Navigating Challenges of Virtual Science Instruction During and Beyond COVID-19

Blake Touchet, University of Louisiana at Lafayette
Lauren Leonpacher, Lafayette Parish School System
Heidi Hitter, Lafayette Parish School System

Abstract

This paper provides mentor teacher experiences involved with the planning, preparation, implementation, and reflection of a virtual mathematics and science summer camp in the summer of 2020. In the wake of the COVID-19 pandemic, the annual the summer camp was forced to pivot to a completely online format. Primary concerns discussed by mentor teachers included accessibility, Zoom meeting etiquette, selecting activities that used only household items, and student safety during the activities. Through weeks of collaborative planning, activity and lesson preparation, technology troubleshooting, and practice run-throughs, the team was able to implement a successfully engaging camp for sixty students. Informal feedback from participants revealed the efficiency of particular strategies, technologies, and activities that were implemented during the week. Setting clear norms and expectations for students during the sessions in general and clear objectives for each activity specifically were found to be essential. Strategic use of the breakout room function in Zoom to facilitate small group discussion and the private chat function to maintain communication with students who were not able to use audio/video technology was effective. Finally, the team found that it was necessary to emphasize flexibility in all aspects of the camp. This information can be used to refine practices for similar virtual science camps and may be able to inform practices in science classrooms in which K-12 learning remotely becomes necessary.

Keywords: COVID-19; Science Camp; Science Education; Remote Instruction

Introduction

This manuscript provides a narrative account from the Advancing Mathematics and Science Excellence (AMSE) summer camp mentor teachers as they planned, implemented, and reflected upon their experiences during the 2020 COVID-19 pandemic (Saharuddin, Hussein, Abdullah, & Yasin, 2020). It is hoped that sharing these experiences, successes, and struggles

will serve as a practical model for educators in similar situations attempting to make the transition to remote instruction.

The AMSE summer camp is an annual week-long hands-on, engaging experience for rising 6th through 8th grade students in the Acadiana region of south Louisiana that takes place the first week of June. The camp serves two major purposes. The first is to provide a supportive experience for middle school students interested in STEM, and the second is to serve as the major internship experience for STEM majors participating in the Strengthening Teacher Education with Math and Science Scholars ($STEMS^2$) project funded by the National Science Foundation (DUE # 1439900). $STEMS^2$ interns are undergraduate students majoring in a STEM field who have also shown interest in secondary education and may pursue certification. The summer camp gives $STEMS^2$ interns an opportunity to practice planning, preparing, and delivering engaging science lessons and activities to groups of students before potentially pursuing teacher certification ($STEMS^2$ Mini-Internship). However, with the closing of Louisiana public schools on March 13, 2020 due to the COVID-19 pandemic, the staff responsible for planning the overall logistics of the camp were faced with a number of unique unknown variables and difficult decisions.

Challenges and Opportunities

By April, it was clear that a traditional face-to-face camp would not be feasible. Although apprehensive, the staff agreed that trying to create a virtual camp would be a better alternative to canceling or rescheduling the camp. Brainstorming began on how to convert this experience into a format that could educate a group of middle school students from their own homes without sacrificing engagement or educational quality. Logistical challenges initially discussed by camp mentor teachers and project directors included device and internet accessibility, Zoom meeting etiquette, student access to supplies for activities, and student safety during the activities. From a pedagogical standpoint, mentor teachers were also concerned about the challenges of maintaining student attendance and engagement, forming meaningful interpersonal connections with each student, and providing emotional support for the students who, at the time that the camp was given, had been under stay-at-home orders for nearly two months (Liu, Bao, Huang, Shi, & Lu, 2020).

The transition to a fully online format also presented opportunities for everyone involved. Mentor teachers were tasked with leading a team of undergraduate $STEMS^2$ interns, researching

and implementing new educational technologies, planning innovative lessons, and carrying out a "proof of concept" event demonstrating that this type of hands-on virtual camp was possible (Woods, Pettit, & Pace, 2020). STEMS^2 interns were provided with the opportunity to assist in every step of the planning, preparation, and implementation of the camp, to interact directly with students in a teaching capacity, and to reflect upon their own practice and that of the mentors that they observed during the camp (Smyth, 1989).

Planning and Preparation

As with most other aspects of education, AMSE mentor teachers felt that the planning stage was the most critical aspect contributing to the success of the camp (Sahin-Taskin, 2017). The first planning meeting was a brainstorming session in which the staff discussed potential sub-themes that could connect back to the camp's overarching theme for the purpose of cohesiveness (Munakata, & Vaidya, 2015). One consideration was that the activities of each team should inform and enhance one another without overlapping to a repetitive extent. Another consideration was to ensure that each daily lesson within those sub-themes only involved activities that would be feasible and safe for students to individually complete from home with limited supplies. The final consideration was choosing activities that would be phenomenon-driven and address the Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices for the middle school grade band of the Louisiana Student Standards for Science (Penuel, Turner, Jacobs, Van Horne, & Sumner, 2019).

Cohesive Lessons

The first component mentor teachers considered was cohesiveness (Munakata, & Vaidya, 2015). Every year the AMSE camp has a theme which focuses and connects all of the activities through some central thread. This provides the campers with motivation and advises the selection of activities for mentor teachers and STEMS^2 interns to prepare. For instance, the 2019 theme was "Game on!" and most camp activities (including break-out rooms, games, and competitions) centered around that theme. Before the decision to move the camp to a fully remote format, the theme for 2020 was "Out of this World!" For this reason, mentor teachers thought it was important to retain this theme and to plan experiences that related to the idea of space exploration.

By the end of the first planning meeting, the mentor teachers had decided upon the sub-themes of "Alien Ecology and Evolution," "Designing and Building Vehicles for Exploration,"

"Landing the Mars Rover," and "H_2OMG!" The "Alien Ecology and Evolution" sub-theme would focus on the characteristics of life, adaptation, evolution by natural selection, and structure and function. "Designing and Building Vehicles for Exploration" involved the students doing exactly that: designing, building, testing, and redesigning vehicles including a car and a boat. The "Landing the Mars Rover" sub-theme was a combination of chemistry and engineering in which the students would investigate chemical reactions and then design an air-bag type landing apparatus. Finally, the "H_2OMG!" theme would focus on the properties of water, such as polarity, adhesion and cohesion, density, solubility, refraction, and their importance from the perspectives of physics, chemistry, and biology.

Once mentor teachers had decided upon general sub-themes for their teams, they then arranged to meet individually with their STEMS^2 interns to plan out the specific details of each daily lesson and come up with a materials list for each activity. Because this program was specifically designed to develop the teaching potential of the undergraduate STEMS^2 interns, mentor teachers made it a point to involve them as much as possible in this stage of the project (Sahin-Taskin, 2017). Mentor teachers presented the overall sub-theme for their teams and gave an overview or outline of their vision for the week and then allowed the scholars to select and plan out the details of one of the five daily lessons to lead on their own.

Subsequently, STEMS^2 interns presented their potential activities to the rest of the team. Teams then worked together to organize activities in a sequence that would allow AMSE camp participants to progressively build their knowledge leading up to a culminating design activity. Each STEMS^2 intern volunteered to lead one of the day's activities. Mentor teachers then tasked the interns with researching, clarifying, and practicing their activities further.

Practicing Performance

Additional team planning meetings were used as practice runs for STEMS^2 interns since the AMSE camp would be the first time many STEMS^2 interns had actually led a lesson with a group of middle school students. Drawing on their myriad of experiences teaching, mentor teachers decided it would be best to have each STEMS^2 intern present activities to their team before the week of the camp in order to work through issues with pacing, materials, techniques, and general nervousness (Chabalengula, Mumba, & Mbewe, 2012). Mentors and interns unanimously expressed that these practice runs were invaluable experiences that allowed STEMS^2 interns to confidently plan all of the details that could have been overlooked otherwise,

carry out their activities during the camp, and prepare for alternatives in the event that something were to not go as planned.

During these practice runs, teams were able to discuss when and how they would deliver content, when students would collect and prepare their materials, when students would be put into breakout rooms for small group discussions, when they would come back to whole group for sharing and demonstrations, and how time would be managed for each session. Another issue discussed related to materials needed for camp participants to carry out the activities. Not only did the teams purposefully choose items that all children were likely to have around the house, they also provided a list of alternatives that could be substituted in the event an item could not be found. It was important to the mentor teachers and project directors that the lack of a specific item or ingredient not inhibit a child from participating in the day's activities. The teams were also able to discuss and solve issues that do not typically arise in face-to-face teaching such as how to position cameras so that students can see a demonstration or how to talk students through an activity step-by-step without physically being in the room with them.

Implementation

In scheduling camp sessions, project directors divided the initial 138 registered campers by grade level. Project directors planned to have 8 sections of campers with 15 to 20 students per section. To make for an even rotation through the sessions and to provide a consistent educational experience through the camp, each camper would participate in 4 sessions per day alternating between math and science. The sessions were each 50 minutes with 10 minutes between sessions which allowed students to transition between Zoom meeting rooms and provided time for the staff to clean up, prepare, and reset the demonstrations and activities for the next group of campers. A two-hour break for lunch was scheduled for campers each day between the two morning sessions and the two afternoon sessions. In addition, a daily debriefing session was scheduled so that project directors, mentor teachers, and STEMS^2 interns could update one another about progress made, collaborate on solving logistical or technology problems, and share innovations or revelations that other teams may find helpful in facilitating their own sessions. This process of constant reflection and collaboration was another practice that turned out to be invaluable to staff members during the camp (Smyth, 1989).

The week before camp began, each mentor teacher emailed parents of each registered camper assigned to their "homeroom" section which was the first AMSE camp session of the

day. This email contained a spreadsheet with pre-scheduled Zoom meeting links for each session and time period as well as a spreadsheet with materials needed for each session organized by day. This information was sent to campers and their parents well in advance of the AMSE camp start date in order to 1) provide them with enough time to collect and organize required materials for each activity, 2) test out the Zoom links, and 3) ask questions if they were unfamiliar with the technology being used.

Attendance

Although initially there were a small number of withdrawals from the camp registry, there was little indication that the camp would be much different than expected. However, during the first session of the first day of camp, it quickly became clear that less than half of the registered campers had logged into the Zoom meeting rooms to participate. Instead of the expected 15-20 campers per session, most teams recorded between 6 and 8 campers and some sections had even fewer. While the mentor teachers and interns leading the sessions for that day began interacting with the campers, introducing everyone, and outlining the activities for the camp, the other mentor teachers began reaching out through phone and email to parents of absent campers. However, despite this outreach during the first session and another attempt to reach the parents after the first day's sessions were finished, there were very few responses. A small number of parents confirmed that they had indeed decided not to attend and an even smaller number confirmed that they had forgotten about the camp.

Building Relationships

Despite the unexpectedly low attendance numbers, campers that did attend were actively engaged with camp lessons and activities. One strategy that helped to create engagement early on was an ice-breaker activity. For instance, during the general introductions, one team included questions that allowed staffers and campers to get to learn about one another's activities and interests right away. These ice-breakers and introductions took about 15 minutes, but helped the students to establish relationships with one another and with the staff, whom they were meeting for the first time. They also helped to set the tone that the mentor teachers wanted for the camp which was light, fun, and open to curiosity and discussion. Mentor teachers wanted to show the campers immediately that, even though this was a math and science camp being conducted virtually, that did not mean that the experience had to be dry, cold, disconnected, or boring. This was one routine mentor teachers continued daily. Even though the ice-breakers after the first day

were shorter, taking about 5 minutes every day, the sessions always started with greetings and fun questions in order to get all students engaged in the conversation and comfortable expressing themselves through this new video conferencing format.

Video Conferencing Etiquette

Another practice that aided in student engagement was the establishment of Zoom etiquette norms and standards that were agreed upon by the campers and staffers. Mentor teachers found that easy actions such as having everyone's microphone muted when in whole group were necessary for everyone to be able to hear the speaker. When students wanted to ask a question or add something to the discussion, they would simply unmute their microphone and then mute it again once they were finished with the conversation. This prevented students from talking over one another or interrupting the class with background noise. When in smaller breakout rooms, however, all microphones were kept unmuted so that there could be free and open discussion. Mentor teachers found that these simple guidelines were effective, and if there was a rare issue with a student being a little rambunctious and causing a disturbance, it was easy for the mentor teacher to use their Zoom host privilege to simply mute that student's microphone remotely and have a discussion with the student about their behavior using the private chat feature. This kept the student from feeling embarrassed or singled out and was a very easy way to manage disruptions.

Cameras were also found to be a somewhat tricky issue at first. There are valid concerns for both having student cameras on and for having them off. For instance, if the student cameras were off, it made engagement and formative assessment very difficult. If students are working on a project, teachers need the ability to monitor progress for the purposes of both student safety and comprehension. Facial cues, head nods, and thumbs up are impossible if the students' cameras are off, and it is also impossible to tell if a student is engaged with the lesson, bored, asleep, on their cell phones, or completely out of the room if student cameras are off. On the other hand, having the cameras on all the time made some of the camp participants uncomfortable. Some students were shy and did not want the feeling of other students staring at them. Some students did not have a clean and private work space and did not want the other students seeing inside of their rooms or homes. Some students were not alone in their work space and did not want younger siblings distracting the other camp participants. Also, sometimes

technology issues made all of this a moot point because a student's device did not have a functioning camera.

Ultimately, mentor teachers felt the best course of action was to prioritize open and honest communication. Mentor teachers asked that, if possible, all students have their cameras on for the first few minutes during the introduction, when speaking or asking a question verbally, or at the request of any staff member for assessment purposes. At other times, students could turn their cameras off if it made them more comfortable with the caveat that they maintain active engagement and participation using the Zoom chat feature. This meant that if a student's camera was off, they needed to respond to questions, share discussions, and update staff on their progress *frequently* in the group chat. If students were not adept at doing this, it was helpful to assign one team member not leading the lesson to maintain constant communication with that student using the private chat. This ensured that students were maintaining active engagement in the lessons even in the event that their cameras were off and their microphones were muted.

Explicit Instructions and Guidance

Comparing the format of this camp with a more traditional classroom perspective, mentor teachers found it helpful to overemphasize most procedures that are often taken for granted in a classroom setting. For instance, mentor teachers knew from experience that it is necessary to have clear, visibly stated objectives and to repeat instructions and steps multiple times. This became even more of a necessity in a virtual setting. Staff found that posting learning objectives, instructions, and steps of the activities multiple times and in multiple formats to be a best practice. For example, when giving instructions for how to perform a particular activity, the staff found it necessary to verbally give the instructions to the whole group and post the step-by-step instructions in the group chat and then have the scholars verbally repeat and visibly share the instructions again once the students they were with in smaller groups entered the breakout rooms. This made for smoother transitions, minimized confusion, and helped with time management.

Materials

Another unexpected revelation during the week of camp was due to the flexible nature of the materials that the students gathered. Because the students were using items and ingredients that they recycled or repurposed from their respective homes, this made each students' experience unique which actually allowed for deeper and more productive discussions when the

students were performing their activities and sharing results with their groups. For instance, one of the "H_2OMG!" activities involved the students using various household liquids to create a density column. The staff members began by demonstrating how to determine whether one liquid was denser than another without using a scale or balance since the students did not have this equipment available. After performing the demonstrations, the staff members discussed the results with the students and then allowed them to figure out the order in which the layers should be added so that they would not mix when making the density column. The students were then tasked with creating their own density columns using 5 different liquids. The staff member leading the activity suggested the students use water, rubbing alcohol, milk, vegetable oil, and dish soap. However, some students did not have some of these at hand, so they substituted them with what they had available. Some students substituted olive oil for vegetable oil, laundry detergent for dish soap, or hydrogen peroxide in place of alcohol.

The beauty of allowing students to be flexible was the conversations that these replacements sparked with their peers when comparing their results with one another and asking questions about the discrepancies they noticed. The fact that they were able to predict what would happen with different liquids and struggle through explaining the differences when comparing their projects actually deepened their understanding of the concepts of density and polarity that were learning through this activity.

Lessons Learned

At the time of writing, many schools around the United States are in the process of planning to teach while the pandemic is still ongoing. With COVID-19 infection and death rates still increasing, many state and local school plans, including the Strong Start plan from the Louisiana Department of Education, involve either a full remote learning scenario or a hybrid learning model (Louisiana Department of Education, 2020). This Advancing Mathematics and Science Excellence summer camp experience may be able to offer some insight for districts, schools, and teachers looking for ways to plan for and implement remote learning experiences for their students.

Addressing the Attendance Dilemma

While the biggest challenge that remained unsolved by the staff was attendance, there are multiple variables that could have contributed to such low attendance numbers including the camp being voluntary, campers ranging in geographic location from Slidell, LA to Dallas, TX,

and some of the campers registering before learning that it would be conducted remotely. While these variables made it difficult to ensure regular attendance, schools can use this as a preview of what may become a norm and a warning to be proactive about the issue (Verma, Campbell, Melville, & Park, 2020). Setting up multiple lines of communication, such as phone, email, social media, and online learning management systems, with families and putting a plan in place that encourages frequent contact will allow schools to prevent many of these attendance issues before they become a problem. These steps should also provide support for families that may have solvable problems that are contributing to their lack of attendance and/or participation such as lack of devices or access to internet services (Hartshorne, Baumgartner, Kaplan-Rakowski, Mouza, & Ferdig, 2020).

One significant limitation that must be noted about attendance is that the average number of students per section in formal classroom settings is significantly higher than the 6-8 students per section average at the camp (Mokuolum, & Fatoba, 2020). However, there are strategies that can mitigate complications that come with larger class sizes in a remote learning scenario that cannot be taken advantage of in a traditional face-to-face setting. These strategies include intentional use of breakout room features with a larger group or breaking one class into multiple smaller sections. This would require working with each group for shorter periods of time, but would allow more personalized intervention with each group of students. For instance, a class of 30 students could be divided into 3 groups of 10 students. Although each group would spend a third of the class time interacting with the teacher, this time would provide for more engaging and meaningful instruction. This strategy would be useful for lessons that require closer guidance as opposed to a general lecture which could be done with the whole group.

Preparation and Collaboration

Preparation and planning are absolutely invaluable to the instructional process, but even more so when using new or unfamiliar technologies and techniques (Keefe, 2020). One of the mentor teachers went so far as to attend over 40 hours of virtual professional development in the month leading up to the camp in order to learn how to use the features online learning technologies. While that is not practical for most educators, a thorough and consistent professional development series within a professional learning community will be of tremendous assistance to educators teaching remotely for the first time. Also, as noted by the staff in the camp, performing practice runs of the activities using the technologies and having an opportunity

to critique and adjust them before putting them into practice can be a major contributor to success.

Collaboration with other educators implementing the same remote learning tools can also contribute to the quality and efficiency of instruction as well as to the mental and emotional health of all educators involved (Keefe, 2020). This situation is challenging for everyone, and no teacher should be attempting to perform in isolation. Forming professional learning communities with other teachers in the same grade band or other teachers of the same content area in order to share the educational responsibility is a best practice and will be essential moving forward (Keefe, 2020; Woods, Pettit, & Pace, 2020).

Authentic Connections in Virtual Learning

Finally, this experience has reinforced the importance of forming and maintaining meaningful personal connections with each student. Just like planning and collaboration, research has shown that this to be important in traditional educational situations, but it will prove to be even more essential for remote education (Woods, Pettit, & Pace, 2020). Inquiry is driven by student interest, so in the classroom, if students are not active and willing participants, they may not learn as efficiently; however, students are willing to participate in lessons they are not interested in if they have cultivated a strong relationship with the teacher (Scales, Pekel, Sethi, Chamberlain, & Van Boekel, 2020). Although this may not seem easy or plausible with the use of a virtual platform, the experiences discussed in this narrative demonstrate that it is indeed possible to form these relationships with effort on the part of both teachers and students.

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Author Biographies

Blake Touchet is a doctoral student at the University of Louisiana at Lafayette. Mr. Touchet teaches biology dual enrollment courses for the Vermilion Parish School System.

Lauren Leonpacher is a middle school science teacher at David Thibodeaux STEM Academy in Lafayette, LA.

Heidi Hitter is a science teacher at Broussard Middle School in Broussard, LA.

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