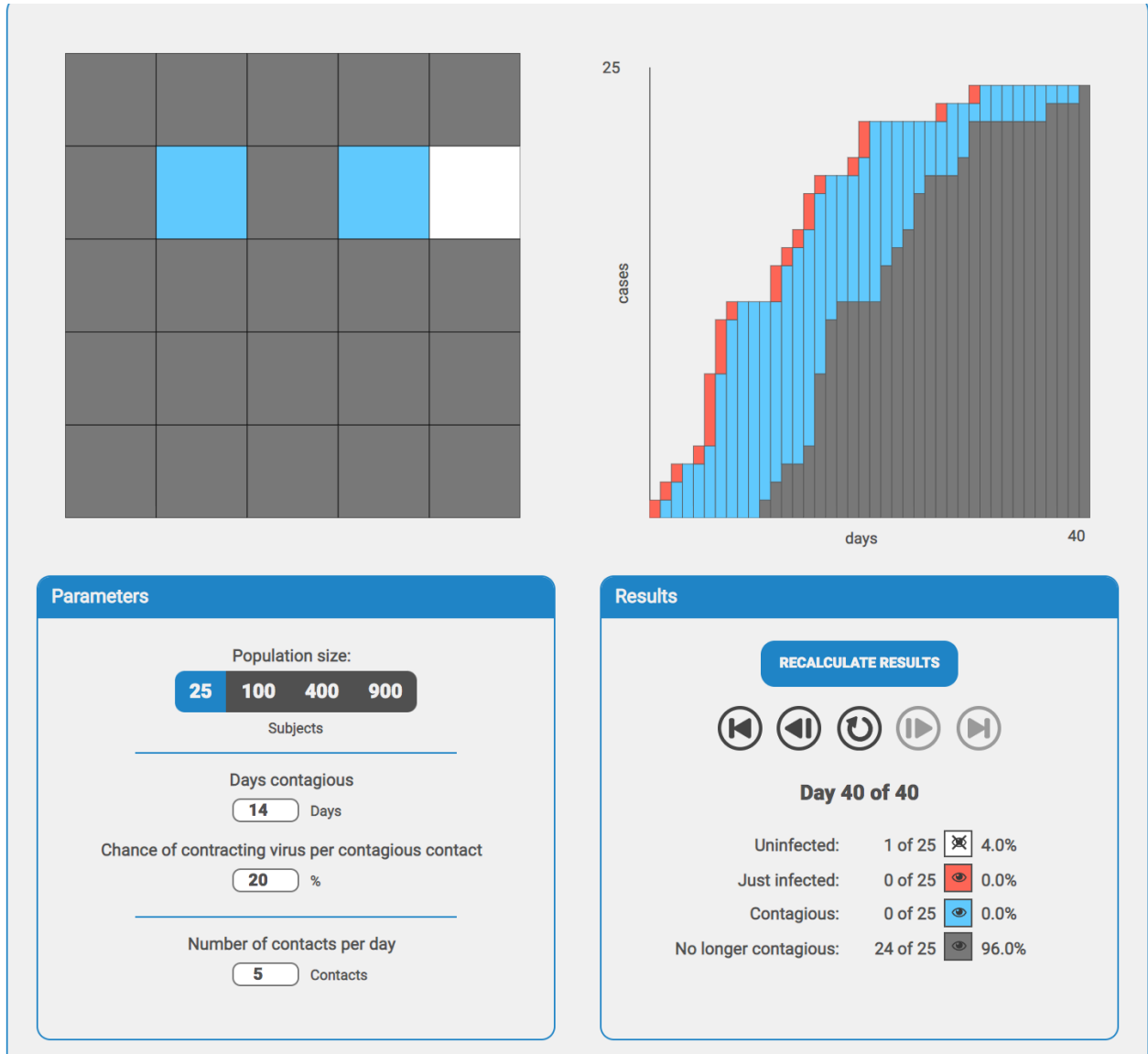
Week 4 Activity: Modeling the Spread of Disease

To model the spread of disease required access to the NCTM Illuminations Simulation “Pandemics: How are Viruses Spread?”. The session started with a brief retrieval practice from weeks prior. Participants were then asked to describe which parameters may impact how quickly a virus could spread. Several ideas were shared, including, how close they are to someone if they are in large groups and how careful they are when putting their hands on their face. The simulation considered the parameters of population size, the number of affected people in a population, the number of contacts per person, and how long each person would be contagious. To model the simulation, the facilitator selected the initial parameters with student input. The chosen parameters and output can be found in Figure 2. Using this simulation, participants were invited to

try out their parameters and describe their findings. This activity integrates mathematical and scientific concepts to understand current societal problems.

Figure 2

Modeling the Pandemic Simulator



Week 5 Activity: Graphing a Sneeze

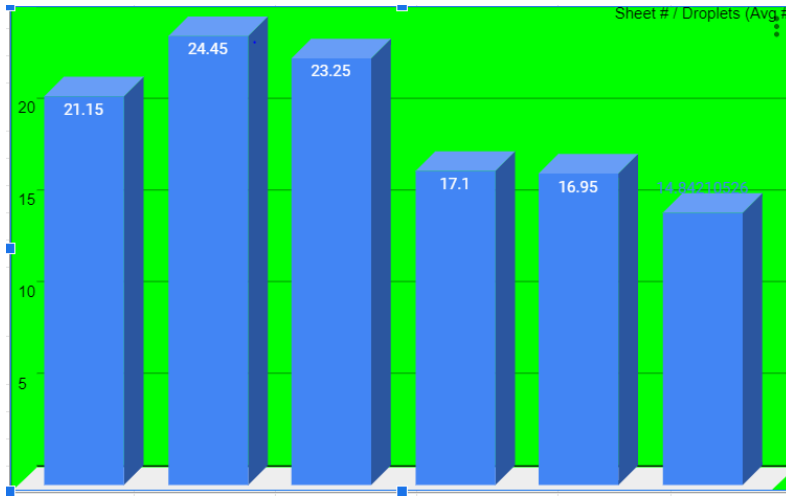
In this lesson, participants were asked to recall preventative solutions to limiting the spread of disease. This led to the next integrated investigation of graphing a sneeze. This activity was adapted from Science Friday's activity "Snotty Plots: How do you graph a sneeze?" Since this summer's implementation, the webpage has been updated to include remote and at-home versions of the investigation. To implement, the facilitator recorded the set-up before the session. This was necessary because of the limited time together. The activity required minimal materials including tempera paint, six sheets of paper, tape, a stool or garbage can, and a plastic transfer pipette. Participants used green and yellow tempera paint to model a sneeze contained in a plastic transfer pipette. After releasing the sneeze from the pipette, they counted the number of sneeze droplets on each of the six sheets of paper and recorded them on each of the sheets. They were reminded to take pictures of their sheets in order to share their results in the following week.

Week 6 Activity: Wrap Up and Share Out

During the final week, participants wrapped up all of their projects, completed interest surveys, and shared takeaways from their experiences. In the prior week, participants worked on modeling the path of a sneeze. During the final week, they shared their results with a Google Form submission, and we created a class graph (Figure 3). Participant analyzed their data and found that most drops occurred around sheets two and three. They also found that there were still a considerable number of drops on the sixth sheet, which represented about 55 inches away from the direct source. The last week of our meetings was also a great day to conclude with the final retrieval practice. Participants were asked to share their takeaways from the experiments and answered quick, engaging selected-response items aligned to previous content.

Figure 3

Graphing a Sneeze Cohort Data



Note: Each column represents one sheet of paper. The first column is sheet 1 and the last column is sheet 6.

All six sheets were taped together, end to end.

LESSONS LEARNED

We learned much from the first implementation of the virtual GSI STEM camp experience. When shifting from an on-campus to virtual model of engagement, it is important to keep the following in mind:

- *Provide an orientation for caregivers and participants prior to the first day of camp.* This will allow participants to ask questions and meet the staff and facilitators beforehand.
- *Use a reliable and consistent method of communication for caregivers and participants.* It is important to make participating in virtual events as easy as possible for caregivers and participants. We utilized the same Zoom link each day (with few exceptions) to limit confusion. We also utilized an LMS that provided access to camp documents and descriptions of upcoming activities.

- *Make the content engaging and authentic.* We found that participants were really interested in learning more about disease and the scientific phenomenon of disease because of its relevancy to the pandemic with which they were experiencing.
- *Follow NSTA recommendations for science safety.* Prior to planning curriculum and preparing kits with science equipment, we consulted the NSTA's Safety Blog (<https://www.nsta.org/blog/welcome-nsta-safety-blog>) to ensure that staff, facilitators, and participants were knowledgeable of the safety requirements of the activities planned.

CONCLUSION

From this experience, we believe that virtual learning experiences have the potential to meet the needs of science students at home. While the virtual experience was not the initially planned experience for GSI participants, it provided opportunities for more primary and secondary students to become engaged in STEM content from the comfort of their bedrooms, kitchens, and cars. More specifically, this platform allowed us to meet program and curricula goals, as well as extend participants' knowledge through multiple rounds of *engagement, exploration, explanation, elaboration, and retrieval practice (informal evaluation)*. With careful preparation, planning, and appropriate access to technological tools, informal and formal science educators should continue to find ways to conduct investigations, projects, and collaborative challenges with students that foster inquiry into the real-world phenomenon. Perhaps, science thinking at home will lead students to find potential solutions to problems experienced at home and in their communities.

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